ICIAM 2015

8th International Congress on
Industrial and Applied Mathematics

PROGRAM
&
ABSTRACTS

Beijing, China

August 10 - 14, 2015

How to Use the Schedule Book

The information of each talk is encoded as an 8-bit string, **AB-Cd-EF-xy**, meaning that the talk of **TYPE**AB will be given on **Date**Cd during the **TIMESPANS**EF at **ROOM**xy. The symbols are explained as follows.

Code: Type-Date-Time-Room No.

Type	IL=Invited Lectures, SL=Special Lectures, MS=Minisymposia, IM=Industrial Minisymposia, CP=Contributed Papers, PP=Poster Papers
Date:	Mo=Monday, Tu=Tuesday, We=Wednesday, Th=Thursday, Fr=Friday
Timespan:	A=8:30-9:30, B=10:00-11:00, C=11:10-12:10, BC=10:00-12:10, D=13:30-15:30, E=16:00-18:00, F=19:00-20:00, G=12:10-13:30, H=15:30-16:00
Room No.	See the table below

Code No.	Room #	Code No.	Room #	Code No.	Room #	Code No.	Room #	Code No.	Room #	Code No.	Room #
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2	309A	13	VIP3-2	24	211	35	408	46	306B	57	402A
3	306A	14	111	25	210A	36	409	47	108	58	401
4	308	15	213B	26	110	37	301B	48	212B	59	402B
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9	203A	20	210B	31	405	42	301A	53	311B	64	104
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Examples:

MS-Tu-BC-13: Minisymposium, Tuesday 10:00-12:00, Room VIP3-2.

CP-Th-E-55: Contributed Papers, Thursday 16:00-18:00, Room 106.

ICIAM 2015 Classification Codes

A01 Linear Algebra
A02 Real and Complex Analysis
A03 Ordinary Differential Equations
A04 Partial Differential Equations
A05 Discrete Mathematics
A06 Numerical Analysis
A07 Computational Science
A08 Computer Science
A09 Probability and Statistics
A10 Control and Systems Theory
A11 Optimization and Operations Research
A12 Information, Communication, Signals
A13 Applied, Algebraic, and Computational Geometry
A14 Imaging Science
A15 Fluids
A16 Physics and Statistical Mechanics
A17 Geophysical, Atmospheric & Oceanographic Science
A18 Chemistry, Chemical Engineering
A19 Life Science and Medicine
A20 Social Science
A21 Finance and Management Science
A22 Education in the Mathematical and Computational Science
A23 Simulation and Modeling
A24 Materials Science and Solid Mechanics
A25 Applications of the Mathematical and Computational Sciences in Industry
A26 Dynamical Systems and Nonlinear Analysis
A27 Other Mathematical Topics and their Applications
A28 General

Schedule at a Glance

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August 14</th></tr>
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(3 in parallel)</td><td>Invited Lectures
(3 in parallel)</td><td>Public Lecture
(Ballroom A at Level 1)</td><td>Invited Lectures
(3 in parallel)</td></tr>
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<tr><td>10:00-11:00</td><td rowspan="7">Registration
(10:00-20:00)</td><td>Invited Lectures
(3 in parallel)</td><td>Invited Lectures
(3 in parallel)</td><td rowspan="2">Minisymposia
(66 in parallel)</td><td>Invited Lectures
(3 in parallel)</td></tr>
<tr><td>11:10-12:10</td><td>Invited Lectures
(3 in parallel)</td><td>Invited Lectures
(3 in parallel)</td><td>Invited Lectures
(3 in parallel)</td></tr>
<tr><td>12:10-13:30</td><td colspan="5">Lunch Break
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(66 in parallel)</td><td>Minisymposia
(66 in parallel)</td><td>Minisymposia
(66 in parallel)</td><td>Minisymposia
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(66 in parallel)</td></tr>
<tr><td>15:30-16:00</td><td colspan="5">Coffee Break & Poster Session</td></tr>
<tr><td>16:00-18:00</td><td>Minisymposia
(66 in parallel)</td><td>Minisymposia
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(66 in parallel)</td><td>Minisymposia
(66 in parallel)</td></tr>
<tr><td>18:00-19:00</td><td rowspan="2">Reception
(18:00-20:00
North Lobby at Level 4)</td><td colspan="4">Dinner Break</td><td rowspan="2">ClosingCeremony
(18:10-18:40,
Ballroom C at Level 1)</td></tr>
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(Ballroom C at Level 1)</td><td>Peter Henrici Prize Lecture
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ICIAM 2015 Schedules

Monday, August 10, 2015

EM-Mo-D-01 13:30–15:30 311A
Third Workshop on Hybrid Methodologies for Symbolic-Numeric Computation - Part I of VIII

For Part 2, see EM-Mo-E-01
For Part 3, see EM-Tu-D-01
For Part 4, see EM-Tu-E-01
For Part 5, see EM-We-D-01
For Part 6, see EM-We-E-01
For Part 7, see EM-Th-BC-01
For Part 8, see EM-Th-D-01

Organizer: Giesbrecht, Mark — Univ. of Waterloo
Organizer: Kaltofen, Erich — North Carolina State Univ.
Organizer: Safey El Din, Mohab — Univ. Pierre & Marie Curie
Organizer: Zhi, Lihong — Acad. of Mathematics & Sys. Sci.

Abstract: Hybrid symbolic-numeric computation methods, which first appeared some twenty years ago, have gained considerable prominence. Algorithms have been developed that improve numeric robustness (e.g., in quadrature or solving ODE systems) using symbolic techniques prior to, or during, a numerical solution. Likewise, traditionally symbolic algorithms have seen speed improvements from adaptation of numeric methods (e.g., lattice reduction methods). There is also an emerging approach of characterizing, locating, and solving "interesting nearby problems", wherein one seeks an important event (for example a nontrivial factorization or other useful singularities), that in some measure is close to a given problem (one that might have only imprecisely specified data). Many novel techniques have been developed in these complementary areas, but there is a general belief that a deeper understanding and wider approach will foster future progress. The problems we are interested are driven by applications in computational physics (quadrature of singular integrals), dynamics (symplectic integrators), robotics (global solutions of direct and inverse problems near singular manifolds), control theory (stability of models), and the engineering of large-scale continuous and hybrid discrete-continuous dynamical systems. Emphasis will be given to validated and certified outputs via algebraic and exact techniques, error estimation, interval techniques and optimization strategies.
Our workshop will follow up on the seminal SIAM-MSRI Workshop on Hybrid Methodologies for Symbolic-Numeric Computation held in November 2010 and the Fields Institute Workshop on Hybrid Methodologies for Symbolic-Numeric Computation, November 16-19, 2011 at the University of Waterloo, Canada. We will provide a forum for researchers on all sides of hybrid symbolic-numeric computation.

▶ EM-Mo-D-01-1 13:30–14:30
Hybrid Symbolic-numeric Computation: A Marriage Made in Heaven
Kaltofen, Erich — North Carolina State Univ.

Abstract: Hybrid algorithms use floating point arithmetic for speed and symbolic computation for the type of objects: formulas and exact identities and inequalities.
New hybrid algorithms are presented: for solving optimization problems by sum-of-squares proofs; for computing a sparse interpolant in power or Chebyshev basis via linear progressions. There, we allow for errors in the inputs, performing error-correction by methods from digital error correcting codes.
Joint with Andrew Arnold, Clement Pernet, Zhengfeng Yang, Lihong Zhi.

▶ EM-Mo-D-01-2 14:30–15:00
Applying Symbolic Sparse Interpolation Techniques to Numeric Data
Roche, Daniel — U.S. Naval Acad.

Abstract: We examine the problem of discovering a sparse polynomial from noisy samples at chosen points. Recent progress in efficient sparse interpolation algorithms over exact domains such as integers and finite fields is based on reducing the problem with potentially large degree to a related one with much lower degree. We will discuss the challenges and successes in adapting these techniques to the numeric setting.

▶ EM-Mo-D-01-3 15:00–15:30
Sparse Polynomial Interpolation with Arbitrary Orthogonal Polynomial Bases
Yang, Zhengfeng Yang — East China Normal Univ.

Abstract: The problem of sparse interpolation with arbitrary orthogonal bases can be regarded as a generalization of sparse interpolation with the Chebyshev basis. In Lakshman and Saunder [1996], an algorithm, based on Prony/Blahut's method is provided to interpolate polynomials that are sparse in the Chebyshev basis (of the first kind). In this talk, we will present new algorithms for interpolating a univariate black-box univariate polynomial that has a sparse representation by allowing arbitrary orthogonal bases. This is joint work with Erich L. Kaltofen.

EM-Mo-D-02 13:30–15:30 309A
Differential Algebra and Related Topics - Part I of VIII

For Part 2, see EM-Mo-E-02
For Part 3, see EM-Tu-D-02
For Part 4, see EM-Tu-E-02
For Part 5, see EM-We-D-02
For Part 6, see EM-We-E-02
For Part 7, see EM-Fr-D-02
For Part 8, see EM-Fr-E-02

Organizer: Feng, Ruyong — Acad. of Mathematics & Sys. Sci.,CAS
Organizer: Guo, Li — Rutgers Univ. at Newark, USA
Organizer: Gao, Xiao-Shan — Acad. of Mathematics & Sys. Sci., Chinese Acad. of Sci.

Abstract: This meeting is to offer an opportunity for participants to present original research , to learn of reserch progress and new developments on differential algebra and related topics, particularly, the applications of differential algebra to control theory, physics, chemistry, biology and so on.

▶ EM-Mo-D-02-1 13:30–14:30
25 Years of Wilf-Zeilberger Algorithmic Proof Theory
Zeilberger, Doron — Rutgers Univ.

Abstract: The past, present, and future of Wilf-Zeilbegrer algorithmic proof theory will be summarized in 50 minutes.

▶ EM-Mo-D-02-2 14:30–15:00
Pushing Forward the Dimension of Fcc Lattices
Koutschan, Christoph — RICAM

Abstract: The generating function G for the return probabilities in a d-dimensional face-centered cubic lattice satisfies an ODE whose order grows quadratically with d. Until recently only the ODEs for d¡=7 were known; using a recursive method for computing the coefficients of G, proposed by Zenine, Hassani, Maillard, we are able to go up to d=11. These ODEs share many remarkable properties which we shall discuss in this talk. This is joint work with Jean-Marie Maillard.

▶ EM-Mo-D-02-3 15:00–15:30
The Positive Part of Multivariate Series
Kauers, Manuel — Johannes Kepler Univ.

Abstract: We discuss the expansion of multivariate rational functions in terms of formal multivariate infinite series. Such series in general involve terms with negative exponents, and their positive part is defined as the power series obtained by discarding all these terms with negative exponents. We show how the positive part can be computed using creative telescoping. — joint work with Alin Bostan, Frederic Chyzak, Lucien Pech and Mark van Hoeij.

MS-Mo-D-03 13:30–15:30 306A
Applied Integrable Systems - Part I of V

For Part 2, see MS-Mo-E-03
For Part 3, see MS-Tu-D-03
For Part 4, see MS-Tu-E-03
For Part 5, see MS-We-D-03

Organizer: Hu, Xing-Biao — Inst. of Computational Mathematics, Chinese Acad. of Sci. (CAS), China
Organizer: Kajiwara, Kenji — Kyushu Univ.
Organizer: Kakei, Saburo — RIkkyo Univ.
Organizer: Maruno, Kenichi — Waseda Univ.

Abstract: In recent years, there have been major developments in applications of integrable systems. Originally, integrability has been recognized through solitons, which are particle-like nonlinear waves in various physical systems. Thanks to rich mathematical structure of integrable systems, recen-

t applications of integrable systems extend to a wide range of pure/applied mathematics and physical sciences, such as algebraic geometry, combinatorics, probability theory, numerical algorithms, cellular automata, (discrete) differential geometry, computer visualizations, statistical physics, nonlinear physics and so on. The purpose of this minisymposium is to bring together researchers to discuss recent advances on various aspects of applied integrable systems.

▶ MS-Mo-D-03-1 13:30–14:00

Integrable Deformations of Discrete Curves

Kajiwara, Kenji — Kyushu Univ.

Abstract: We present some results on integrable discrete deformations of space/plane discrete curves in various settings, including: (i) isoperimetric deformation of plane curves (discrete mKdV equation) (ii) conformal deformation of plane curves (discrete Burgers equation) (iii) deformation of space curves described by the discrete nonlinear Schrödinger equation. We also discuss construction of exact solutions to the dynamics of discrete curves, which is a great advantage of applying the theory of discrete integrable systems to geometry.

▶ MS-Mo-D-03-2 14:00–14:30

Hirota's Discrete KP Equation and Its Reductions from Geometric Point of View

Doliwa, Adam — Univ. of Warmia & Mazury

Abstract: We present geometric theory of Hirota's seminal discrete KP equation and of certain its distinguished reductions. We discuss interplay between root-lattice and incidence geometry aspects of the theory.

▶ MS-Mo-D-03-3 14:30–15:00

From Higher Bruhat and Tamari Orders to Simplex and Polygon Equations

Mueller-Hoissen, Folkert — Max Planck Inst. for Dynamics & Self-Organization

Abstract: Higher Bruhat orders are partially ordered sets encoding the combinatorial structure underlying simplex equations, which contain the famous Yang-Baxter equation. Each higher Bruhat order admits a decomposition, where one part of it is a corresponding "higher Tamari order". In the same way in which simplex equations realize higher Bruhat orders, there is a family of "polygon equations" that realize higher Tamari orders. They contain the well-known pentagon equation. Joint work with Aristophanes Dimakis.

▶ MS-Mo-D-03-4 15:00–15:30

The Higher Order Normalized Differential Invariants and Syzygies for Submanifolds under Group Actions

Yao, Ruoxia — Shaanxi Normal Univ.

Abstract: Motivated by the widely used equivariant moving frame method, the infinitesimal generators of transformation groups and the universal recurrence formulae for differential invariants are reinvestigated, then some results including not only the fundamental sets of higher order normalized differential invariants, the explicit normal forms built by them for submanifolds under group actions, but also the syzygies on the generating set of normalized differential invariants are presented.

IM-Mo-D-04 13:30–15:30 308

Mathematics and Algorithms in Computer-Aided Manufacturing, Manufacturing Systems and Numerical Control - Part I of VI

For Part 2, see IM-Mo-E-04
For Part 3, see IM-Tu-D-04
For Part 4, see IM-Tu-E-04
For Part 5, see IM-We-D-04
For Part 6, see IM-We-E-04

Organizer: Li, Hongbo — Acad. of Mathematics & Sys. Sci., Chinese Acad. of Sci.

Organizer: Shpitalni, Moshe — Technion, Israel

Abstract: The fast development of advanced manufacturing technology has witnessed the growing importance of mathematical methods and algorithms, ranging from algebraic geometry, discrete geometry and differential geometry to differential equations, computational mathematics and computer mathematics. Conversely, problems arising from the field of advanced manufacturing have also stimulated the development of such branches in pure and applied mathematics as computational geometry and mathematics mechanization.
Mathematics and Algorithms for Computer-Aided Manufacturing, Engineering and Numerical Control is intended to be an interdisciplinary forum focusing on the interaction between the side of mathematical methods and algorithms, and the other side of computer-aided manufacturing (CAM), computer-aided engineering (CAE) and computer numerical control (CNC). It concentrates on (but is not restricted to) the following topics: tool path planning, multiscale simulation, feature-based process chain with CAM/CNC coupling, interpolation for CNC controllers.
The proposed industrial mini-symposium of 20 talks will provide an excellent platform for the participants to get acquainted with new research results, to exchange new ideas, and to create new collaboration.
To ensure full success of the proposed mini-symposium, we have invited 8 speakers from abroad. All are knowledgeable world experts in their fields, with impressive records of research, publications and awards, as well as solid background of mathematics. The invited speakers are from various countries and represent different aspects in Manufacturing, Manufacturing Systems and Computer Numerical Control.

▶ IM-Mo-D-04-1 13:30–14:15

Manufacturing Systems Controlled by Agents

Weiss-Cohen, Miri — Ort Braude
Mitnovitsky, Michael — Technion
Shpitalni, Moshe — Technion

Abstract: A new agent-based adaptive control system has been developed in order to simulate and examine a dynamic, flexible and stochastic job shop problem that considers random events, such as random job arrivals, uncertain processing times, unexpected machine break downs, various shop utilization levels and the possibility of processing flexibility. The system provides advanced decision-making strategies for responsive factories based on agents with local intelligence. We demonstrate, by simulation, and discuss the excellent results achieved.

▶ IM-Mo-D-04-2 14:15–15:00

Efficient and Robust Time-Optimal CNC Interpolation under Dynamic Constraints

Gao, Xiao-Shan — Acad. of Mathematics & Sys. Sci., Chinese Acad. of Sci.

Abstract: To fully utilize the dynamic ability of the CNC machines and enforce a given precision bound and minimum time machining time is a basic problem in CNC Machining. In this talk, we will show that efficient numerical algorithms could be developed for several problems of this type, and in particular dynamic constraints are considered.

▶ IM-Mo-D-04-3 15:00–15:30

The New Requirements of CNC and Development Practice of LT-CNC

Yu, Dong — Shenyang Inst. of Computing Tech., CAS

Abstract: By analysis of the machining data process of CNC system, the new requirements of CNC are proposed, such as influence of the NC data quality, control of contour tolerances, reproducibility of adjacent tool paths, dynamic oscillation free movements , five axis capability, etc. Based on the analysis, the control features for fast, accurate milling with high surface definition are summarized, and the development practice of LT-CNC is described.

MS-Mo-D-05 13:30–15:30 215

Compressed Sensing, Extensions and Applications - Part I of III

For Part 2, see MS-Mo-E-05
For Part 3, see MS-Tu-D-05

Organizer: Kutyniok, Gitta — Technische Universität Berlin

Organizer: Holger, Rauhut — RWTH Aachen Univ.

Abstract: Compressed sensing has seen an enormous research activity in recent years. The key principle is that (approximately) sparse signals can be recovered efficiently from what was previously believed to be vastly incomplete information. For this reason, compressed sensing and its algorithms (often convex optimization approaches) have a large range of applications such as magnetic resonance imaging, radar, wireless communications, and more. Remarkably, all provably optimal measurement schemes are based on randomness and therefore, compressed sensing connects various mathematical fields such as random matrix theory, optimization, approximation theory, and harmonic analysis. Recent developments have extended the theory and its algorithms to the recovery of low rank matrices from incomplete information, to the phaseless estimation problem, and to low tensor recovery. The minisymposium aims at bringing together experts in the field and to provide an overview of its most recent results.

▶ MS-Mo-D-05-1 13:30–14:00

Almost Lossless and Stable Analog Signal Separation

Stotz, David — ETH Zurich
Boelcskei, Helmut — ETH Zurich

Abstract: We develop an information-theoretic framework to study almost lossless and stable analog signal separation. Our results reveal Minkowski dimension as the foundational element of the theory. As a byproduct, we discover a new technique for showing that the intersection of generic subspaces with subsets of sufficiently small Minkowski dimension is empty. This result can be viewed as a measure-theoretic version of the celebrated null-space property in compressed sensing theory.

▶ MS-Mo-D-05-2 14:00–14:30

Function Approximation via Infinite-dimensional Weighted L^1 Minimization

Adcock, Ben — Simon Fraser Univ.

Abstract: The reconstruction of multivariate functions from a limited sets of pointwise samples is an important problem in a number of applications. In this talk I will present an infinite-dimensional framework for this problem based on weighted l^1 minimization. This framework general, and applies to arbitrary point sets and expansion systems. I will explain why working in infinite dimensions is important, describe the critical role that weights play in the formulation, and address recovery guarantees.

▶ MS-Mo-D-05-3 14:30–15:00

Phase Retrieval via Wirtinger Flow: Theory and Algorithms

Li, Xiaodong — Univ. of Pennsylvania

Abstract: In phase retrieval, one aims to recover a signal from magnitude measurements. In this talk, we show how to recover the signal by a non-convex optimization method. The initialization scheme is based on a spectral method; then a specific type of gradient descent is applied iteratively. This algorithm is guaranteed to converge to the original signal with fast convergence rate. Large scale simulations are also employed to verify the effectiveness of our method.

▶ MS-Mo-D-05-4 15:00–15:30

Fast Phase Retrieval for High-Dimensions

Iwen, Mark — Michigan State Univ.

Abstract: We develop a fast phase retrieval method which is near-linear time, making it computationally feasible for large dimensional signals. Both theoretical and experimental results demonstrate the method's speed, accuracy, and robustness. We then use this new phase retrieval method to help establish the first known sublinear-time compressive phase retrieval algorithm capable of recovering a given s-sparse signal $\mathbf{x} \in \mathbb{C}^d$ (up to an unknown phase factor) in just $\mathcal{O}(s \log^5 s \cdot \log d)$-time.

MS-Mo-D-06 13:30–15:30 201

Delay Systems and Applications - Part I of II

For Part 2, see MS-Mo-E-06

Organizer: Braverman, Elena — Univ. of Calgary

Abstract: The purpose of the minisymposium is to provide a wide forum for presentations and discussions on the recent trends in the theory of differential and difference equations with deviating arguments. The topic includes delayed and advanced systems, as well as various applications of such models, for example, in mathematical biology.

▶ MS-Mo-D-06-1 13:30–14:00

On Stability of Equations and Systems with A Distributed Delay

Braverman, Elena — Univ. of Calgary

Abstract: We consider either an equation of population dynamics or a system with a monotone increasing production term including a distributed delay and, generally, nonlinear mortality term. Delay-independent stability results are obtained including multistability in the case of a single equation. This is joint work with L. Berezansky.

▶ MS-Mo-D-06-2 14:00–14:30

Asymptotic Behavior of Solutions for A Class of Higher Order Delay Differential Equations

Rogovchenko, Yuriy — Univ. of Agder

Abstract: In this paper, we study the asymptotic behavior of solutions to a class of higher order Emden-Fowler differential equations with delayed argument. Sufficient conditions for all solutions to be either oscillatory or to converge to zero are obtained. Oscillation criterion is also derived. Two examples are provided to demonstrate that new theorems improve and extend a number of results reported in the literature.

▶ MS-Mo-D-06-3 14:30–15:00

Continuous Separation for Non-autonomus Delay Differential Equations: Theoretical Results and Numerical Applications.

Obaya, Rafael — Univ. de Valladolid

Abstract: We investigate dynamical properties of nonautonomous linear cooperative families of ODEs and FDEs based on the existence of a continuous separation. We provide numerical algorithms for the computation of the dominant one-dimensional subbundle of the continuos separtion and the upper Lyapunov exponent of the semiflow. These methods are used in study onf nolinear families of neural networks of Hopfield type. The talk is based in joint works with S. Novo, A. Sanz and J. Calzada.

▶ MS-Mo-D-06-4 15:00–15:30

Delay Systems in Disease and Information Spread

Wu, Jianhong — York Univ.

Abstract: We consider delay differential systems arising from information and disease spread, and illustrate the impact of delay on the nonlinear dynamics.

MS-Mo-D-07 13:30–15:30 202A

Mathematics of Climate: From the Tropics to Antarctica - Part I of III

For Part 2, see MS-Mo-E-07

For Part 3, see MS-Tu-D-07

Organizer: Stechmann, Samuel — Univ. of Wisconsin-Madison

Organizer: Golden, Kenneth — Univ. of Utah

Abstract: The Earth offers a multitude of modeling challenges, from the dynamics of the atmosphere and oceans, to the melting of the polar ice caps. To understand and model these climate processes, a wide range of mathematics is needed, such as differential equations, multiscale modeling, and stochastic processes. In this minisymposium, the presentations span a broad range of climate processes and mathematical areas, and will be accessible to a more general audience. They include a blend of modeling, experiments, and data analysis, and demonstrate how mathematics is being employed to address fundamental problems of climate science.

▶ MS-Mo-D-07-1 13:30–14:00

Global Warming: How Can Mathematics Help People to Know It is Real?

Shen, Samuel — San Diego State Univ.

Abstract: Various kinds of climate data from land, ocean, satellite and numerical models can be optimally analyzed using innovative mathematical and statistical methods to demonstrate climate change and highlight natural climate variability, such as El Nino. This lecture will describe how global warming is defined and how the historical global average temperature curves beginning in 1860 from the Intergovernmental Panel on Climate Change were obtained and used as a gauge of global warming.

▶ MS-Mo-D-07-2 14:00–14:30

A Conceptual Model of Climate Variability During the Pleistocene

Kaper, Hans G — Georgetown Univ.

Engler, Hans — Georgetown Univ.

Abstract: In this talk we discuss some conceptual models that explain the characteristic features of the glacial-interglacial cycles in the Earth's climate system over the past two million years (the Pleistocene).

▶ MS-Mo-D-07-3 14:30–15:00

Progress Towards Improving Seasonal Climate Prediction by Mathematical Methods.

Tang, Youmin — Univ. of Northern British Columbia

Abstract: In this talk, we will present some progresses in improving seasonal climate predictions by using more advanced mathematical methods. The first example is to rely on the basic properties of stochastic theory to develop an efficient technique for the extraction of climatically relevant singular vectors (CSV) in the presence of weather noise. Emphasis is placed on the applications of the CSV in seasonal climate predictions and to construct optimal ensemble climate predictions. The results indicates that the CSVs can well characterize the optimal error growth of the climate predictions and lead to better ensemble predictions than traditional time lag (TLE) method. The second example is to apply for the information theory to quantify the potential climate predictability. It is found that the information-based measures such as relative entropy and multiple information can better characterize the real predictability than the traditional methods of signal-to-noise ratio. At last, our recent progress in the state estimate of state-space models is discussed with applications of Bayesian-based algorithms. A simplified algorithm of Sigma-point Kalman filter is develop to deal with the state estimation of high-dimensional systems like atmospheric and oceanic general circulation models.

▶ MS-Mo-D-07-4 15:00–15:30

The Impact of Southern Ocean Storms on Sea Ice

Kohout, Alison — NIWA

Abstract: Measurements of wave propagation through Antarctic sea ice are presented. These show that large ocean waves penetrate hundreds of kilometers into the sea ice, further than previously predicted by accepted theory. This implies a more prominent role for ocean waves in sea ice breakup and retreat than previously thought.

MS-Mo-D-08 13:30–15:30 202B
Numerical methods for compressible multi-phase flows - Part I of VI
For Part 2, see MS-Mo-E-08
For Part 3, see MS-We-E-47
For Part 4, see MS-Th-BC-47
For Part 5, see MS-Th-D-47
For Part 6, see MS-Th-E-47

Organizer: Deng, Xiaolong — Beijing Computational Sci. Research Center
Organizer: Wei, Suhua — Inst. of Applied Physics & Computational Mathematics
Organizer: Tian, Baolin — Insitute of Applied Physics & Computational Mathematics
Organizer: Tiegang, Liu — Beihang Univ.
Organizer: Sussman, Mark — Florida State Univ.
Organizer: Wang, Shuanghu — IAPCM

Abstract: Compressible multi-phase flows appear in many natural phenomena, and are very important in many applications, including space science, aerospace engineering, energy, homeland security, etc. Numerical calculation is a key for understanding many related problems. More and more numerical methods are being developed and improved. In this mini-symposium, novel numerical methods will be presented to show the progress in the area of compressible multi-phase flows, including interface capturing/tracking methods, phase change calculations, mixing methods, fluid-structure interaction methods, multi-physics calculations, adaptive mesh refinement, and high performance computing.

▶ MS-Mo-D-08-1 13:30–14:00
Smoothed Particle Hydrodynamics for Multi-phase Flows
Liu, Moubin — Peking Univ.

Abstract: In this paper, an improved SPH model for multiphase flows with complex interfaces and large density differences is developed. The multiphase SPH model is based on the assumption of pressure continuity over the interfaces and avoids directly using the information of neighboring particles' densities or masses in solving governing equations. In order to improve computational accuracy and to obtain smooth pressure fields, a corrected density re-initialization is applied. A coupled dynamic solid boundary treatment (SBT) is implemented both to reduce numerical oscillations and to prevent unphysical particle penetration in the boundary area. The density correction and coupled dynamics SBT algorithms are modified to adapt to the density discontinuity on fluid interfaces in multiphase simulation. A cut-off value of the particle density is set to avoid negative pressure, which can lead to severe numerical difficulties and may even terminate the simulations. Three representative numerical examples, including a Rayleigh-Taylor instability test, a non-Boussinesq problem and a dam breaking simulation, are presented and compared with analytical results or experimental data. It is demonstrated that the present SPH model is capable of modeling complex multiphase flows with large interfacial deformations and density ratios.

▶ MS-Mo-D-08-2 14:00–14:30
A Symmetry Preserving Support-Operators Diffusion Discretization Scheme in Three-Dimensional Cartesian Geometry
Zhang, Mingyu — Inst. of Applied Physics & Computational Mathematics

Abstract: It is one of the important issues in high-dimensional, two-dimensional (2D) or three-dimensional (3D), Cartesian geometry to preserve perfect one-dimensional (1D) spherical symmetry. Following the idea of Caramana et al. [2], a symmetry preserving support-operators diffusion discretization scheme in 3D Cartesian geometry is developed. Spherically symmetrical flux is realized in numerical simulation of 1D symmetrical problem in 3D Cartesian geometry. Some numerical tests are given to prove the developed symmetrical schemes.

▶ MS-Mo-D-08-3 14:30–15:00
Preventing Numerical Oscillations in the Flux-split Based Finite Difference Method for Compressible Flows with Discontinuities
He, Zhi-wei — Inst. of Applied Physics & Computational Mathematics
Zhang, Yousheng — Inst. of Applied Physics & Computational Mathematics
Tian, Baolin — Insitute of Applied Physics & Computational Mathematics
Xinliang, Li — Inst. of Mechanics,cas
Li, Li — Inst. of Mechanics,cas

Abstract: Numerical oscillations by point-wise flux vector splitting (FVS) and component-wise nonlinear difference discretization of convection terms are revealed and prevented in compressible flows with discontinuities, where pressure and velocity oscillations can be induced by either one of the two operations. Two practicable principles are proposed to prevent the oscillations. Numerical tests confirm the effectiveness,robustness and low computation cost of our proposed method.

▶ MS-Mo-D-08-4 15:00–15:30
A High-Order Accurate Algorithm for Diffusion Equations with Discontinuous Diffusion Coefficients on Distorted Meshes
Shuhong, Song — Inst. of Applied Physics & Computational Mathematics

Abstract: Among the methods with cell-centered unknowns on large distortion meshes, most adopt the vertex unknowns indirectly to discretize diffusion equations such that their accuracy is ultimately determined by he approximation to the vertex unknowns. In this paper, taking advantage of the high-order accuracy of the "twin-fitting" method especially on discontinuous diffusion coefficients, a new treatment for the vertex unknowns is developed to apply to a nine-point scheme. Numerical experiments show that the new nine-point

MS-Mo-D-09 13:30–15:30 203A
Free Boundary Problems: Theory, Numerics, and Applications - Part I of II
For Part 2, see MS-Mo-E-09

Organizer: Walker, Shawn — Louisiana State Univ.

Abstract: This mini-symposium will be on moving interface and free-boundary problems that occur in a variety of applications, such as two-phase flows, biology, shape optimization, and multi-physics. Talks will range from theory and computations to applications, or a combination.

▶ MS-Mo-D-09-1 13:30–14:00
Implicitly-solvated Bimolecular Dynamics Simulation for the Moving Dielectric Interface
Geng, Weihua — Southern Methodist Univ.
Krasny, Robert — Univ. of Michigan

Abstract: In Poisson-Boltzmann (PB) model, solute and solvent regions are separated by a dielectric interface and we are interested in tracing its location and conformational change. We numerically solved the PB model under a well-posed boundary integral formulation. The fast treecode algorithms and GPU computing combined make it realistic to apply the PB model to biomolecular dynamics simulation. We derived and implemented the numerical schemes for computing the dominant and computationally demanding electrostatic solvation force.

▶ MS-Mo-D-09-2 14:00–14:30
A Fully Practical Adaptive Energy Conserving Scheme for A Cahn-Hilliard Navier-Stokes Model with Variable Densities.
Kahle, Christian — Univ. of Hamburg

Abstract: We present a fully practical residual-based adaptive simulation framework for two-phase flows with variable densities governed by a Cahn-Hilliard Navier-Stokes model with double obstacle potential. The method is based on a new stable time integration scheme, which conserves the energy decay. In the adaptive framework the generation of discrete energy contributions stemming from coarsening is avoided by an appropriate modification of the coarsening strategy. Authors: Harald Garcke, Michael Hinze, Christian Kahle

▶ MS-Mo-D-09-3 14:30–15:00
Sperm Motility in 3D: Towards An Understanding of Swimming in Groups
Simons, Julie — Tulane Univ.

Abstract: Most sperm swim using a primarily planar waveform. However, their swimming behavior is modulated by the complex effects of surface interactions, nearby neighbors, and other factors. Mathematically, sperm motility has largely been studied in viscous, Newtonian fluids with planar waveforms. We will present a new model that is robust to three-dimensional effects, based upon a previous planar model. The sperm flagellum is modeled using an immersed elastic boundary and the method of regularized Stokeslets.

▶ MS-Mo-D-09-4 15:00–15:30
A Localized Meshless Method for Reaction-advection-diffusion Equations on Folded Surfaces
Ruuth, Steven — Simon Fraser Univ.

Abstract: In this talk, we propose a radial basis function discretization of the closest point method that may be used to approximate reaction-advection-diffusion equations on smooth or folded surfaces. The method has a priori error bounds in terms of percentage of the norm of the solution and has extensions to more general flows and surfaces. A number of numerical experiments are provided. This is joint work with K.-C. Cheung, and L. Ling.

MS-Mo-D-10 13:30–15:30 206B
Ultradiscretization and its application in modeling - Part I of II
For Part 2, see MS-Mo-E-10

Organizer: Tokihiro, Tetsuji — the Univ. of Tokyo
Organizer: Willox, Ralph — the Univ. of Tokyo
Organizer: Matsukidaira, Junta — Ryukoku Univ.

Abstract: A cellular automaton (CA) is a discrete dynamical system composed of an array of cells that only take a finite number of states. CAs can exhibit complex time evolution patterns and are used as mathematical models for a variety of natural and social phenomena. Ultradiscretization is a mathematical tool for constructing CAs from continuous systems. It has been successfully used to obtain CA models that share important features with continuous phenomena. The purpose of this organized session is to offer researchers the opportunity to discuss recent advances in ultradiscrete systems and in particular their application to fundamental biology.

▶MS-Mo-D-10-1 13:30–14:00
Combinatorial and Solvable Structures of Random Domino Automaton
Bialecki, Mariusz — Inst. of Geophysics, Polish Acad. of Sci.

Abstract: We introduce Random Domino Automaton - recently proposed slowly driven system being a stochastic toy model of earthquakes and also a generalisation of 1D Drossel – Schwabl forest-fire model. A solution of the set of discrete equations describing stationary state of Random Domino Automaton in inverse-power case is presented. We describe also a link to Motzkin numbers.
The presentation emphasizes mathematical structure and properties of the model.

▶MS-Mo-D-10-2 14:00–14:30
The Topology of A DNA String and Its Gene Expression
Bao, Yuanyuan — Tohoku Forum for Creativity, Tohoku Univ.

Abstract: Spatial structure and gene expression of a DNA interact with each other in various ways. In this talk, we discuss some topological (structural) properties of a DNA string, regarded as an embedded curve in the 3-space. We then talk about how these properties support the process of gene expression, such as transcription and alternative splicing.

▶MS-Mo-D-10-3 14:30–15:00
Statistical Method for Constructing Cellular Automata
Kawaharada, Akane — Univ. of Shizuoka

Abstract: We propose a statistical construction method of cellular automata based on observation data. Cellular automaton are discrete dynamical systems whose configurations are determined by local rules acting on each cell in synchronous. Since cellular automata generate rich and complex behaviors, we can expect they are good models for simulating phenomena. In this talk, we introduce the method and apply to some physical phenomena. Cellular automata with three neighbors and 2 – 8 states are obtained.

▶MS-Mo-D-10-4 15:00–15:30
Modeling Cell-cell Interactions in Gliomas
Badoual, Mathilde — Paris Diderot Univ.

Abstract: Diffuse low-grade gliomas are brain tumors that grow slowly, but that are incurable because some glioma cells migrate within the parenchyma surrounding the tumor. Here, we will present a stochastic approach, based on a cellular automaton, where the interactions between migrating cells are taken into account and the properties of the correlations between cells are studied in order to characterise the leading edge of the tumor. We also calculated the continuous limit.

MS-Mo-D-11 13:30–15:30 203B
Recent advances in matrix computations for extreme-scale computers - Part I of II
For Part 2, see MS-Mo-E-11

Organizer: Li, Xiaoye — Lawrence Berkeley National Laboratory
Organizer: Duff, Iain — STFC Rutherford Appleton Laboratory

Abstract: Numerical linear algebra is at the heart of scientific and industrial discoveries. The forthcoming arrival of the exascale era provides tremendous opportunities and challenges for further development of algorithms and software extreme-scale computing. This minisymposium emphasizes problem reformulations, algorithm redesigns and code refactorings for the efficient use of high performance computers. Topics range from direct methods, iterative methods, preconditioning, and the emerging fast algorithms for both dense and sparse algebraic systems. The speakers will present various techniques to reduce communication, synchronization and memory footprint. Performance of the new algorithms will be demonstrated on modern manycore parallel machines.

▶MS-Mo-D-11-1 13:30–14:00
Combining Direct and Iterative Methods to Solve Very Large Sparse Equations on Massively Parallel Architectures
Duff, Iain — STFC Rutherford Appleton Laboratory

Abstract: We have developed a hybrid solver for large sparse systems. The basis for our approach is block Cimmino where the rectangular blocks are solved by a direct method on an augmented system. The partitioning can determine whether we use a direct method or purely iterative one. We can augment the system to force orthogonality between the blocks. We show the performance of our approach on a range of large problems on several different parallel platforms.

▶MS-Mo-D-11-2 14:00–14:30
On the Design of Parallel Linear Solvers for Large Scale Problems
Pierre, RAMET — Bordeaux Univ. & Inria

Abstract: In this talk we will discuss our research activities on the design of parallel linear solvers for large scale problems that range from dense linear algebra, to parallel sparse direct solver and hybrid iterative-direct approaches. In particular we will describe the implementations designed on top of runtime systems that should provide both code and performance portabilities. Finally, we will present some preliminary results on the integration of h-matrice kernels in our sparse direct solver framework.

▶MS-Mo-D-11-3 14:30–15:00
Asynchronous Optimized Schwarz Methods
Szyld, Daniel — Temple Univ.

Abstract: Optimized Schwarz Methods are domain decomposition methods, where one imposes Robin conditions on the artificial interfaces. The Robin parameter can be optimized to obtain very fast convergence. We present an asynchronous version of this method, where the problem in each subdomain is solved using whatever boundary data is locally available and with no synchronizations with other processes. We prove convergence of the method, and illustrate its efficiency on large three-dimensional problems. (Joint with Frederic Magoules).

▶MS-Mo-D-11-4 15:00–15:30
Solving Linear Equations with HSS Structure: Theory and Practice
Li, Xiaoye — Lawrence Berkeley National Laboratory
Rouet, Francois-Henry — Lawrence Berkeley National Laboratory
Ghysels, Pieter — Lawrence Berkeley National Lab

Abstract: Low-rank block structures arise in matrices from integral equations, boundary element methods, and discretized PDEs. We will show that, both in theory and in practice, the hierarchically semi-separable (HSS) structured factorization is an effective way of exploiting the low-rankness. It provides a powerful tool for solving linear equations, both dense and sparse, with arithmetic and memory complexity asymptotically lower than the standard methods. It can be parallelized well on modern manycore parallel machines.

MS-Mo-D-12 13:30–15:30 208B
Extremal Combinatorics, Probabilistic Combinatorics, and their applications - Part I of III
For Part 2, see MS-Mo-E-12
For Part 3, see MS-Tu-D-12

Organizer: Ma, Jie — Univ. of Sci. & Tech. of China
Organizer: Huang, Hao — Inst. for Mathematics & its Applications, Univ. of Minnesota
Organizer: Chen, Guantao — Georgia State Univ.

Abstract: Combinatorics is a fundamental discipline of modern mathematics which studies discrete objects and their properties. This minisymposium we propose will focus on the subfield of extremal and probabilistic combinatorics, which has witnessed an exciting development over the past decades, and also has many striking practical applications in mathematical optimization, computer science, statistical physics and voting society. We aim to bring the top researchers to the minisymposium, where they will present the recent progress, discuss open challenges, exchange research ideas, and initiate new collaborations. We expect a minisymposium of this nature to have a lasting impact on the future of the subject.

▶MS-Mo-D-12-1 13:30–14:00
Maximizing Proper Colorings on Graphs
Ma, Jie — Univ. of Sci. & Tech. of China
Naves, Humberto — IMA - Inst. for Mathematics & its Applications

Abstract: Linial and Wilf asked for the graphs with fixed numbers of vertices and edges which maximize the number of proper q-colorings. We characterize the asymptotic structure of extremal graphs for fixed edge density and

q. We also disprove a conjecture of Lazebnik, stating that the Turán graph Ts(n) has more q-colorings in its family, by providing counterexamples for $s < q < O(s^2/\log s)$. When $q > 100s^2/\log s$, we show Turán graph indeed achieves the maximum.

▶ MS-Mo-D-12-2 14:00–14:30

Biclique Decomposition of Random Graphs

Huang, Hao Inst. for Mathematics & its Applications, Univ. of Minnesota

Abstract: The biclique partition number bp(G) is the minimum number of complete bipartite graphs needed to partition the edges of a graph G. Erdős conjectured that for the random graph $G = G(n, 0.5)$, $bp(G) = n - \alpha(G)$ with high probability, where $\alpha(G)$ is the independence number. In this talk I will discuss some recent progress and and remaining challenges in this area, and construct a counterexample to this conjecture. Joint work with Noga Alon and Tom Bohman.

▶ MS-Mo-D-12-3 14:30–15:00

Counting Cliques in Graphs with Forbidden Subdivision

Oum, Sang-il KAIST

Abstract: We prove that for all positive integers t, every n-vertex graph with no K_t-subdivision has at most $2^{94t}n$ cliques. We also prove that asymptotically, such graphs contain at most $2^{(5+o(1))t}n$ cliques, where $o(1)$ tends to zero as t tends to infinity. This strongly answers a question of D. Wood asking if the number of cliques in n-vertex graphs with no K_t-minor is at most $2^{ct}n$ for some constant c. Joint work with C. Lee.

▶ MS-Mo-D-12-4 15:00–15:30

Decomposition of Sparse Graphs into Forests: the Nine Dragon Tree Conjecture for $k \leq 2$

Kim, Seog-Jin Konkuk Univ.

Abstract: The *fractional arboricity* $Arb(G)$ is the maximum of $\frac{|E(H)|}{|V(H)|-1}$ over all subgraphs H with at least two vertices. Generalizing the Nash-Williams Arboricity Theorem, the Nine Dragon Tree Conjecture asserts that if $Arb(G) \leq k + \frac{d}{k+d+1}$, then G decomposes into $k + 1$ forests with one having maximum degree at most d. We prove it for all d when $k \leq 2$. This is joint work with M. Chen, A.V. Kostochka, D.B. West, and X. Zhu.

MS-Mo-D-13 13:30–15:30 VIP3-2

Analysis and algorithm for coupling of kinetic and fluid equations - Part I of III

For Part 2, see MS-Mo-E-13
For Part 3, see MS-Tu-D-13

Organizer: Lu, Jianfeng Duke Univ.
Organizer: Sun, Weiran Simon Fraser Univ.

Abstract: Kinetic equations are widely used to model complex systems occurring in gas dynamics and transport phenomenon, as examples. In these applications, it is common that dense and dilute parts coexist in the system. This leads to multiple spatio-temporal scales which introduce difficulties in both analysis and numerics. Kinetic-fluid coupling hence has received intensive studies in recent years. This minisymposium aims to bring together experts in analysis and algorithm in kinetic equations to discuss the current status and future developments of the field. It also provides a platform for further interaction and collaboration for researchers in this and related areas.

▶ MS-Mo-D-13-1 13:30–14:00

A Hierarchy of Hybrid Numerical Methods for the Boltzmann Equation.

Rey, Thomas Lille 1 Univ.

Abstract: In this work in collaboration with F. Filbet, we construct a hierarchy of hybrid numerical methods for the Boltzmann equation, based on moment realizability. We present hybrid schemes where the hydrodynamic part is given either by the compressible Euler or Navier-Stokes equations, or even with more general models, such as the Burnett system. We present numerical simulations in both 1 and 2 dimensions of physical space, and 3 of velocity.

▶ MS-Mo-D-13-2 14:00–14:30

Measure Valued Solutions to the Boltzmann Equation

Yang, Tong City Univ. of Hong Kong

Abstract: Some recent results on the existence, regularity and large time behavior for the Boltzmann equation with measure valued initial data will be presented.

▶ MS-Mo-D-13-3 14:30–15:00

Nonlinear Acoustic Wave Propagation in A Rarefied Gas: Numerical Analysis Based on Kinetic and Fluid Equations

Aoki, Kazuo Kyoto Univ.

Abstract: Nonlinear acoustic waves caused by an infinitely wide plate oscillating in its normal direction and propagating into a semi-infinite expanse of a rarefied gas are investigated numerically on the basis of a model Boltzmann equation and of the compressible Navier-Stokes equations with the correct temperature jump condition on the oscillating plate. The long-time behavior of the solution, including the attenuation of the waves and the creation of the acoustic stream, is obtained accurately.

▶ MS-Mo-D-13-4 15:00–15:30

Continuous Coupling of Kinetic and Aeroacoustic Models

Frank, Martin RWTH Aachen Univ.

Abstract: We investigate the simulation of the acoustic near and far field of a turbulent flow through a thin porous medium. Within the porous medium and the turbulence close to the porous medium, we need to resolve the fine scales of the pores and the turbulence, respectively. We investigate a smooth transition function approach for the coupling of a kinetic simulation method to the linearized Euler equations that govern aeroacoustics.

MS-Mo-D-14 13:30–15:30 111

Mathematical Theories and Computational Aspects of Complex Fluids - Part I of III

For Part 2, see MS-Mo-E-14
For Part 3, see MS-Tu-D-14

Organizer: Wang, Changyou Purdue Univ.
Organizer: Liu, Chun Penn State Univ.
Organizer: LIn, Fanghua Courant Inst./NYU

Abstract: Complex fluids, fluids with microstructure, are ubiquitous in our daily life and modern day engineering and biology applications. We are facing new challenges in mathematical theories and techniques in order to resolve issues such as ensemble of micro-elements, intermolecular interactions, coupling to hydrodynamics and applied electric or magnetic fields. The multiphysics-multiscale nature of these complicated materials also provide the best testing ground for new techniques and ideas.
In these mini-symposium sessions, we will bring some of the most active researchers in this field, together with postdocs and students. The purpose is to present the most current results, provoking new ideas, as well as motivate the young researchers to work in the field.

▶ MS-Mo-D-14-1 13:30–14:00

Global Regularity to the Navier-Stokes Equations for A Class of Large Initial Data

Lei, Zhen Fudan Univ.

Abstract: We prove that for initial data of the form

$$u_0^\epsilon(x) = (v_0^h(x_\epsilon), \epsilon^{-1}v_0^3(x_\epsilon))^T, \quad x_\epsilon = (x_h, \epsilon x_3)^T,$$

the Cauchy problem of the incompressible Navier-Stokes equations on $\mathbb{R}^3$ is globally well-posed for all $\epsilon > 0$, provided that the initial velocity profile v_0 is analytic in x_3 and certain norm of v_0 is sufficiently small but independent of ϵ.

▶ MS-Mo-D-14-2 14:00–14:30

Wellposedness of Compressible Elastodynamics

Hu, Xianpeng City Univ. of Hong Kong

Abstract: This talk is devoted to the study on the wellposedness issue of compressible elastodynamics.

▶ MS-Mo-D-14-3 14:30–15:00

A Variational Approach to Thin Film Hydrodynamics of Binary Mixtures

Qian, Tiezheng Hong Kong Univ. of Sci. & Tech.

Abstract: In order to model the dynamics of thin films of mixtures, solutions, and suspensions, a thermodynamically consistent formulation is needed such that various coexisting dissipative processes with cross couplings can be correctly described in the presence of capillarity, wettability, and mixing effects. In the present work, we apply Onsager's variational principle to the formulation of thin film hydrodynamics for binary fluid mixtures.

▶ MS-Mo-D-14-4 15:00–15:30

Decoupled Energy Stable Schemes for Vesicle Membrane Phase Field Model

Zhang, Hui Beijing Normal Unversity

Abstract: We present numerical approximations of phase-field vesicle membrane models. We first reformulate the model derived from an energetic variational formulation into a form which is suitable for numerical approximation, and establish their energy laws. Then, we construct a stabilized, decoupled time discretization scheme for the coupled nonlinear systems. The scheme are unconditionally energy stable and lead to decoupled elliptic equations to solve at each time step. Furthermore, these elliptic equations are linear stabilized version.

MS-Mo-D-15 13:30–15:30 213B
Evolution of interfaces driven by anisotropic laws - Part I of II
For Part 2, see MS-Mo-E-15

Organizer: Rybka, Piotr — The Univ. of Warsaw
Organizer: Giga, Yoshikazu — Univ. of Tokyo

Abstract: The minisymposium presents the state of art of rigorous analysis and numerical simulations of interfacial motions. We have in mind problems, where diffusion or anisotropy play a key role: 1) The multigrain motion, where the interaction between grains are the main issue. 2) Models of crystal growth and other phenomena in physics and industrial applications, where singular diffusion (or fractional diffusion) equations play the major role. Other approaches to crystal growth like the BCF models are in the scope of the minisymposium. 3) Image analysis and its subtle relation to the singular parabolic problem appearing in the crystal growth models.

▶MS-Mo-D-15-1 13:30–14:00
The Euler–Lagrange Equation for the Anisopropic Least Gradient Problem
Mazon, Jose — Universitat de Valencia

Abstract: We find the Euler–Lagrange equation for the anisotropic least gradient problem

$$\inf \left\{ \int_\Omega \phi(x, Du) \ : \ u \in BV(\Omega), \ u|_{\partial\Omega} = f \right\}$$

being ϕ a metric integrand and $f \in L^1(\partial\Omega)$. We also characterize the functions of ϕ-least gradient as those whose boundary of the level set are ϕ-area minimizing in Ω.

▶MS-Mo-D-15-2 14:00–14:30
Algorithms for Anisotropic Mean Curvature Flow of Networks
Esedoglu, Selim — Univ. of Michigan

Abstract: We describe how to extend the threshold dynamics algorithm of Merriman, Bence, and Osher to weighted mean curvature flow of networks, where the surface tension of each interface in the network may be different and may depend on the direction of the normal. Joint work with Felix Otto and Matt Elsey.

▶MS-Mo-D-15-3 14:30–15:00
Depinning for Geometric Flows
Braides, Andrea — Univ. of Rome Tor Vergata

Abstract: We consider inhomogeneous surface energies whose homogenized (static) limits are described by crystalline perimeters. The corresponding flows present pinning and depinning phenomena due to the presence of many local minima, so that their limit description varies from the geometric flow of the Gamma-limit. We compute the effective flow and show how the Gamma-limit description must be corrected. We highlight how such phenomena can be framed within the theory of minimizing movements along a sequence.

▶MS-Mo-D-15-4 15:00–15:30
Surface Evolution and Grain Boundary Migration: Some Theory and Applications
Novick-Cohen, Amy — Technion IIT

Abstract: In applications, grain boundary migration by mean curvature motion and surface evolution by surface diffusion often couple dynamically yielding a complex combination of evolving surfaces where both these two types of motion occur. In my lecture, a variety of physical problems will be described which may be modeled by such motions. While some of these problems appear to require an anisotropic formulation, often isotropic description are useful to consider.

MS-Mo-D-16 13:30–15:30 205A
Data-driven mathematical models for production and traffic flow - Part I of II
For Part 2, see MS-Mo-E-16

Organizer: HERTY, MICHAEL — RWTH AACHEN Univ.
Organizer: Goettlich, Simone — Univ. of Mannheim

Abstract: We bring together researchers working on macroscopic models based on partial differential equations for modeling nonlinear phenomena in traffic or production. Contrary to existing approaches we emphasize mathematical models obtained from empirical or measured data. The models may be obtained by mean field limits, statistical approaches or by phenomenological approaches. We are interested in mathematical differential models of either kinetic or hyperbolic type commonly observed in the field of traffic and production. The exchange between those two applications should lead to new insights and mathematical techniques.

▶MS-Mo-D-16-1 13:30–14:00
Second-order Models for Traffic Flow and Estimation of Fuel Consumption
Piccoli, Benedetto — Rutgers Univ. - Camden

Abstract: We revise a number of recently proposed second order models for traffic flow such as Aw-Rascle and Phase Transition Models. We test the models on NGSIM data for their prediction capabilities of fuel consumption. In particular we investigate the quality of prediction for under-sampled data.

▶MS-Mo-D-16-2 14:00–14:30
Data-fitted Macroscopic Production Models
Goettlich, Simone — Univ. of Mannheim
HERTY, MICHAEL — RWTH AACHEN Univ.

Abstract: Starting from discrete event simulations based we simulate the interplay between product density and flux. Data-fitting helps to determine the right parameters for flux functions to close first and second order conservation laws. For the first order case well-known relations from M/M/1-queuing theory can be reproduced. To include more information from the data into the model, a second equation is introduced leading to a second order model which is close to to the Aw-Rascle-Zhang model.

▶MS-Mo-D-16-3 14:30–15:00
Uncertainty Quantification in Traffic Flow Models Calibration from GPS Data
Goatin, Paola — Inria

Abstract: Facing the problem of macroscopic traffic flow models calibration with Floating Car Data from GPS devices, we propose to introduce the dependence form random parameters in the mean velocity closure equation and the initial density profile. We use a semi-intrusive deterministic approach to quantify uncertainty propagation in traffic density evolution and travel-times estimation. Numerical results are presented. The approach is then validated on processed real data on a stretch of highway in South-East France.

▶MS-Mo-D-16-4 15:00–15:30
A Multi-commodity Traffic Flow Model for Heterogeneous Flow in General Networks
Samaranayake, Samitha — MIT

Abstract: We consider a multi-commodity traffic flow model for solving the dynamic system optimal traffic assignment problem with partial control. The goal of which is to find the system optimal allocation of the controllable flow. We should that this model provides explicit solutions to the boundary problem and leads to an efficient solutions to our optimization problem via the discrete adjoint method. Numerical results are provided for freeway corridor from Southern California.

MS-Mo-D-17 13:30–16:00 205B
Mathematical Theories for Hydrodynamic Stability/Instability

Organizer: Guo, Yan — Division of Applied Mathematics, Box F, Brown Univ., Providence, RI 02912, USA
Organizer: Jiang, Song — Inst. of Applied Physics & Computational Mathematics

Abstract: Stability problem plays a fundamental role in the fluid study. A stable steady state is physically important for its observation, while instability of steady states is the source of complicated dynamic patterns which eventually may become turbulent. In general, it has been a challenging mathematical problem to find effective methods to characterize stability of a given steady state. In recent years, new variational methods and rigorous asymptotic analysis are developed to determine linear stability of viscous as well as inviscid steady flows. New progresses in the study of nonlinear stability and instability have also been made. The goal of this workshop is to foster interactions between different research groups with different mathematical methods in the study of fluid stability.

▶MS-Mo-D-17-1 13:30–14:00
On the Free Boundary Problem for Layers of Viscous Fluids
Yanjin, Wang — Xiamen Univ.

Abstract: We consider the dynamics of two layers of viscous fluid lying atop one another. This is a free boundary problem: the interfaces between the fluids and above the upper fluid are free to move. The fluids are acted on by gravity and surface tension forces. We prove the sharp nonlinear stability and instability criterion of the equilibrium.

▶MS-Mo-D-17-2 14:00–14:30
Evolution of Ascending Flow of the Air with Condensation of Vapor
Fujita Yashima, Hisao — Université 8 Mai 1945 Guelma

Abstract: We consider the motion of the air with condensation of water vapor in a high cylinderic domain. The motion is described by classical hydrodynamic equations (see e.g. Landau-Lifchitz), to which we add condensation term with latent heat and dynamical effect of water droplets. Numercal solution shows the very quick growth of ascending motion and its stabilization by

the effects of droplets.

▶ MS-Mo-D-17-3 14:30–15:00

Instability of Shear Flows in 3-d Prandtl Boundary Layer Equations

Wang, Yaguang Shanghai Jiaotong Univ.

Abstract: In this talk, we shall study the stability of the three dimensional Prandtl boundary layer equatons, which shows that monotonic shear flows are linearly and nonlinearly unstable in the three dimensional Prandtl boundary layers in general.

▶ MS-Mo-D-17-4 15:00–15:30

Stability for the Incompressible 2-D Boussinesq System for Magnetohydrodynamics Convection

Gui, Guilong School of Mathematics, Northwest Univ., China

Abstract: Consideration in this talk is the stability analysis of the 2-D magnetohydrodynamics-Boussinesq system with the temperature-dependent viscosity, thermal diffusivity and electrical conductivity. It's established that, the steady-state is globally stable when the steady linear mean temperature profile is increasing in terms of height. Moreover, the decay estimate of the solution to the perturbed system is investigated. It is also shown that, if the mean state decreases with height, the steady state is nonlinearly unstable.

▶ MS-Mo-D-17-5 15:30–16:00

2D Navier-Stokes Equations with Large Reynolds Number

Guo, Yan Division of Applied Mathematics, Box F, Brown Univ., Providence, RI 02912, USA

Abstract: Instability of channel flows and steady Prandtl layer expansions for large Reynolds number will be discussed.

MS-Mo-D-18 13:30–15:30 209B

Nonlinear Dispersive Wave Equations - Part I of II

For Part 2, see MS-Mo-E-18

Organizer: Yanzhi, Zhang Missouri Univ. of Sci. & Tech.
Organizer: Cai, Yongyong Beijing Computational Sci. Research Center
Organizer: Lakoba, Taras Univ. of Vermont

Abstract: Nonlinear dispersive wave equations have applications in various fields, such as quantum mechanics, nonlinear optics, fluid dynamics, electromagnetic theory and so on. This mini-symposium focuses on both theoretical and numerical studies on various nonlinear dispersive wave equations. The topics include, but not limited to, existence of traveling wave solutions, orbital stability of solitary waves, numerical algorithms to solve nonlinear wave equations, and numerical computations.

▶ MS-Mo-D-18-1 13:30–14:00

Nonlinear Wave and Schrodinger Equation on Non-trapping Asymptotically Conic Manifold

Zhang, Junyong Beijing Inst. of Tech. & Beijing Computational Sci. Research Center

Abstract: We will look at the establishment of the global-in-time Strichartz estimates for the wave and Schrodinger equation on non-trapping asymptotically conic manifold. By using the Strichartz estimates, we study the well-posedeness and long-time behavior of the solutions to some nonlinear wave and Schrodinger equations. Some of results are from a joint work with Andrew Hassell.

▶ MS-Mo-D-18-2 14:00–14:30

Inverse Problems for the Schrödinger Equation via Carleman Estimate

Zheng, Chuang Beijing Normal Univ.

Abstract: In this talk we will discuss the Semilinear fourth order Schrödinger operator and its Carleman estimate. The Carleman estimate is used to prove the Lipschitz stability for an inverse problem consisting in retrieving the stationary potential from boundary measurements.

▶ MS-Mo-D-18-3 14:30–15:00

Pseudo-arclength Continuation Algorithms for Symmetry-breaking Solutions of Spin-1 Bose-Einstein Condensates

Chien, Cheng-Sheng Chien Hsin Univ. of Sci. & Tech.

Abstract: We study pseudo-arclength continuation algorithms for computing the ground state and excited-state solutions of two-dimensional spin-1 BEC. Here the chemical potential, the magnetic potential, and magnetization are used as the three components for the continuation variable. We implement the pseudo-arclength continuation algorithm until the magnetization condition is satisfied. Of particular interest here is the investigation of symmetry-breaking solutions. Some numerical experiments on Na-23 and Rb-87 are reported.

▶ MS-Mo-D-18-4 15:00–15:30

Ground States of Two-Dimentional Attractive Bose-Einstein Condensates

Guo, Yujin Wuhan Inst. of Physics & Mathematics, Chinese Acad. of Sci.

Abstract: This talk is focussed on the analytic properties, including the threshold, mass concentration and symmetry breaking, of ground states for Bose-Einstein condensates (BEC) with attractive interactions in R^2.

MS-Mo-D-19 13:30–15:30 307B

Multiscale methods with applications in fluid mechanics and materials modeling. - Part I of III

For Part 2, see MS-Mo-E-19
For Part 3, see MS-Tu-D-19

Organizer: Brown, Donald Univ. of Bonn
Organizer: Henning, Patrick Univ. of Muenster

Abstract: With this Minisymposium we aim to gather leading researchers in the field of numerical multiscale methods, i.e. methods that are constructed to efficiently tackle differential equations with a large spectrum of length and time scales. The speakers present a wide range of different applications and approaches resulting in an extensive exchange of ideas. Among others, parabolic and hyperbolic multiscale problems are discussed, as well as Maxwell's equations or the two-phase flow equations in porous media. The minisymposium focuses on the practical aspects of the methods, as well as on questions regarding a corresponding numerical analysis.

▶ MS-Mo-D-19-1 13:30–14:00

Multiscale Multilevel Monte Carlo Estimation of Transport Properties in Heterogeneous Flows

Icardi, Matteo KAUST
TEMPONE, RAUL KING ABDULLAH Univ. OF Sci. & Tech.

Abstract: We propose a general-purpose algorithm and computational code for the solution of Partial Differential Equations (PDEs) on random geometry and with random parameters. We make use of the key idea of MLMC, based on different discretization levels, extending it in a more general context, making use of a hierarchy of resolution scales, solvers, models and other numerical/geometrical discretization parameters. Modifications of the classical MLMC are proposed to further reduce variance far from the asymptotic regimes.

▶ MS-Mo-D-19-2 14:00–14:30

A Generalized Multiscale Finite Element Method for the Brinkman Equation

Li, Guanglian Texas A&M Univ.

Abstract: We develop and analyze a robust and efficient Generalized Multiscale Finite Element Method (GMsFEM) for the Brinkman model in two dimensions. Using the GMsFEM framework we construct suitable coarse-scale spaces for the velocity and pressure that yield a robust mixed GMsFEM. This is a joint work with Juan Galvis and Ke Shi.

▶ MS-Mo-D-19-3 14:30–15:00

Multiscale Simulations for Wave Propagation in Heterogeneous Media Using Generalized Multiscale Finite Element Methods

Fu, Shubin Texas A&M Univ.

Abstract: We propose a Generalized Multiscale Finite-Element Method for elastic wave propagation in heterogeneous, anisotropic media, where we construct basis functions from multiple local problems for both the boundaries and interior of a coarse node support or coarse element. The application of multiscale basis functions can capture the fine scale medium property variations, and allows us to greatly reduce the degrees of freedom that are required to implement the modeling.

▶ MS-Mo-D-19-4 15:00–15:30

Numerical Homogenization for the Wave Equation.

Henning, Patrick Univ. of Muenster

Abstract: We propose and analyze a multiscale method for the wave equation. The proposed method does not require any assumptions on space regularity or scale-separation and it is formulated in the framework of the Localized Orthogonal Decomposition (LOD). We derive rigorous a priori error estimates for the L2-approximation properties of the method, finding that convergence rates of up to third order can be achieved.

MS-Mo-D-20 13:30–15:30 210B
Low-rank Tensor Approximation in Multi-parametric and Stochastic PDEs - Part I of II
For Part 2, see MS-Mo-E-20

Organizer: Litvinenko, Alexander KAUST, UQ & ECRC Centers
Organizer: Matthies, Hermann TU Braunschweig, Inst. of Scientific Computing
Organizer: Nouy, Anthony Ecole Centrale Nantes

Abstract: Approximations of stochastic and multi-parametric differential equations may lead to extremely high dimensional problems that suffer from the so called curse of dimensionality. Computational tractability may be recovered by relying on adaptive low-rank/sparse approximation. The tasks are 1) to keep a low-rank approximation of the high-dimensional input data through the whole computing process, 2) compute the solution and perform a post-processing in a low-rank tensor format. The post-processing may include computation of different statistics, visualization of a small portion of large data, large data analysis. The aim is to develop numerical methods which will reduce the computational cost as well as the storage requirement from $O(n^d)$ to $O(knd)$, where k is a small integer (related with the rank). The purpose of this minisymposium is to bring together experts in adaptive discretization/solution of stochastic/multi-parametric problems, experts in multi-linear algebra and experts in uncertainty quantification methods.

▶MS-Mo-D-20-1 13:30–14:00
Time-dependent Low-rank Approximation Method for Solving Parametric Dynamical Systems
BILLAUD-FRIESS, Marie Ecole Centrale de Nantes
Nouy, Anthony Ecole Centrale Nantes

Abstract: This talk concerns a low-rank approximation method for the model reduction of non-linear parametric dynamical systems. The proposed approach combines the construction of a time dependent reduced space in which the full model is projected to derive the reduced dynamical system that takes into account the basis dynamic through a modified flux. Here, the reduced space basis is selected in a greedy fashion among a snapshot in parameter of the solution trajectories using a posteriori error estimate.

▶MS-Mo-D-20-2 14:00–14:30
Approximating Stochastic Galerkin Operator in the Tensor Train Data Format
Litvinenko, Alexander KAUST, UQ & ECRC Centers
Matthies, Hermann TU Braunschweig, Inst. of Scientific Computing

Abstract: We apply Tensor Train approximation to solve stochastic elliptic PDE with stochastic Galerkin discretization. We compare two strategies of the polynomial chaos expansion: sparse and full polynomial sets. In full set, the polynomial orders are chosen independently in each variable, which provides higher flexibility and accuracy. We demonstrate that full expansion set encapsulated in TT format is indeed preferable in cases when high accuracy and high polynomial orders are required. Many numerical experiments are provided.

▶MS-Mo-D-20-3 14:30–15:00
Kolmogorov Widths and Low-rank Approximations of Parametric Elliptic PDEs
Bachmayr, Markus UPMC Paris 06

Abstract: This talk is concerned with low-rank approximations of solution manifolds of parametric diffusion equations, with a particular focus on the case of piecewise constant parametrized diffusion coefficients. Decay estimates for the Kolmogorov widths of solution manifolds are established, which are closely connected to the performance that can be achieved by the reduced basis method. The estimates are illustrated by numerical experiments. (Joint work with Albert Cohen.)

▶MS-Mo-D-20-4 15:00–15:30
Adaptive-fiber Tensor-trains with Application to Bayesian Inference
Gorodetsky, Alex Massachusetts Inst. of Tech.
Marzouk, Youssef Massachusetts Inst. of Tech.

Abstract: Tensor-train (TT) decompositions can enable dramatic compression of arrays arising from discretizations of high dimensional functions. In many applications, however, it is unclear how to specify the discretization level. We propose an extension to TT decomposition that yields virtual discretization-invariance by taking advantage of additional structure (e.g., smoothness, periodicity, along with derivative information) to adaptively approximate each tensor fiber. We apply the new adaptive-fiber TT decomposition to yield a sampling-free Bayesian inference approach.

IM-Mo-D-21 13:30–15:30 309B
Mathematical Optimization of Gas Transport
Organizer: Koch, Thorsten TU Berlin / Zuse-Insitute Berlin

Abstract: About 25
Talk 1: Evaluating gas network capacities Prof. Dr. Thorsten Koch, TU-Berlin, koch@zib.de In 2008 Open Grid Europe, Germany's largest gas transport system operator, initiated the Research Cooperation Network Optimization (ForNe) due to the challenges imposed by new regulations on gas transportation. Researcher from six intuitions and supported by the German regulation authority worked on modelling and solving mid- and long-term capacity planning problems in gas transport networks. Building on the mathematical results of the project a prototype system was built using a new paradigm in capacity planning. We will report on the results of this seven year project.
Talk 2: Complex European gas supply leads to ever new challenges Dr. Jessica Rövekamp, Open Grid Europe GmbH, jessica.roevekamp@googlemail.com The European gas supply is characterized by a variety of sources of supply, high import dependency, numerous market actors along the value chain and different gas compositions and pressure levels in the pipeline system. Member States have different requirements for gas properties as well as different measurement and regulation systems. Thereby, the focus is always on the security of supply. The discourse shows how these challenges are dealt with and what future developments the European gas supply will have to adapt to.
Talk 3: Mathematical modeling, simulation, and optimization using the example of gas networks Prof. Dr. Alexander Martin, Universität Erlangen-Nürnberg, Alexander.Martin@math.uni-erlangen.de Beginning Oct. 1st 2014, the German national science foundation's collaborative research center/transregio 154 Mathematical modeling, simulation, and optimization using the example of gas networks will start with more than 20 projects at 5 locations over a 4 to 12 year timeframe. The focus is to study the underlying and inherent mathematical problems including the design of a consistent hierarchy of models, from PDE driven up to combinatorial, the studying of appropriate error controls at each level as well as the development of global optimal solutions methods. We will report on these goals, challenges, and present first results.
Talk 4: MODAL: GasLab Dr. Janina Körper, Zuse-Institute Berlin (ZIB), koerper@zib.de Supported by the German Federal Ministry of Education and Research the Research Campus MODAL (Mathematical Optimization and Data Laboratories) started its operation in 2014. A major part of it is the GasLab where ZIB together with Open Grid Europe will research new methods for improved real time control of the gas transport network. Complementing the previous talk, which focusses on improved theory, the GasLab's mission is to bring the latest in mathematical optimization into practical use.

▶IM-Mo-D-21-1 13:30–14:00
Evaluating Gas Network Capacities
Koch, Thorsten TU Berlin / Zuse-Insitute Berlin

Abstract: In 2008 OGE, Germany's largest gas transport system operator, initiated the Research Cooperation Network Optimization due to the challenges imposed by new regulations on gas transportation. Researcher from 6 intuitions worked on modelling and solving mid- and long-term capacity planning problems in gas transport networks. Building on the mathematical results of the project a prototype system was built using a new paradigm in capacity planning. We report on the results of this 7 year project.

▶IM-Mo-D-21-2 14:00–14:30
Mathematical Modeling, Simulation, and Optimization Using the Example of Gas Networks
Martin, Alexander Friedrich-Alexander-Univ. Erlangen-Nuremberg

Abstract: The focus of the collaborative research center TRR154, supported by the German science foundation, is to study the optimization of gas transport networks and its underlying and inherent mathematical problems including the design of a consistent hierarchy of models, from PDE driven up to combinatorial, the studying of appropriate error controls at each level as well as the development of global optimal solutions methods. We will report on these goals, challenges, and present first results.

▶IM-Mo-D-21-3 14:30–15:00
Complex European Gas Supply Leads to Ever New Challenges
Roevekamp, Jessica CYRCO GmbH

Abstract: The European gas supply is characterized by a variety of sources of supply, high import dependency, numerous market actors along the value chain and different gas compositions and pressure levels in the pipeline system. The goal is to create one European market while securing future supply, although Member States have different regulatory regimes. The discourse shows how these challenges are dealt with and what future developments the European gas supply will have to adapt to.

▶IM-Mo-D-21-4 15:00–15:30

MODAL GasLab - Optimization Approaches of Real World Problems in the Gas Transport Industry

Lenz, Ralf — Zuse Inst. Berlin
Gamrath, Inken — Zuse Inst. Berlin
Hennig, Kai — Zuse Inst. Berlin
Koch, Thorsten — TU Berlin / Zuse-Insitute Berlin
Koerper, Janina — Konrad-Zuse-Centrum for Information Tech. Berlin
Simon, Felix — Zuse Inst. Berlin

Abstract: The MODAL GasLab (Mathematical Optimization and Data Analysis Laboratories) brings state-of-the-art mathematical optimization methods into practice in the gas transport industry. For example, critical flow and pressure situations in gas networks might interrupt the gas supply of system-relevant gas power stations. To prevent this, a new contract has been designed to guarantee their gas supply by predefined entries. Here, we present a model formulation as well as first heuristic solution approaches based on game theory.

MS-Mo-D-22 13:30–15:30 206A

Recent Advances in A Posteriori Error Estimation and Adaptive Methods - Part I of II

For Part 2, see MS-Mo-E-22

Organizer: Zhang, Shun — City Univ. of Hong Kong
Organizer: Cai, Zhiqiang — Purdue Univ.

Abstract: Self-adaptive numerical methods provide a powerful and automatic approach in scientific computing. In particular, Adaptive Mesh Refinement (AMR) algorithms have been widely used in computational science and engineering and have become a necessary tool in computer simulations of complex natural and engineering problems. The key ingredient for success of self-adaptive numerical methods is a posteriori error estimates that are able to accurately locate sources of global and local error in the current approximation. Talks in this mini-symposium will cover some recent advances in the development and analysis of both a posteriori estimators and (convergent) adaptive schemes, as well as indicate directions of future research.

▶MS-Mo-D-22-1 13:30–14:00

Robust and Optimal A Priori and A Posteriori Error Estimats for Diffusion Equations with Discontinuous Coefficients

Zhang, Shun — City Univ. of Hong Kong

Abstract: For diffusion problems of discontinuous coefficients, the quasi-monotonicity assumption (QMA) is a very important condition to guarantee the robustness of the problem independent of the coefficients. In this talk, new results of robust and optimal a priori and a posteriori error estimates for various finite element approximations of diffusion problems with discontinuous coefficients without QMA are discussed.

▶MS-Mo-D-22-2 14:00–14:30

Robust A Posteriori Error Estimates for HDG Method for Convection-Diffusion Equations

Qiu, Weifeng — City Univ. of Hong Kong
Chen, Huangxin — Xiamen Univ.

Abstract: We propose a robust a posteriori error estimator for the hybridizable discontinuous Galerkin (HDG) method for convection-diffusion equations with dominant convection. The reliability and efficiency of the estimator are established for the error measured in an energy norm. The energy norm is uniformly bounded even when the diffusion coefficient tends to zero.

▶MS-Mo-D-22-3 14:30–15:00

A Posteriori Error Estimation Using Auxiliary Subspace Techniques

Ovall, Jeffrey — Portland State Univ.

Abstract: The discretization error for conforming simplicial finite elements is estimated by computing a function in an auxiliary subspace. The corresponding error estimates are proven to be efficient and reliable (up to an oscillation term), and numerical experiments demonstrate its robustness with respect to singularities, variation in the coefficients of the differential operator, and polynomial degree used in the discretization.

▶MS-Mo-D-22-4 15:00–15:30

Optimality of Adaptive Finite Element Methods for Controlling Local Energy Errors

Demlow, Alan — Texas A&M Univ.

Abstract: While proof of convergence and optimality of adaptive FEM (AFEM) for controlling standard energy errors is now relatively standard, there are few corresponding results concerning optimality of AFEM for controlling other norms of the error. In this talk we discuss optimality of an AFEM for controlling local energy norms of the error.

MS-Mo-D-23 13:30–15:30 208A

Recent Developments in Finite Element Methods for Variational Inequalities - Part I of II

For Part 2, see MS-Mo-E-23

Organizer: Nataraj, Neela — Indian Inst. of Tech. Bombay
Organizer: Gudi, Thirupathi — Indian Inst. of Sci., Bangalore

Abstract: Variational inequalities have been playing a key role in the modern scientific world. The theory of variational inequalities provides a generalization of the theory of boundary value problems and has applications in many fields like Applied Mathematics, Mechanics, Theory of Control and so on. Unlike variational equations, inequalities exhibit additional singularities due to occurrence of free boundaries, which limit the regularity of the solution. The study of computational methods for variational inequalities thus offers more challenges. The error analysis for the finite element methods of these problems should also be derived under the limited regularity assumptions. Adaptive finite element techniques are quite desirable for these class of problems. We would like to discuss and exchange some of the latest developments in the error analysis of finite element methods for variational inequalities.

▶MS-Mo-D-23-1 13:30–14:00

A Reliable Residual Based A Posteriori Error Estimator for A Quadratic FEM for the Obstacle Problem

Gudi, Thirupathi — Indian Inst. of Sci., Bangalore

Abstract: In this talk, we discuss on derivation of a reliable residual based a posteriori error estimator for the quadratic finite element method for the obstacle problem. The crux of the error analysis is involved in defining an appropriate Lagrange multiplier due to obstacle constraint. The numerical experiments of adaptive algorithm with Dorfler marking strategy shows optimal order convergence and illustrates that the quadratic adaptive fem is not suboptimal.

▶MS-Mo-D-23-2 14:00–14:30

A Nonconforming Finite Element Approximation for Optimal Control of the Obstacle Problem

Nataraj, Neela — Indian Inst. of Tech. Bombay

Abstract: The talk deals with the analysis of a nonconforming finite element method for the discretization of optimization problems governed by variational inequalities. The state and adjoint variables are discretized using Crouziex-Raviart (CR) nonconforming finite elements and the control is discretized using a variational discretization approach. Error estimates have been established for the state and control variables. The theoretical results are justified by numerical experiments.

▶MS-Mo-D-23-3 14:30–15:00

Optimality and Convergence of A Standard Adaptive Conforming Linear Element Method for An Obstacle Problem

Hu, Jun — Peking Univ.

Abstract: In this talk we present the first optimality and convergence analysis of a standard adaptive conforming linear element method for an obstacle problem. The main ingredients for the analysis are the usual Scott-Zhang quasi–interpolation operator and a refined a posteriori error estimator. This is a joint work with Carsten Carstensen.

▶MS-Mo-D-23-4 15:00–15:30

A Posteriori Error Analysis for Finite Element Methods for Fourth Order Variational Inequalities

Sung, Li-yeng — Louisiana State Univ.

Abstract: In this talk we will discuss a posteriori error estimates for finite element methods for fourth order variational inequalities, with applications to obstacle problems for Kirchoff plates and optimal control problems with pointwise state constraints. This is joint work with Susanne C. Brenner, Joscha Gedicke and Yi Zhang.

MS-Mo-D-24 13:30–15:30 211

Recent Advances in Kinetic Equations: Numerical Methods and Their Applications - Part I of II

For Part 2, see MS-Mo-E-24

Organizer: Haack, Jeff — Los Alamos National Laboratory
Organizer: Hu, Jingwei — Purdue Univ.
Organizer: Tang, Min — shanghai jiao tong Univ.

Abstract: Kinetic equations and related models play an important role in many science and engineering branches. Examples include: gas/plasma dynamics, radiative transfer, semiconductor modeling, complex systems in biological

or social sciences, etc. Designing numerical methods in these applications present similar challenges, ranging from multiscale modeling, nonlinear analysis, to large computational expense requiring high performance computing. This minisymposium aims to report the recent progress in the development of numerical methods for various kinetic equations, and by bringing researchers from diverse fields, to stimulate new problems and methods.

▶ MS-Mo-D-24-1 13:30–14:00

Mathematical Description of Bacterial Motion by Chemotaxis : Kinetic Description and Hydrodynamic Limit

Vauchelet, Nicolas — Univ. Paris 6

Abstract: Since experimental observations have shown that the motion of bacteria (e.g. Escherichia Coli) is due to the alternation of 'runs' and 'tumbles', mathematical modelling of this motion thanks to a kinetic description has been proposed. From this mesoscopic description, macroscopic models have been derived whose study and numerical simulations are challenging, since blow up phenomena appears at the limit.

▶ MS-Mo-D-24-2 14:00–14:30

A Fast Spectral Method for the Boltzmann Equation of Monatomic Gas Mixtures

Wu, Lei — Univ. of Strathclyde

Abstract: a fast spectral method is proposed to solve the Boltzmann equation for gas mixtures, with a computational cost $\sqrt{m_r}M^2N_\xi^4\log N_\xi$, where N_ξ is the number of frequency nodes in each frequency direction, M^2 is the number of solid angle discretization, and m_r is the molecular mass ratio. The algorithm is validated by comparing the numerical results with analytical Bobylev-Krook-Wu (DSMC) solutions in the spatial- homogeneous (inhomogeneous) problems, for m_r up to 36.

▶ MS-Mo-D-24-3 14:30–15:00

Analysis of the Stationary Wigner Equation with Inflow Boundary Conditions

Lu, Tiao — Peking Univ.

Abstract: The stationary Wigner equation with inflow boundary conditions (BVP) has been wideley applied in numerical simulation of nano semiconductor devices. I will introduce our recent work on analysis of the mathematical properties of the BVP and then present a semi-discrete version of the Wigner equation and prove that the constructed numerical solution by using the Shannon-Whittaker interpolation formula converges to the solution of the continuous BVP as the velocity mesh size goes to zero.

▶ MS-Mo-D-24-4 15:00–15:30

Conservative Discrete Velocity Method for Non-equilibrium Flows

Zhang, Yonghao — Univ. of Strathclyde

Abstract: Rapid advances have been made for micro/nano-fluidic technology, which demands computationally efficient design simulation tools that can capture non-equilibrium flow phenomena. Our recent development of conservative discrete velocity method for modelling gas flows beyond the Navier-Stokes hydrodynamics will be discussed. With a moderate discrete velocity set, we find our model can accurately recover steady and transient solutions of the kinetic equation in the slip-flow and early transition regimes.

MS-Mo-D-25 13:30–15:30 210A

Isogeometric methods and design-through-analysis tools in CAD/CAE - Part I of III

For Part 2, see MS-Mo-E-25
For Part 3, see MS-Tu-D-25

Organizer: BUFFA, Annalisa — IMATI "E. Magenes", CNR
Organizer: Giannelli, Carlotta — INdAM c/o Univ. of Florence

Abstract: The development process of industrial digital products relies on geometrical and numerical technologies provided by computer aided applications. The computational models are usually designed through commercial Computer Aided Design (CAD) systems and subsequently processed and approximated with Computer Aided Engineering (CAE) software tools.
In order to drastically improve the efficiency and robustness of this process, a deep interaction among scientists from geometric modeling and numerical analysis is needed. An active area of research in this context is related to isogeometric analysis, an emerging paradigm for the solution of partial differential equations which combines and extends finite element techniques with CAD methods related to spline technologies. The isogeometric perspective outlines new paths of research for the identification of geometric representations suitable for numerical simulation.
Indeed, isogeometric analysis is based on the idea that the exact geometry of the model should be preserved throughout the overall design-through-analysis process and numerical methods should be able to simulate physical phenomena directly on the CAD model. This is possible only if new, spline based, numerical techniques are designed and innovative schemes for geometric design are developed.
The minisymposium will address theoretical and computational issues that arise in the identification, characterization and use of advanced geometric and analytical methods that share the goal of promoting new paradigms for a better CAD/CAE integration.

▶ MS-Mo-D-25-1 13:30–14:00

Algebraic Methods in NURBs Representations, Toward Isogeometric Analysis

Elber, Gershon — Technion, Israel Inst. of Tech.

Abstract: IGA brought geometric design and analysis (D&A) close. We will discuss several geometric challenges in light of IGA needs. The first will consider precise integration over trimmed surfaces, by untrimming them. Another topic that will be considered is the problem of contact analysis. Several methods to detect contacts and collisions and to precisely integrate over noncompatible surfaces will be considered.
* In collaboration with Fady Massarwi, Myung Soo Kim and Annalisa Buffa.

▶ MS-Mo-D-25-2 14:00–14:30

A New Basis Construction for the PHT-Splines

Kang, Hongmei — Univ. of Sci. & Tech. of China
Chen, Falai — Univ. of Sci. & Tech. of China
Deng, Jiansong — Univ. of Sci. & Tech. of China

Abstract: In this talk, we first point out some limitations of PHT-spline basis, i.e., some of the basis functions decay rapidly for certain mesh refinement, which leads to numerical instability in data fitting and finite element analysis. We then propse a new basis construction for the PHT-splines which overcome the above limitations.

▶ MS-Mo-D-25-3 14:30–15:00

Overlapping Schwarz Preconditioners for Isogeometric Collocation Methods

Cho, Durkbin — Dongguk Univ.
Pavarino, Luca F. — Univ. of Milan
Scacchi, Simone — Univ. of Milan
Beirao Da Veiga, Lourenco — Univ. of Milan

Abstract: In this talk, an additive overlapping Schwarz method for isogeometric collocation discretizations is introduced and studied. The resulting preconditioner, accelerated by GMRES, is shown to be scalable with respect to the number of subdomains and very robust with respect to the isogeometric discretization parameters such as the mesh size and polynomial degree, as well as with respect to the presence of discontinuous elliptic coefficients and domain deformations.

▶ MS-Mo-D-25-4 15:00–15:30

Scalable BDDC Preconditioners for Isogeometric Analysis of Elliptic Problems.

Pavarino, Luca F. — Univ. of Milan
Cho, Durkbin — Dongguk Univ.
Scacchi, Simone — Univ. of Milan
Zampini, Stefano — KAUST
Beirao Da Veiga, Lourenco — Univ. of Milan
Widlund, Olof B. — Courant Inst. of Mathematical Sci., New York Univ.

Abstract: We will present and study BDDC (Balancing Domain Decomposition by Constraints) preconditioners with different scalings for Isogeometric Analysis discretizations of scalar elliptic problems. We show that the condition number of the resulting BDDC preconditioner is scalable with a quasi-optimal polylogarithmic bound, independently of coefficient discontinuities across subdomain interfaces. Extensive numerical experiments support the theory and show the BDDC strong performance, in particular when a novel deluxe scaling is employed.

MS-Mo-D-26 13:30–15:30 110

Perturbation theory for linear/nonlinear eigenvalue problems in action - Part I of II

For Part 2, see MS-Mo-E-26

Organizer: Nakatsukasa, Yuji — Univ. of Tokyo
Organizer: Miedlar, Agnieszka — EPF Lausanne

Abstract: In numerical analysis, perturbation theory has earned their fame as primarily theoretical contributions, but nonetheless their role in practical computations is crucial. Perturbation results are used extensively for analyzing stability of numerical algorithms or the accuracy of numerical approximation, and sometimes to inspire new algorithm design. Applications include solving PDEs, simulating dynamical systems and model reduction. With the goal to share its beauty and practical importance to a broader audience, this minisymposium reviews classical and recent outstanding results and open problems in eigenvalue perturbation theory, treating both matrices (linear, polynomial and general nonlinear eigenvalue problems) and linear operators.

▶MS-Mo-D-26-1 13:30–14:00

Relative Perturbation Theory for Diagonally Dominant Matrices

Dopico, Froilan M. Universidad Carlos III de Madrid

Abstract: Diagonally dominant matrices are very important in applications and have been extensively studied in the last 50 years. Therefore, it is difficult to believe that something really new can be said on these matrices. However, in the last four years a number of highly structured perturbation results have been proved for these matrices and used to prove that many accurate computations are possible for these matrices. This talk presents an overview of these perturbation results.

▶MS-Mo-D-26-2 14:00–14:30

Convergence Proof for Some Iterative Projection Methods from A Perturbation Bound for Symmetric Eigenvalue Problems

Aishima, Kensuke The Univ. of Tokyo

Abstract: We study the convergence of certain efficient projection methods using restarting and shift-and-invert technique for solving symmetric eigenvalue problems. More precisely, we show that the Ritz pairs converge to exact eigenpairs, although they are not necessarily the target eigenpairs. The key tool for the proof is a perturbation bound obtained by Crouzeix, Philippe, and Sadkane. Our result covers the Jacobi – Davidson and the rational Krylov methods with restarting and preconditioning.

▶MS-Mo-D-26-3 14:30–15:00

Perturbation of Partitioned Linear Response Eigenvalue Problems

Teng, Zhongming Fujian Agriculture & Forestry Univ.
Li, Ren-Cang Univ. of Texas at Arlington

Abstract: This talk is concerned with the perturbation of the partitioned linear response eigenvalue problem. A bound on how the eigenvalues change is obtained. It is of linear order with respect to the diagonal blocks perturbations but of quadratic order with respect to the off-diagonal perturbations. The result is helpful in understanding how the Ritz values move towards eigenvalue in some efficient numerical algorithms for the linear response eigenvalue problem.

▶MS-Mo-D-26-4 15:00–15:30

Generic Low-Rank Perturbations of Alternating Matrix Pencils

Batzke, Leonhard Technical Univ. Berlin

Abstract: Many applications, in particular ones from control, lead to T-alternating (i.e., symmetric / skew-symmetric) matrix pencils and important characteristics can be read off from the canonical form of this pencil. In this talk, we will discuss how the canonical form is altered when a T-alternating regular matrix pencil is subjected to a low-rank perturbation. Surprisingly, compared to arbitrary perturbations, the effect we observe is very different when the perturbation is T-alternating as well.

MS-Mo-D-27 13:30–15:30 407

Numerical Simulations in Poromechanics - Part I of III

For Part 2, see MS-Mo-E-27
For Part 3, see MS-Tu-D-27

Organizer: Gaspar, Francisco Univ. of Zaragoza
Organizer: Hu, Xiaozhe Tufts Univ.
Organizer: Rodrigo, Carmen Univ. of Zaragoza
Organizer: Zikatanov, Ludmil The Pennsylvania State Univ.

Abstract: Poromechanics studies the interactions between fluid motion and deformation in porous media. It has important applications including consolidation, subsidence due to fluid withdrawal, and hydraulic fracturing. Many discretizations and solver schemes have been developed for poromechanics but the design of effective simulation techniques for handling the coupling between fluid motion and solid deformation is still a challenging task. The main theme of the minisymposium is on the advanced numerical algorithms for simulating poromechanics. The focus is on robust discretizations, adaptivity and efficient nonlinear and linear solvers for various poroelastic models and their applications.

▶MS-Mo-D-27-1 13:30–14:00

Numerical Issues in the Simulation of Coupled Poromechanics by Mixed Finite Elements

Ferronato, Massimiliano Univ. of Padova

Abstract: The numerical solution to coupled poromechanics is still a challenging task because of several issues: (1) pore pressure instability, (2) large number of unknowns, and (3) ill-conditioning of the discretized system. The use of Mixed Finite Elements can alleviate the numerical oscillations in the pressure solution, but give rise to very large and ill-conditioned systems of algebraic equations. The use of efficient block preconditioners is presented and discussed to accelerate convergence in complex real-world applications.

▶MS-Mo-D-27-2 14:00–14:30

Uzawa Smoother in Multigrid for Poroelasticity Equations

Luo, Peiyao TU Delft
Rodrigo, Carmen Univ. of Zaragoza
Gaspar, Francisco Univ. of Zaragoza
Oosterlee, Cornelis CWI -center for mathematics & computer Sci.

Abstract: A multigrid method is employed for the poroelastic equations with an Uzawa-type iteration as the smoother. Our analysis of the smoother is based on the framework of local Fourier analysis. An analytic bound can be obtained on the smoothing factor associated with the proposed smoother. Numerical experiments show that the smoothing factor reflects well the two-grid convergence factor obtained from local Fourier analysis, as well as the actual convergence factor from the real multigrid cycles.

▶MS-Mo-D-27-3 14:30–15:00

A Robust Multigrid Method for Discontinuous Galerkin Discretizations of Stokes and Linear Elasticity Equations

Hong, Qinqquo Johann Radon Inst. for Computational & Applied Mathematics (RICAM), Austrian Acad. of Sci. (ÖAW)
Kraus, Johannes Univ. of Duisburg-Essen
Xu, Jinchao PKU,and The Pennsylvania State Univ.
Zikatanov, Ludmil The Pennsylvania State Univ.

Abstract: We consider multigrid methods for discontinuous Galerkin H(div)-conforming discretizations of the Stokes and linear elasticity equations. We show that the variable V-cycle and W-cycle multigrid methods with nonnested bilinear forms are optimal and robust, with convergence rates independent of the mesh size and also of the material parameters such as the Poisson ratio. We further report on the extension of the convergence results to the Brinkman problem.

MS-Mo-D-28 13:30–15:30 109

Weak Galerkin Method and Its Applications - Part I of III

For Part 2, see MS-Mo-E-28
For Part 3, see MS-Tu-D-28

Organizer: Chen, Long Univ. of California at Irvine
Organizer: Ye, Xiu Univ. of Arkansas at Little Rock
Organizer: Zhang, Ran Jilin Univ.

Abstract: The Weak Galerkin method is an extension of the standard Galerkin finite element method where classical derivatives were substituted by weakly defined derivatives on functions with discontinuity. As such, the WG methods have the flexibility in handling complex geometry and low regularity solutions, the simplicity in analyzing real-world physical problems, and the symmetry in reformulating the original PDEs. The aim of this mini-symposium is to bring together specialists in order to ex- change ideas regarding the development of WG-FEMs and its industry and research applications. Since women is an underrepresented group in mathematics and engi- neering, we pay a particular attention to attract female participants.

▶MS-Mo-D-28-1 13:30–14:00

Weak Galerkin Finite Element Methods: Basic Principles and Recent Developments

Wang, Junping National Sci. Foundation

Abstract: In this talk, the speaker will first describe the basic principles for weak Galerkin (WG) finite element methods by using some model PDEs. The speaker will then present some recent developments of WG on three class of problems: (1) PDEs in non-divergent form, (2) PDEs that are generally characterized by inf-sup conditions, and (3) div-curl systems.

▶MS-Mo-D-28-2 14:00–14:30

Innovative Weak Galerkin Finite Element Methods with Application in Fluorescence Tomography

Wang, Chunmei Georgia Inst. of Tech.

Abstract: Fluorescence Tomography (FT) is an emerging, in vivo non-invasive 3-D imaging technique which reconstructs images that characterize the distribution of molecules that are tagged by fluorophores. We present a new and efficient numerical algorithm for FT model by using weak Galerkin (WG) finite element methods. Error estimates in an H^2-equivalent norm and the usual L^2 norm are established. Some numerical experiments are presented to illustrate the efficiency and accuracy of the numerical scheme.

▶MS-Mo-D-28-3 14:30–15:00

Recent Development of Weak Galerkin Methods

Ye, Xiu — Univ. of Arkansas at Little Rock

Abstract: Newly developed weak Galerkin finite element methods will be introduced for solving partial differential equations. Weak Galerkin methods have the flexibility of employing discontinuous elements and share the simple formulations of continuous finite element methods at the same time. The Weak Galerkin method is an extension of the standard Galerkin finite element method where classical derivatives were substituted by weakly defined derivatives on functions with discontinuity. Recent development of weak Galerkin methods will be discussed.

▶ MS-Mo-D-28-4 — 15:00–15:30

Weak Galerkin Finite Element Methods and Numerical Applications

Mu, Lin — Michigan State Univ.

Abstract: Weak Galerkin FEMs are new numerical methods that were first introduced by Wang and Ye for solving general second order elliptic PDEs. The differential operators are replaced by their weak discrete derivatives, which endows high flexibility. This new method is a discontinuous finite element algorithm, which is parameter free, symmetric, symmetric, and absolutely stable. Furthermore, through the Schur-complement technique, an effective implementation of the WG is developed. Several numerical applications will be discussed.

MS-Mo-D-29 13:30–15:30 305

Multilevel Monte Carlo methods and applications - Part I of III

For Part 2, see MS-Mo-E-29
For Part 3, see MS-Tu-D-29

Organizer: TEMPONE, RAUL — KING ABDULLAH Univ. OF Sci. & Tech.
Organizer: Giles, Michael — Univ. of Oxford
Organizer: Nobile, Fabio — MATHICSE - EPFL

Abstract: Monte Carlo methods are general, flexible sampling methods for the computation of expected values of observables arising in stochastic systems. Monte Carlo methods are very attractive since they are simple to implement and their rate of convergence is very robust. Still, in the context of random evolution of large systems arising from the discretization of differential equations subject to randomness, their cost can be too large for practical purposes. The recently created Multilevel Monte Carlo method extended, to multiple levels, the idea of using a coarse numerical approximation as a method for control variate to a finer one, reducing the variance and the required number of samples on the finer grid. Multilevel Monte Carlo changed the computational landscape of stochastic problems described in terms of differential equations, which are commonplace, for instance, when carrying out Uncertainty Quantification in applications. In this minisymposium we intend to present the latest algorithmic and theoretical contributions to Multilevel Monte Carlo methods, focusing also on novel applications arising in, among others, stochastic social, chemical and biological modeling, wireless communication networks, computational finance, stochastic particle systems and engineering modeling with random PDEs.

▶ MS-Mo-D-29-1 — 13:30–14:00

Stabilization of Multilevel Monte-Carlo Methods for Stochastic Differential Equations with Multiple Scales

Abdulle, Assyr — EPFL

Abstract: In this talk we will present recent developments in the design of stabilized numerical methods for stiff stochastic problems [A.Abdulle,G.Vilmart, PIROCK: a swiss-knife partitioned implicit-explicit ROCK integrator for stiff diffusion-advection-reaction problems with or without noise, J. Comput. Phys. 2013]. We then present two stabilized multilevel Monte Carlo method for mean square stable SDEs [A.Abdulle, A.Blumenthal, Stabilized multilevel Monte Carlo method for stiff stochastic differential equations, J. Comput. Phys. 2013].

▶ MS-Mo-D-29-2 — 14:00–14:30

Multilevel Ensemble Kalman Filter

Law, Kody — ORNL
TEMPONE, RAUL — KING ABDULLAH Univ. OF Sci. & Tech.
Hoel, Haakon — Univ. of Oslo

Abstract: This work embeds a multilevel Monte Carlo (MLMC) sampling strategy into the Monte Carlo step of the ensemble Kalman filter (ENKF), thereby yielding a multilevel ensemble Kalman filter (MLENKF) which has provably superior asymptotic cost to a given accuracy level. The theoretical results are illustrated numerically.

▶ MS-Mo-D-29-3 — 14:30–15:00

MLMC for PDE Solutions Based on Feynman-Kac Theorem

Giles, Michael — Univ. of Oxford
Bernal, Francisco — Instituto Superior Tecnico

Abstract: The Feynman-Kac theorem expresses solutions to high-dimensional parabolic PDEs as expectations of functionals of Brownian diffusions. Existing methods using the Euler-Maruyama discretisation achieve O(eps) RMS accuracy at a cost which is $O(\epsilon^{-3})$. We present a new MLMC method with a reduced cost which is $O(\epsilon^{-2})$ if log terms are neglected. This relies heavily on theoretical results derived by E. Gobet and others, and is supported by numerical experiments.

▶ MS-Mo-D-29-4 — 15:00–15:30

The Forward-reverse Method for Conditional Markov Processes

Bayer, Christian — Weierstrass Inst., Berlin

Abstract: In this paper we derive stochastic representations for the finite-dimensional distributions of a multidimensional Markov process on a fixed time interval, conditioned on the terminal state. The conditioning can be with respect to a fixed point or more generally with respect to some subset. The corresponding Monte Carlo estimators have essentially root-N accuracy, and hence they do not suffer from the curse of dimensionality. We also present applications in statistical inference of stochastic reaction networks.

MS-Mo-D-30 13:30–15:30 VIP2-2

Mathematics, statistics and computation in metrology

Organizer: Cox, Maurice — National Physical Laboratory

Abstract: Mathematics, statistics and computation in metrology encompass any area where observations are made or gathered and, together with available contextual information, are analysed using mathematical, statistical or numerical procedures. The minisymposium includes the mathematical and statistical modelling of measuring systems, the numerical solution of those models and, given observational uncertainties, the quantification of uncertainties associated with the solution. Numerical methods applied cover the use of existing capability such as provided by software libraries and novel solution techniques that are yet to find their way into mainstream use. Application areas are diverse including physics, chemistry, biology and medicine.

▶ MS-Mo-D-30-1 — 13:30–14:00

Data Analysis for Chemical Microscopy

Dewar, Mike — Numerical Algorithms Group Ltd

Abstract: Spectroscopic microscopy is used for the detection of molecular compounds within the micro and nano-scale structures of cells, tissues and materials. Analysis of the very large hyperspectral image stacks acquired is computationally challenging, and accurate interpretation often depends on combining multiple complementary imaging modes. This talk will describe the development of tools to allow non-ICT experts to combine multiple types of imaging data and efficiently explore these data sets to create novel insights.

▶ MS-Mo-D-30-2 — 14:00–14:30

Tipping Point Analysis: A Computational Framework for Studying Transitions and Bifurcations in Time Series

Livina, Valerie — National Physical Laboratory

Abstract: We develop a methodology for anticipating (pre-tipping), detecting (tipping) and forecasting of tipping points in dynamical systems. Early warning signals are analyzed using lag-1 autocorrelations in sliding windows; detection is performed using potential analysis with potential contour plot; forecast is performed by extrapolation of dynamically derived Chebyshev coefficients of the approximation of the probability density. We distinguish transitional and bifurcational tipping points by the structure of the underlying potential in the stochastic modelling equation.

▶ MS-Mo-D-30-3 — 14:30–15:00

Chebyshev Polynomials in Metrology

Cox, Maurice — National Physical Laboratory

Abstract: Formulation of many problems in metrology involve optimization, approximation, differential equations, and other mathematical disciplines. Numerical software libraries exist to help solve such problems. In recent years the Chebfun software facility appeared that offered high-accuracy numerical computation with functions, but with “symbolic feel and numerical speed”. This talk will indicate how metrology can benefit from Chebfun and give examples of application such as uncertainty propagation and calculations involving probability distributions.

▶ MS-Mo-D-30-4 — 15:00–15:30

Regularization for High-speed Waveform Metrology

Dienstfrey, Andrew — National Inst. of Standards & Tech.

Abstract: We study multiple algorithms to select regularization parameters to stabilize deconvolution in high-speed communication measurement applications, investigating these algorithms in the presence of unspecified noise cor-

relation, analyzing their joint multivariate performance distribution by Monte Carlo. We find that several parameter selection algorithms are not robust to unspecified noise correlations. While directly relevant to metrology for high-speed communication systems, our analysis suggests that these results apply to dynamic metrology applications more broadly

MS-Mo-D-31 13:30–15:30 405
Numerical Computation with Functions and Chebfun - Part I of III
For Part 2, see MS-Mo-E-31
For Part 3, see MS-Tu-D-31
Organizer: Trefethen, Lloyd N. Univ. of Oxford
Organizer: Guettel, Stefan The Univ. of Manchester
Abstract: A recent theme in algorithms and software is efficient numerical computation with functions in a manner that "feels symbolic" since the accuracy is high and underlying discretizations (Chebyshev, Fourier,...) are hidden from the user. Projects of this kind include Chebfun, pychebfun, ApproxFun, and PaCAL. A pervasive theme in this work is the use of continuous analogues of familiar discrete mathematical objects and algorithms. This minisymposium will present new developments in the areas of (1) differential and integral equations, (2) working with functions, and (3) rootfinding and linear algebra.

▶ MS-Mo-D-31-1 13:30–14:00
Solving ODEs with Chebfun and Chebgui
Trefethen, Lloyd N. Univ. of Oxford
Abstract: Chebfun is the most convenient system in existence for numerical solution of ODEs and systems of ODEs. We describe its design, the combined effort by, among others, Driscoll, Birkisson, Bornemann, and Hale. Everything is done in a continuous setting using Frechet derivative operators instead of Jacobian matrices. We highlight newer features including ultraspherical discretizations and Chebfun solution of IVPs. All this can be accessed with no programming at all through the graphical user interface CHEBGUI.

▶ MS-Mo-D-31-2 14:00–14:30
Remez and CF Digital Filtering and Approximation in Chebfun
Javed, Mohsin Univ. of Oxford
Abstract: The Remez algorithm, also known as the Parks-McClellan algorithm, is used for designing finite impulse response digital filters. In this talk we will discuss how Chebfun's trigonometric interpolation and root finding algorithms allow us to design digital filters robustly and accurately. We compare our algorithm with MATLAB's implementation. We also show how a new filter design algorithm based on the Cartheodory-Fejer approximation is the natural near-best filter design procedure of practical importance.

▶ MS-Mo-D-31-3 14:30–15:00
Toward Chebfun in 3D
Hashemi, Behnam Univ. of Oxford
Abstract: We present experiments with three techniques to represent 3D functions in Chebfun. The first technique is a purely trivariate tensor product method which computes an order-3 tensor containing coefficients of the Chebyshev expansion of the given function f. The other two approaches are based on low-rank approximations and use ACA-type ideas to create a slice decomposition of f, being different in whether or not they explicitly use the full tensor of values of f.

▶ MS-Mo-D-31-4 15:00–15:30
Bayesian Inference for Multiphase Darcy Flow Models
Icardi, Matteo KAUST
Abstract: When Darcy's equation is extended to multiphase flows, it is often used in conjunction with empirical models, whose parameters lump many complex physical phenomena and have to be estimated case by case. In this work we implement with Chebfun one-dimensional Darcy flow models and a Bayesian algorithm to estimate posterior PDFs of flow parameters

MS-Mo-D-32 13:30–15:30 307A
Reduced-order modeling in uncertainty quantification and computational fluid dynamics - Part I of III
For Part 2, see MS-Mo-E-32
For Part 3, see MS-We-E-03
Organizer: Chen, Peng ETH Zurich (Swiss Federal Inst. of Tech. in Zurich)
Organizer: Quarteroni, Alfio EPFL
Organizer: Rozza, Gianluigi SISSA, International School for Advanced Studies
Abstract: This proposed minisymposium is about the development and application of reduced-order modeling techniques in the fields of uncertainty quantification and computational fluid dynamics for control, optimization and design. Large-scale computing is commonly faced in these fields due to the high computational complexity of solving parametric and/or stochastic systems described by, e.g. partial different equations, which may lead to unaffordable computational burden for real-world application. In order to tackle this challenge, reduced-order modeling (e.g. RB, POD, EIM, PGD) techniques with the aim of capturing and utilizing the most important features of these systems are particularly in need for real-time and/or many-query computing.
This minisymposium focuses on the development and application of reduced-order modeling techniques in following themes: 1. efficient and reliable a posteriori error estimates for reduced solution and output; 2. forward uncertainty quantification problems, e.g. sensitivity analysis, risk prediction or reliability analysis with scientific and engineering applications; 3. stochastic inverse problems (model calibration, parameter identification) by variational or Bayesian approach; 4. control, optimization and design in computational fluid dynamics possibility under uncertainties.
Reduced-order modeling techniques have undergone fast development during the last decade and become a new frontier in scientific computing. Their increasing popularity is witnessed by many minisymposia at congress and conferences around the world, such as ICIAM, ICOSAHOM, WCCM, SIAM CSE, SIAM UQ, ECCOMAS, ENUMATH. The aim of this minisymposium is to discuss the most recent development of these techniques with emphasis in the field of UQ and CFD and identify new directions and perspectives. For this purpose we have invited 12 speakers with great expertise from several universities around the world, e.g. (MIT, Stanford, Paris VI, EPFL, TU Munich, CAS, Sandia National Laboratories, etc.)

▶ MS-Mo-D-32-1 13:30–14:00
Introduction of Reduced-order Modeling for UQ and CFD
Rozza, Gianluigi SISSA, International School for Advanced Studies
Chen, Peng ETH Zurich (Swiss Federal Inst. of Tech. in Zurich)
Abstract: We present some recent development of reduced-order modeling techniques in the fields of uncertainty quantification and computational fluid dynamics. We consider multilevel and weighted algorithms in the context of reduced-order modeling to capture and utilize the most important features of the underlying systems. Examples of high-dimensional variational data assimilation for blood flow in carotid artery will be shown to demonstrate the efficiency and accuracy of our proposed algorithms.

▶ MS-Mo-D-32-2 14:00–14:30
Dynamical Low Rank Approximation of Incompressible Navier Stokes Equations with Random Parameters
Musharbash, Eleonora EPFL
Nobile, Fabio MATHICSE - EPFL
Abstract: We propose a Reduced Basis approach for time dependent incompressible Navier Stokes equations with random parameters, based on a time evolving, Dynamically Orthogonal, basis. The solution is approximated in a low dimensional, time dependent manifold MS. This is achieved by projecting at each time step the residual of the governing equation onto the tangent space to MS. Numerical tests at moderate Reynold number will be presented, with emphasis on the case of stochastic boundary conditions.

▶ MS-Mo-D-32-3 14:30–15:00
Adaptive Model Reduction for Large-scale Inverse Problems with High Dimensional Unknowns.
Cui, Tiangang MIT
Marzouk, Youssef Massachusetts Inst. of Tech.
Willcox, Karen MIT
Abstract: Algorithmic scalability to high dimensional parameters and computational efficiency of numerical solvers are two significant challenges in large-scale, PDE-constrained inverse problems. Here we will explore the intrinsic dimensionality in both state space and parameter space of inverse problems by analyzing the interplay between noisy data, ill-posed forward model and smoothing prior. The resulting reduced subspaces naturally lead to a scalable and fast model reduction framework for solving large-scale inverse problems with high dimensional parameters.

▶ MS-Mo-D-32-4 15:00–15:30
Hybridized Reduced Basis Method and Generalized Polynomial Chaos for Solving Partial Differential Equations
Jiang, Jiahua Univ. of Massachusetts Dartmouth
Abstract: The generalized Polynomial Chaos (gPC) method is a popular method for solving partial differential equations (PDEs) with random parameters. However, when the probability space has high dimensionality, the solution ensemble size required for an accurate gPC approximation can be large. We show that this process can be made more efficient by closely hybridizing

gPC with Reduced Basis Method (RBM). Since the reduced model is more efficient, costs are significantly reduced.

MS-Mo-D-33 13:30–15:30 406
Random Graphs and Complex Networks - Part I of II
For Part 2, see MS-Mo-E-33

Organizer: Han, Dong Shanghai Jiao Tong Univ.
Organizer: Wu, Xian Yuan School of Math. Sci., Capital normal Univ.
Organizer: Zhang, Xiao-Dong Shanghai Jiao Tong Univ.

Abstract: We focus on the following questions of random graph and complex networks. How to classify the structure of different random growing networks? How do the dynamical processes taking place on a random network shape the network topology? Spectral theory of random graphs. Random matrix and its application. Stochastic processes on random graphs and complex networks.

▶MS-Mo-D-33-1 13:30–14:00
Some Questions Concerning Random Walks on Trees in A Random Environment
Chen, Dayue Peking Univ.

Abstract: Consider the speed of the λ-biased random walk on Galton-Watson trees. It was proved by Lyons, Pemantle & Peres that the speed exists, and was conjectured that the speed is monotone on λ for $0 < \lambda < m$. In the same spirit we consider the simple random walk on the infinite cluster of the Bernoulli bond percolation of trees, and investigate the relation between the speed of the simple random walk and the retaining probability

▶MS-Mo-D-33-2 14:00–14:30
Nodal Domain Partition and Community Structure in Networks
Zhang, Xiao-Dong Shanghai Jiao Tong Univ.

Abstract: Discrete nodal domain theory is used to provide a criterion to determine how many communities a network has and how to partition these communities by means of topological structure and geometric characterization. By capturing the signs of the Laplacian eigenvectors, we separate the network into several reasonable clusters. The method leads to a fast and effective algorithm with application to a variety of real network data sets.

▶MS-Mo-D-33-3 14:30–15:00
Mixing Time of Random Walk on Poisson Geometry Small World
Wu, Xian Yuan School of Math. Sci., Capital normal Univ.

Abstract: Let's consider the supercritical Poisson continuous percolation on d-dimensional torus T_n^d with volume n^d. By adding "long edges " randomly to the largest percolation cluster, we obtain a random graph G_n. We first prove that the diameter of G_n grows at most polynomially fast in $\ln n$, Secondly, we prove that the random walk on G_n possesses the rapid mixing property, namely, the random walk mixes in time at most polynomially large in $\ln n$.

▶MS-Mo-D-33-4 15:00–15:30
Laplacian Spectra of Random Hypergraphs
Lu, Linyuan Univ. of South Carolina
Peng, Xing Univ. of California, San Diego

Abstract: The Laplacian eigenvalue of a graph plays an important role in controlling other graph parameters. It is closed related to random walks. In this talk, we introduce a set of Laplacian eigenvalues of a uniform hypergraph by considering high-order random walks and we also calculate the Laplacian eigenvalues of random hypergraphs.

MS-Mo-D-34 13:30–15:30 112
Computational Methods and Applications for the Boltzmann Equations - Part I of II
For Part 2, see MS-Mo-E-34

Organizer: Wang, Yanli Inst. of Applied Physics & Computational Mathematics

Abstract: The Boltzmann equation is very important in a number of high-tech fields such as the space exploration, plasma and the semiconductor simulations. However, the numerical cost of solving the Boltzmann equation directly in large systems is still unaffordable. The highly efficient numerical solvers are needed to solve this problem. Or, people may build the simplified models instead of directly solving the Boltzmann equation, where the moment method is the main method. The numerical difficulties in different application areas also vary greatly and are always hard to solve. Numerical methods to solve the Boltzmann equation are also widely used in these related application areas. Recently, the research on direct Boltzmann solvers and moment methods together with their applications are very active. The purpose of this mini-symposium is to gather most representative researchers and report their progress. It invites speakers from different parts of the world and provides a good opportunity to exchange ideas.

▶MS-Mo-D-34-1 13:30–14:00
An Asymptotic-preserving Numerical Scheme for the Electronic M1 Model in the Diffusive Limit.
Brull, Stephane Institut Polytechnique de Bordeaux

Abstract: This work is devoted to the derivation of an asymptotic-preserving scheme for the electronic M1 model in the diffusive regime. A Godunov type scheme, based on approximated Riemann solvers and satisfying the admissibility conditions is proposed. Numerical tests cases will be presented in the classical and in the diffusive regime.

▶MS-Mo-D-34-2 14:00–14:30
Multigrid Acceleration for Steady-state Boltzmann Equation Based on Moment Method
HU, Zhicheng The Hong Kong Polytechnic Univ.

Abstract: The stationary solution of Boltzmann equation has a special significance in various modern kinetic fields. While the steady state is unavailable in general via an analytical way, numerical simulation for it is also very challenging. We concentrate in this talk on efficient solution strategies for the stationary Boltzmann equation with BGK-type collision term, based on multigrid method and unified formulation of numerical regularized moment method of arbitrary order.

▶MS-Mo-D-34-3 14:30–15:00
A Moment Method with L^2 Convergence in the Gas Kinetic Theory
Cai, Zhenning RWTH Aachen Univ.

Abstract: In Grad's moment method, the distribution function is expanded into a series in a weighted L^2 space. However, in some problems like heat transfer between two parallel plates, the exact solution may be outside this space, which causes divergence of the moment method. To overcome this, we expand the distribution function in the unweighted L^2 space, and add a conservation fix to keep the conservation laws. Numerical simulation shows the convergence of this new method.

▶MS-Mo-D-34-4 15:00–15:30
Applications of NRxx Method in Plasma and Semiconductor
Wang, Yanli Inst. of Applied Physics & Computational Mathematics

Abstract: Vlasov-Poisson and Wigner equations are fundamental equations in Plasma and Semiconductor respectively. We focus on numerically solving these two equations using the regularized moment method. Distribution functions are approximated by Hermite polynomial expansion, which is shifted by local macroscopic velocity and scaled by the square root of local temperature. A new regularization method is adopted to get globally hyperbolic moment equations. Numerical simulations demonstrate that NRxx method shows a high efficiency when solving both equations.

MS-Mo-D-35 13:30–15:30 408
Numerical methods improvements and large-scale computing techniques for electromagnetic simulations in different disciplines - Part I of II
For Part 2, see MS-Mo-E-35

Organizer: Xu, Jin Inst. of Software
Organizer: Liu, Jinjie Delaware State Univ.

Abstract: In order to simulate complicated EM phenomena, such as inhomogeneous medium, curve interface and boundary, complicated BCs, many new techniques need to be developed and old ones be extended, such as DG, Matched Interface and Boundary (MIB) method, high-order algorithms, Method of Moment (MOM), Fast Algorithms, etc. These methods are efficient and powerful in current EM simulations, but there are also many new challenges need to be solve. Therefore, new developments and extensions are needed. Furthermore, in order to use large-scale supercomputers, original algorithms need to be modified and efficient parallel models need to be developed. Combination of above techniques can dramatically improve the capability of electromagnetic simulations. This mini-symposium focuses on these new methods improvements, including high-order methods, algorithms and large-scale computing techniques, which can improve EM simulations dramatically.

▶MS-Mo-D-35-1 13:30–14:00
Rigorous 3D Photolithography Simulation
Cui, Tao ICMSEC, AMSS, CAS
Chen, Zhiming AMSS, Chinese Acad. of Sci.

Abstract: The complexity of modern photolithography makes extensive simulations indispensable. In this talk, based on the parallel adaptive finite element toolbox PHG, an extremely fast time-harmonic finite element solver was developed to simulation of light scattering from DUV/EUV masks. Source transfer domain decomposition method will be used as preconditioner for solving ill-conditioned algebraic system.

▶ MS-Mo-D-35-2 14:00–14:30

Homogenization of quasi-static Maxwell' s equations

Jiang, Xue Beijing Univ. of Posts & Telecommunications
Zheng, Weiying Chinese Acad. of Sci.

Abstract: This paper studies the homogenization of quasi-static and nonlinear Maxwell' s equations in grain-oriented (GO) silicon steel laminations. Based on the magnetic vector potential and the magnetic field, respectively, we propose two macroscale models for the quasi-static Maxwell' s equations. We prove that microscale solutions converge to the solutions of the macroscale models as the thickness of lamination tends to zero. The well-posedness of the homogenized model is established.

▶ MS-Mo-D-35-3 14:30–15:00

Time-domain Numerical Solutions of Maxwell Interface Problems with Discontinuous Electromagnetic Waves

Zhang, Ya Inst. of Software, Chinese Acad. of Sci.

Abstract: This talk is devoted to time domain numerical solutions of two-dimensional (2D) material interface problems governed Maxwell' s equations with discontinuous electromagnetic solutions. We use the discontinuous Galerkin time-domain (DGTD) algorithm – a popular Galerkin Maxwell solver, a proper numerical flux can be designed to accurately capture the jumps in the electromagnetic waves across the interface, and automatically preserves the discontinuity in the explicit time integration. This is a joint work with Jin Xu(ISCAS).

▶ MS-Mo-D-35-4 15:00–15:30

Comparison of Several EM Solvers Based on Different Methods

Xu, Jin Inst. of Software
Zhang, Ya Inst. of Software, Chinese Acad. of Sci.

Abstract: In this paper, we present study on some EM solvers in time domain and frequency domain using different numerical methods. The numerical methods and their parallel models are explained in brief, and comparisons and benchmark results are present next. Furthermore, the difference of these methods in large-scale computing will be emphasized, and some efforts on improving will be present. At last simulation results with different methods will be shown for more understanding of these methods.

MS-Mo-D-36 13:30–15:30 409

Asymptotic limits of discrete structures

Organizer: Yin, Mei Univ. of Denver

Abstract: This mini-symposium will center on asymptotic limits of various discrete structures and their associated phase transitions from a statistical mechanics perspective.
The organizer (who is also the first speaker) will provide an overview of this exciting area of study, elaborate on its broad connections to other areas of mathematics, and suggest new venues for continued research and application.
The second speaker will examine the long time asymptotics of the uncorrelated stochastic volatility model in discrete time. This model is popular in the financial industry, especially in the interest rate derivative markets.
The third speaker will investigate the asymptotics of large directed graphs subject to certain constraints. This model is a close cousin of the exponential random graph model, which is widely used to characterize the structure and behavior of real-world networks.
The fourth speaker will explore the continuous limit of the Frenkel-Kontorova model on periodic and quasi-periodic media. This model is one of the most simple and rich models of classical mechanics and describes a number of physical objects such as dislocations in solids and crystal surfaces.

▶ MS-Mo-D-36-1 13:30–14:00

Asympotic Structure of Constrained Directed Random Graphs

Aristoff, David Colorado State Univ.

Abstract: We study the asymptotics of large directed graphs, constrained to have certain densities of edges and/or outward p-stars. Our models are close cousins of exponential random graph models, in which edges and certain other subgraph densities are controlled by parameters. We find that large graphs always have either uniform or bipodal structure, in some cases with singularities ("phase transitions") separating these structures.

▶ MS-Mo-D-36-2 14:00–14:30

KAM for Equilibrium Solutions of the Frenkel-Kontorova Models on Quasi-periodic Media

Su, Xifeng Beijing Normal Univ.

Abstract: We consider Frenkel-Kontorova models corresponding to one-dimensional quasi-crystals. According to the arithmetic properties of the rotation numbers, we develop different arguments to show the existence of the associated quasi-periodic equilibria using Nash-Moser iterative method.
The results presented have an a-posteriori format. That is, we show that, given an approximate solution of the equilibrium equation, which satisfies some appropriate non-degeneracy conditions, then, there is a true solution nearby. Since the system does not admit an easy

▶ MS-Mo-D-36-3 14:30–15:00

Asymptotic Limits of Discrete Structures

Yin, Mei Univ. of Denver

Abstract: I will provide an overview of this exciting area of study, put the whole area in perspective, and elaborate on its broad connections to other areas of mathematics and beyond.

▶ MS-Mo-D-36-4 15:00–15:30

Coarse Graining, Dynamic Renormalization and the Kinetic Theory of Shock Clustering

Li, Xingjie Helen Brown Univ.

Abstract: In this talk, I will discuss simulations of the benchmark problem arising from shock clustering. The computation of coarsely self-similar flow turbulence can be modeled by Smoluchowski 's dynamics with additive kernel K(x,y)=x+y. Long time numerical integration approach fails for getting the self-similar solutions due to the accumulated errors. In contrast, dynamic renormalization and fixed point algorithms are applied to the results of shortly evolved dynamics, and successfully overcome these difficulties. These methods not only capture the asymptotic behaviour of the exact self-similar solutions, but also approximate the first moments with errors in satisfaction.

MS-Mo-D-37 13:30–15:30 301B

A Statistical perspective of UQ: design, modeling and computations - Part I of III

For Part 2, see MS-Mo-E-37
For Part 3, see MS-Tu-D-37

Organizer: Wu, Jeff Georgia Inst. of Tech.
Organizer: Woods, David Univ. of Southampton
Organizer: Xiong, Shifeng Chinese Acad. of Sci.

Abstract: This minisymposium consists of three sessions. Each co-organizer will organize one session. They will address the three aspects of the title: design, modeling, and computations. The focus will be on these problems from the statistical perspective but will also bring in interface with work in applied mathematics on UQ. In design, both space-filling designs and sparse grids are considered. In modeling, both stochastic kriging and generalized polynomial chaos approximation are considered. Comparisons and contrasts between work in applied math and statistics will be emphasized. Computational challenges for high dimensions and big data are the third theme.

▶ MS-Mo-D-37-1 13:30–14:00

A Multilevel Radial-Basis-Function Method for Computer Experiments

Tuo, Rui Chinese Acad. of Sci.
Webster, Clayton Oak Ridge National Laboratory
Zhang, Guannan Oak Ridge National Laboratory

Abstract: In this work we propose a multilevel collocation method for multi-fidelity computer experiments using the radial basis functions as the interpolator. Theoretical analysis shows that the proposed method possesses a much higher convergence rate than the single-level method. The proposed method is applicable for uncertainty quantification, prediction and optimization problems.

▶ MS-Mo-D-37-2 14:00–14:30

Optimization of Nested Latin Hypercube Designs

Xiong, Shifeng Chinese Acad. of Sci.

Abstract: This paper introduces a multi-layer enhanced stochastic evolutionary algorithm to improve the space-filling property of nested Latin hypercube designs (NLHDs). The proposed algorithm first considers the sub-designs in the lower layers, and optimizes the NLHD layer by layer. Three basic element-exchanging operations are proposed to search better NLHDs. The whole design always keeps the structure of the NLHD after each operation. Numerical examples indicate that the proposed algorithm is fast and efficient.

▶ MS-Mo-D-37-3 14:30–15:00

Quantifying Uncertainties on Excursion Sets under A Gaussian Random Field Prior

Azzimonti, Dario Universität Bern

Abstract: The problem of estimating and quantifying uncertainties for highly non-linear quantities of a deterministic function under a limited evaluation bud-

get is approached with Gaussian random field (GRF) modeling. This method relies on simulations of the GRF posterior distribution. In the particular case of excursion set estimation, we present a method to choose few optimal locations to simulate the posterior GRF that minimizes the expected distance in measure between the posterior excursion set and its reconstruction.

▶ MS-Mo-D-37-4 15:00–15:30

A Unified Framework for Uncertainty and Sensitivity Analysis of Computational Models with Many Input Parameters

Gu, Li Georgia Inst. of Tech.
Wu, Jeff Georgia Inst. of Tech.

Abstract: Uncertainty Analysis (UA) and Sensitivity Analysis (SA) study uncertainties in physical systems. As the system becomes more complex, the number of input parameters can be large and existing methods for UA and SA become infeasible. We propose a unified framework by using a hierarchical variable selection approach to connect UA and SA with the use of one design. The approach is economical in run size and computationally efficient. An application to building energy is given.

MS-Mo-D-38 13:30–15:30 302A

Minisymposium on Statistical Inference for Constrained Stochastic Dynamical Systems - Part I of II

For Part 2, see MS-Mo-E-38

Organizer: Rempala, Grzegorz The Ohio State Univ.
Organizer: Kurtek, Sebastian The Ohio State Univ.

Abstract: With the advent of new data capturing technologies in imaging, genomics, and environmental science, the math modeling community is increasingly facing the challenging issues of proper statistical inference for constrained stochastic dynamical systems. Some typical problems are: models identifiability conditions, methods for combining noisy dynamic observations from multiple scales or technologies, robustness and dimension reduction, quantification of model uncertainty. Since many of the underlying problems cannot be solved analytically, the issues of computational algorithms and practical simulation based inference is also very relevant and requires some theoretical framework. The minisymposium will consist of 2 blocks of 4 presentations each.

▶ MS-Mo-D-38-1 13:30–14:00

Stochastic Epidemic Modeling with Early Stage Approximation

Choi, Boseung Daegu Univ.
Rempala, Grzegorz The Ohio State Univ.

Abstract: In this paper, we consider the epidemic model estimation problem using classical SIR epidemic model. We utilized maximum posterior estimator based on Bayesian approach for parameter estimation. In addition, when the collected number of infected is smaller than true number at the early time period among the pandemic, we proposed a method in order to improve model accuracy. We applied proposed method to the H1N1 epidemic in a small area and performed a simple simulation

▶ MS-Mo-D-38-2 14:00–14:30

Network Geometry and Inference in Biochemical Reaction Systems

Casian, Pantea West Virginia Univ.

Abstract: Identifiability of mass-action reaction networks from experimental data is limited by the fact that distinct networks may give rise to the same ODE system. However, we show that the inherent variability of reaction rate parameters from one experiment to another may be used in conjunction with the geometry of the network to devise an algebraic statistical method for identifying the most likely network structure. This is joint work with G. Rempala and G. Craciun.

▶ MS-Mo-D-38-3 14:30–15:00

Geometric Approach to Pairwise Bayesian Alignment of Functional Data Using Importance Sampling

Kurtek, Sebastian The Ohio State Univ.

Abstract: We present a Bayesian model for pairwise nonlinear registration of functional data. We utilize the geometry of the space of warping functions to define priors and sample from the posterior using importance sampling. A square-root transformation is used to simplify the geometry of the space of warping functions allowing for computation of sample statistics and efficient posterior inference where multiple modes of the posterior distribution corresponding to multiple plausible registrations are found.

▶ MS-Mo-D-38-4 15:00–15:30

Rate-Invariant Analysis of Trajectories on Riemannian Manifolds

Su, Jingyong Texas Tech Univ.

Abstract: We investigate statistical analysis of trajectories on Riemannian manifolds that are observed under arbitrary temporal evolutions. We introduce a quantity that provides both a cost function for temporal registration and a proper distance for comparison of trajectories. This distance, in turn, is used to define statistical summaries, such as the mean and covariances of the synchronized trajectories. We will illustrate this framework using several representative manifolds in multiple applications.

MS-Mo-D-39 13:30–15:30 302B

Recent advances on inverse scattering problems - Part I of III

For Part 2, see MS-Mo-E-39
For Part 3, see MS-Tu-D-39

Organizer: Liu, Xiaodong Inst. of Applied Mathematics, Chinese Acad. of Sci.
Organizer: Liu, Hongyu Hong Kong Baptist Unversity
Organizer: Zhang, Bo Acad. of Mathematics & Sys. Sci., CAS

Abstract: The minisymposium intends to bring together leading experts working on inverse scattering problems and their applications to discuss recent advances and new challenges in this fascinating field.

▶ MS-Mo-D-39-1 13:30–14:00

Detection and Classification from Electromagnetic Induction Data

Chen, Junqing Department of Mathematical Sci., Tsinghua Univ.

Abstract: I will introduce an efficient algorithm for identifying conductive objects using induction data derived from eddy currents. Our method consists of first extracting geometric features from the induction data and then matching them to precomputed data for known objects from a given dictionary. The matching step relies on fundamental properties of conductive polarization tensors and new invariants introduced in this paper. A new shape identification scheme is introduced and studied.

▶ MS-Mo-D-39-2 14:00–14:30

The Direct and Inverse Scattering Problems with Generalized Oblique Derivative Boundary Condition

Wang, Haibing Southeast Univ.
Liu, Jijun Southeast Univ.

Abstract: Consider the exterior problem for the Helmholtz equation with a generalized oblique derivative boundary condition, which arises in some new scattering problems such as the scattering of tidal waves by islands. Compared with the classical scattering models, the tangential derivative on the obstacle boundary leads to some essential differences such as the symmetric property of the Green function and the reciprocity principle of the scattering data. Both the direct and inverse scatteing problems are considered.

▶ MS-Mo-D-39-3 14:30–15:00

An Efficient Finite Element Method for Grating Profile Reconstruction

Zhang, Ruming Michigan Technological Univ.
Sun, Jiguang Michigan Technological Univ.

Abstract: We consider the reconstruction of grating profiles from near-field data. The inverse problem is formulated as an optimization problem with a regularization term. We employ a quasi-Newton method to solve it, for which we devise an efficient finite element method. The stiff matrix and mass matrix are assembled only once at the beginning of the numerical procedure. Then only minimal changes are made to the mass matrix at each iteration.

▶ MS-Mo-D-39-4 15:00–15:30

Shape Derivatives in Differential Forms with Applications to Acoustic and Electromagnetic Scattering Problems

Li, Jingzhi South Univ. of Sci. & Tech. of China

Abstract: This talk provides a unified approach to computing arbitrary order shape derivatives of domain and boundary integrals in differential forms. Hitherto unknown expressions for shape Hessians can be derived with little effort. We illustrate this powerful machinery by deriving the shape derivatives of solutions to second-order elliptic boundary value problems with different boundary/interface conditions. Moreover, applications to acoustic and electromagnetic scattering problems will also be addressed.

MS-Mo-D-40 13:30–15:30 303A

Dynamics Analysis and Intervention of Social Networks

Organizer: Hong, Yiguang Acad. of Mathematics & Sys. Sci.
Organizer: Hu, Xiaodong Acad. of Math & Sys. Sci., CAS

Abstract: Social networks and dynamics has attracted interests of wide range from various areas. There are several important and challenging problems about social networks. The evolution of beliefs or opinions is a fundamental problem in the study of social networks. Here we provide a quite genera sufficient connectivity conditions for the social network to reach an agreement of dispersed beliefs. Another important issue is to locate the source of diffusion, and we establish an approximability of the minimum doubly resolving set problem on general graphs. In addition to the analysis of opinion agreement and opinion source location, opinion intervention is also an important topic to deal with the social crisis and eliminate the psychosocial problem during the opinion evolution. Two new intervention methods are developed to guide crowd or reduce the difference of public opinions.

▶ CP-Mo-D-40-1 13:30–13:50

Active Intervention of Opinion Dynamics by Noise Injection

Su, Wei — Acad. of Math & Sys. Sci.
Hong, Yiguang — Acad. of Mathematics & Sys. Sci.

Abstract: This paper investigates a simple intervention scheme of opinion dynamics to reduce the opinion disagreement only by injecting noise within a finite time. A simplerandom injection mechanism is provided by injecting uniformly distributed noises in the opinion dynamics. It is shown that the seemingly useless noises, which also influence the individual opinions randomly, are effective in reducing the opinion difference and increasing the agreement possibility of opinions in the social networks.

▶ MS-Mo-D-40-2 13:50–14:20

Agreement Seeking of Social Networks: the Influence of Antagonistic Interactions and the Role of Centralized Information

Ziyang, Meng — Technische Universitat Munchen,

Abstract: The evolution of beliefs or opinions is a fundamental problem in the study of social networks. A basic understanding is that sufficient connectivity of the network will lead to an agreement of dispersed beliefs. In the commonly considered networks, the relationships between different agents are considered to be cooperative and the exchanged information is assumed to be local. However, in certain, or even most of network setting, there are also antagonistic interactions that may affect the belief evolution and centralized information that can be used for agreement seeking. In this talk, we try to understand how antagonistic interactions will influence belief evolution of the social networks and what is the role of centralized information in the classical social network model. In particular, we reveal that both cooperative and antagonistic interactions contribute to belief convergence of cooperative-antagonistic network and strong connectivity, instead of quasi-strong connectivity, is critical.

▶ MS-Mo-D-40-3 14:20–14:50

Locating Source of Diffusion in Social Networks

Chen, Xujin — Acad. of Mathematics & Sys. Sci., Chinese Acad. of Sci.
Hu, Xiaodong — Acad. of Math & Sys. Sci., CAS
Wang, Changjun — Acad. of Mathematics & Sys. Sci., Chinese Acad. of Sci.

Abstract: Locating source of diffusion in networksis crucial for controlling and preventing epidemic risks.It has been studied under various probabilistic models.In this paper, we study source location from a deterministic point of view by modeling itas the minimum weighted doubly resolving set (DRS) problem,which is a strengthening of the well-known metric dimension problem.We establish q(lnn)-approximability of the minimum DRSproblem on general graphs for both weighted and unweighted versions.This is the first work providing explicit approximation lower andupper bounds for minimum (weighted) DRS problem, which are nearlytight.

▶ MS-Mo-D-40-4 14:50–15:20

Crowd Dynamics and Optimal Intervention

Hu, Xiaoming — Royal Inst. of Tech.

Abstract: Understanding dynamics for a pedestrian crowd is of great theoretical and practical significance, in particular for strategy design of emergency evacuation in public places. However, experiments in genuine escape panic are difficult, especially with human beings due to ethical and legal concerns, which indicates that mathematical modeling and analysis of the pedestrian dynamics are extremely important for the purposes of planning and verification. In this presentation we will report some results using approaches in multi-agent systems and optimal control.

MS-Mo-D-41 13:30–15:30 303B

Recent developments in the mathematical modeling of brittle and cohesive fracture

Organizer: Bonacini, Marco — Heidelberg Univ.
Organizer: Iurlano, Flaviana — IAM, Univ. of Bonn

Abstract: Methods and techniques coming from the Calculus of Variations and Partial Differential Equations have proved effective in the study of the inelastic behaviour of solids, in particular of material-failure phenomena. They allow to develop a robust and rigorous mathematical approach, efficient both in answering theoretical questions and in providing tools for numerical simulations and applications. The main focus of this minisymposium is to explore recent developments in the matematical modeling of brittle and cohesive fracture, both in the static and dynamic regimes. Particular emphasis will be placed on its interplay with other inelastic phenomena.

▶ MS-Mo-D-41-1 13:30–14:00

A Rate-independent Phase-field Damage Model in Thermo-visco-elastodynamics

Lazzaroni, Giuliano — SISSA
Rossi, Riccarda — Universita' degli studi di Brescia
Thomas, Marita — Weierstrass Inst. for Applied Analysis & Stochastics (WIAS Berlin)
Toader, Rodica — Universita' degli studi di Udine

Abstract: We prove the existence of weak (energetic) solutions for a model of partial damage. The rate-independent, unidirectional flow rule for damage is coupled with the rate-dependent heat equation, and with the momentum balance featuring inertia and viscosity. Our assumptions include the case of the Ambrosio-Tortorelli model. We also consider the limit for vanishing viscosity and inertia, obtaining a fully rate-independent model for displacements and damage, which is independent of temperature.

▶ MS-Mo-D-41-2 14:00–14:30

Homogenization of Brittle Composites with Soft Inclusions

Zeppieri, Caterina Ida — Univ. of Muenster
Barchiesi, Marco — Univ. of Naples
Lazzaroni, Giuliano — SISSA

Abstract: We prove a homogenization result for the energy-functional associated with a purely brittle composite whose microstructure is characterized by soft periodic inclusions embedded in a stiffer matrix. We show that there exists an elementary microscopic arrangement of the two constituents as above that gives rise, in the limit, to homogeneous macroscopic energy-functional of cohesive type.

▶ MS-Mo-D-41-3 14:30–15:00

On Quasi-static Cohesive Fracture Evolution

Larsen, Christopher — WPI

Abstract: We will discuss why proving existence for cohesive fracture evolution has been elusive, and report on some recent progress with a PhD student, Yiqing LI. In particular, we will describe how to handle some of the difficulties, some with the help of a technical assumption on the growth of the cohesive energy density.

▶ MS-Mo-D-41-4 15:00–15:30

Full Characterization of Quasi-static H^1 Evolutions for A Cohesive Interface Model

Negri, Matteo — Univ. of Pavia

Abstract: We consider the quasi-static evolution of a prescribed cohesive interface: dissipative under loading and elastic under unloading. We provide existence (by energy approximation and time discretization) in terms of parametrized BV solutions w.r.t. the H^1 norm. Technically, the evolution is fully characterized by equations: equilibrium, energy balance and Kuhn-Tucker conditions. Catastrophic regimes (jumps) are described by gradient flows of visco-elastic type.

MS-Mo-D-42 13:30–15:30 301A

Real world phenomena explained by microscopic particle models

Organizer: Renger, Michiel — WIAS
Organizer: Patterson, Robert — Weierstrass Inst.

Abstract: Many natural phenomena are best understood as emergent effects of underlying microscopic systems. For design and engineering purposes, it is important to know exactly how microscopic properties influence the macroscopic phenomena. Centred around this common theme, problems ranging from ferromagnetism to ecology will be addressed. Methods will be drawn several areas of mathematics including asymptotic analysis, PDEs and stochastic processes.

▶ MS-Mo-D-42-1 13:30–14:00

Non-equilibrium via Current Reservoirs

Carinci, Gioia — Univ. of Modena & Reggio Emilia

Abstract: Stationary non-equilibrium states are characterized by steady currents flowing through the system. Usually current density is produced by fixing different densities at the boundaries. We instead implement mass transport by introducing current reservoirs producing a given current by injecting particles from the left and removing particles from the rightmost occupied site. I will discuss recent results obtained in the study of this topic, whose purpose is to provide a microscopic model for free boundary problems.

▶ MS-Mo-D-42-2 14:00–14:30

The Empirical and Ensemble Processes of Reacting Particles: Large Deviations and Thermodynamic Principles

Renger, Michiel WIAS
Patterson, Robert Weierstrass Inst.

Abstract: We consider a class of stochastically reacting particle systems for which the empirical process converges to deterministic concentrations with mass-action kinetics. The empirical process of independent copies of the empirical process (the ”ensemble process”) then converges to the corresponding Liouville transport equation. For both limit passages we prove dynamic large deviation principles, and discuss how thermodynamic principles, like entropy-driven gradient flows, can be derived from those large deviations.

▶ MS-Mo-D-42-3 14:30–15:00

Quantifying Coarse-graining Error in Stiff Potentials

Upanshu, Sharma Technische Universiteit Eindhoven

Abstract: Simulations in molecular dynamics suffer due to the curse of dimensionality. However many applications have a natural scale-separation which manifests itself in form of stiff-potentials which allows one to construct lower-dimensional models. Though lower dimensional, these models are still numerically intractable, and therefore there is a need for useful approximations. We present one such approximate model and present error estimates using Wasserstein metric.

▶ MS-Mo-D-42-4 15:00–15:30

Existence and Uniqueness on Smoluchowski Coagulation Equations

Li, Guolong Univ. of Cambridge

Abstract: Smoluchowski coagulation equations are a system of partial differential equations that describes the behaviour of a cluster of diffusing particles which coagulate together after colliding. We will construct an interation scheme to show the well-posedness of these equations under certain physical reasonable conditions.

MS-Mo-D-43 13:30–15:30 VIP4-1

Stochastic Equilibrium Problems: Economic Modeling, Analysis and Computation

Organizer: Su, Che-Lin Univ. of Chicago

Abstract: Motivated by empirical demand estimation problems in economics, the objective of this minisymposium is to discuss and address both theoretical and numerical challenges of stochastic equilibrium problems, arisen from estimation and pricing of pure characteristics demand models. The four presentations aim to first provide an overview of stochastic equilibrium problems and their economic applications, to discuss a regularization method for analyzing and solving stochastic equilibrium problems, to examine the analysis of sample average approximation for a pricing problem formulated as a stochastic equilibrium problem, and finally, to present alternative formulations for studying estimation and pricing problems.

▶ MS-Mo-D-43-1 13:30–14:00

Regularized Mathematical Programs with Stochastic Equilibrium Constraints: Estimating Structural Demand Models

Chen, Xiaojun Department of Applied Mathematics, The Hong Kong Polytechnic Univ.

Abstract: The article considers a particular class of optimization problems involving set-valued stochastic equilibrium constraints. We develop a solution procedure that relies on an approximation scheme for the equilibrium constraints. Based on regularization, we replaces the approximated equilibrium constraints by those involving only single-valued Lipschitz continuous functions. In addition, sampling has the further effect of replacing the ‘simplified’ equilibrium constraints by more manageable ones obtained by implicitly discretizing the (given) probability measure so as to render the problem computationally tractable. Convergence is obtained by relying, in particular, on the graphical convergence of the approximated equilibrium constraints. The problem of estimating the characteristics of a demand model, a widely studied problem in micro-econometrics, serves both as motivation and illustration of the regularization and sampling procedure.

▶ MS-Mo-D-43-2 14:00–14:30

Sample Average Approximation Regularized Method for Products Pricing Problem Based on Pure Characteristics Demand Models

Hailin, Sun Nanjing Univ. of Sci. & Tech.
Chen, Xiaojun Department of Applied Mathematics, The Hong Kong Polytechnic Univ.
Su, Che-Lin Univ. of Chicago

Abstract: Utility-based choice models are often used to determine a consumer's purchase decision among a list of available products. By a pure characteristics model, we consider a firm's multi-product pricing problem. A sample average approximation (SAA) method is used to approximate the expected market share of products considered and the firm's profit. We then apply a regularized method to compute a solution of the SAA problem and study the convergence of the SAA solutions.

▶ MS-Mo-D-43-3 14:30–15:00

Topics in Computing Nash Equilibria

Pang, Jong-Shi Univ. of Southern California

Abstract: This talk presents results on two topics pertaining to the computation of Nash equilibria in non-cooperative games. These are: (a) equilibrium constrained optimization, and (b) games with minmax players. The former topic is treated more broadly under the framework of variational-inequality constrained hemivariational inequality. Interestingly, a particular pull-out approach for solving the latter class of games can be applied to a sampled version of games with stochastic recourse functions.

▶ MS-Mo-D-43-4 15:00–15:30

A Constructive Approach to Estimating Pure Characteristics Demand Models with Pricing

Su, Che-Lin Univ. of Chicago
Pang, Jong-Shi Univ. of Southern California

Abstract: We consider estimating pure characteristics demand models. The main difficulty in solving this problem is that market share equations are nonsmooth. To overcome this difficulty, we first characterize consumers' purchase decisions by a system of complementarity constraints. This new characterization leads to smooth approximated market share equations and allows us to cast the estimation problem as a mathematical program with complementarity constraints. We present numerical results to demonstrate the computational effectiveness of our approach.

MS-Mo-D-44 13:30–15:30 VIP2-1

Nonsmooth Numerics via Piecewise Linearization

Organizer: Griewank, Andreas Humboldt Univ.

Abstract: Most nonsmooth problems are piecewise smooth. Then they have a piecewise linear approximation. We consider the results of successive piecewise linearization applied to various computational tasks, in particular equation solving, (un)constrained optimization and the numerical integration of Lipschitzian dynamical systems.

▶ MS-Mo-D-44-1 13:30–14:00

On Exact Solution of Piecewise Linear ODEs and Use for General Lipschitz ODEs

Kabidoldanova, Assem al-Farabi Kazakh National Univ.
Griewank, Andreas Humboldt Univ.

Abstract: Piecewise linear dynamical systems can be solved up to working accuracy as a sequence of linear systems. In each open polyhedron the solution is defined by the relevant Jacobian and the initial point, which is typically on the boundary. We compute the explicit solutions in the open polyhedron and glue them together at the boundaries between the polyhedron. Piecewise linear systems with smooth forcing can be solved as a sequence of inhomogeneous linear systems.

▶ MS-Mo-D-44-2 14:00–14:30

Evaluating Sensitivities for Dynamic Systems via Piecewise Linearization

Khan, Kamil Argonne National Laboratory

Abstract: This presentation combines recent theoretical developments in nonsmooth dynamic sensitivity analysis with new integration methods involving piecewise linearization, to evaluate directional derivatives and lexicographic derivatives for nonsmooth dynamic systems. The developed methods are illustrated by application to various systems involving collisions and shape boundaries.

▶ MS-Mo-D-44-3 14:30–15:00

Solution of Piecewise Linear Equations

Munson, Todd Argonne National Laboratory
Bosse, Torsten Argonne National Laboratory

Abstract: Piecewise linear systems of equations arise as approximations of nonsmooth functions and are derived by a minor modification of techniques from Algorithmic differentiation. The resulting models contain local information about the nonsmoothness of the original function and can be used within nonlinear equation solving and optimization algorithms. Within this talk we will provide an overview on several approaches to solve piecewise linear equations and their connection with other existing methods.

▶ MS-Mo-D-44-4 15:00–15:30

An Optimization Method for Lipschitzian Piecewise Smooth Minimization

Fiege, Sabrina Univ. of Paderborn
Walther, Andrea Universität Paderborn

Abstract: Nonsmoothness is a typical characteristic of numerous target functions. We present an optimization method based on algorithmic differentiation for Lipschitzian piecewise smooth functions that we named LiPsMin.
The method's idea is to locate an optimum of a piecewise smooth function by successive piecewise linearization. The minimization of the piecewise linearization is realized by a bundle type method that benefits from available additional information via structure exploitation.
This talk presents numerical results of LiPsMin method.

MS-Mo-D-45 13:30–15:30 213A
Triangular decomposition of polynomial systems: solvers and applications - Part I of IV
For Part 2, see MS-Mo-E-45
For Part 3, see MS-Tu-D-45
For Part 4, see MS-Tu-E-45

Organizer: Moreno Maza, Marc The Univ. of Western Ontario
Organizer: Chen, Changbo Chinese Acad. of Sci.

Abstract: The Characteristic Set Method of Wen Tsun Wu has freed Ritt's decomposition from polynomial factorization, opening the door to a variety of discoveries in polynomial system solving. In the past three decades the work of Wu has been extended to more powerful decomposition algorithms and applied to different types of polynomial systems or decompositions: differential systems, difference systems, real parametric systems, primary decomposition, cylindrical algebraic decomposition. Today, triangular decomposition algorithms provide back-engines for computer algebra system front-end solvers, such as Maple's solve command and have been applied in various areas both in the academia and in the industry.
In this proposed workshop, we hope to gather researchers who have applied and extended the works Joseph Fels Ritt and Wen Tsun Wu. Our goals are, first, to disseminate the techniques and software tools which have been developed by this vibrant community and, second, to stimulate further developments and applications of polynomial system decomposition by means of characteristic sets.
At the International Congress on Mathematical Software (ICMS 2014), a satellite conference of the International Congress on Mathematics, in Seoul (South Korea), a session on the same topics as the proposed one had gathered 9 talks, see `http://www.csd.uwo.ca/~moreno/ICMS_Triangular_Decomposition_Session.html`
About another 30 researchers had expressed interest in participating to this session but were not able to do so at that time the year or in that location. Moreover, three other sessions of ICMS 2014 had talks on this subject of polynomial system decomposition by means of characteristic sets.
In a sum, the proposed workshop for ICIAM 2015 is expected to be well attended and to generate rich interactions. At the same time, the available software such as the RegularChains library (see http://www.regularchains.org) will support software demonstration of the applications of the Characteristic Set Method.

▶ MS-Mo-D-45-1 13:30–14:00
Revisiting Term Rewriting in Algebra
Sit, William The City College of The City Univ. of New York
Guo, Li Rutgers Univ. at Newark
Zheng, Shanghua Lanzhou Univ.
Gao, Xing Lanzhou Univ.

Abstract: We introduce a class of term-rewriting systems on free modules and proved some general results on confluence, termination and convergence. The results are applied to a class of algebras known as Rota-Baxter Type algebras, which, with Differential Type algebras, provide examples of linear operators on associative algebras in an effort to answer a question Rota posed in the 1970s.
This is based on joint work with Xing Gao, Li Guo, and Shanghua Zheng.

▶ MS-Mo-D-45-2 14:00–14:30
New Effective Differential Nullstellensatz
Gustavson, Richard CUNY Graduate Center
Kondratieva, Marina Moscow State Univ.
Ovchinnikov, Alexey CUNY Queens College

Abstract: We present a new upper bound for the effective differential Nullstellensatz for differential fields of characteristic zero with several commuting derivations. The first explicit bound was given in 1989 by Grigoriev, for the case of a single derivation. This bound was improved in 2014 by D'Alfonso, Jeronimo, and Solernó, restricting to the case of constant coefficients. We generalize this bound to the case of arbitrary coefficients and several commuting derivations.

▶ MS-Mo-D-45-3 14:30–15:00
A Generic Position Based Method for Real Root Isolation of Zero-dimensional Polynomial Systems
Cheng, Jin-San Chinese Acad. of Sci.

Abstract: We present a generic position method for isolating the real roots of a zero-dimensional polynomial system. The method mainly involves resultant computation and real root isolation of univariate polynomial equations. The roots of the system have a linear univariate representation, which preserves the multiplicities of the roots. The implementation shows that the method is efficient, especially for bivariate polynomial systems. It is a joint work with Kai Jin.

▶ MS-Mo-D-45-4 15:00–15:30
Computing Equilibria of Semi-algebraic Economies Using Triangular Decomposition and Real Solution Classification
Xiaoliang, Li Dongguan Univ. of Tech.

Abstract: In this talk, we are concerned with the problem of determining the existence of multiple equilibria in economic models. We propose a general and complete approach for identifying multiplicities of equilibria in semi-algebraic economies, which may be expressed as semi-algebraic systems. The approach is based on triangular decomposition and real solution classification, two powerful tools of algebraic computation. Its effectiveness is illustrated by three examples of application.
This is joint work with Dongming Wang.

MS-Mo-D-46 13:30–15:30 306B
Attenuation and Dispersion in Photoacoustic Imaging - Part I of II
For Part 2, see MS-Mo-E-46

Organizer: Shi, Cong Univ. of Vienna
Organizer: Ammari, Habib Ecole Normale Superieure

Abstract: Photoacoustic Imaging is a promising imaging method that visualizes biological material parameters. In a typical PAT session, the object is exposed to a short pulse of an electromagnetic wave. The object absorbs a fraction of the induced energy, heats up, and reacts with thermoelastic expansion. This in turn produces acoustic waves, which can be recorded outside the specimen. The mathematical formulation of PAT is an inverse problem related to the wave equation - to reconstruct the source term of the wave equation from measurements of the acoustic wave. PAT combines the high resolution of ultrasound waves and high contrast of EM waves.
The classical mathematical models of PAT ignore the attenuation effects and dispersion within the object, which leads to inaccurate images. There are two main challenges in the topic: one is to model the attenuation effect mathematically, the other is to compensate for the effect in image reconstruction. To correctly model the attenuation effect in a given media, we need to investigate the relation between attenuation, dispersion, and causality. It is known that attenuation and dispersion are connected by the Kramers-Kronig relation. Several attenuation models are documented in the literature, and most of them are derived from power laws. On the other hand, the research on compensation for the attenuation effect has only begun recently, and much remains to be done on both of the problems. This minisymposium focuses on recent advances in this field.

▶ MS-Mo-D-46-1 13:30–14:00
Bayesian Approach to Image Reconstruction in Quantitative Photoacoustic Tomography
Tarvainen, Tanja Univ. of Eastern Finland

Abstract: Quantitative photoacoustic tomography is an emerging imaging technique aiming at estimating quantitative values of optical parameters inside tissues from photoacoustic images which are formed by combining optical information and ultrasound propagation. This is an ill-posed problem and it needs to be approached within the framework of inverse problems. In this work, the image reconstruction problem of quantitative photoacoustic tomography is considered in a Bayesian framework.

▶ MS-Mo-D-46-2 14:00–14:30
Asymptotic Techniques for Photoacoustic Imaging in Attenuating Media
Kalimeris, Konstantinos RICAM

Abstract: We present some of the existing models, taking into account acoustic attenuation under the different physical properties of the biological tissue. A family of time reversal imaging functionals is presented, based on the techniques are based on recently proposed ideas of Ammari et al for the thermo-viscous wave equation. In particular, an asymptotic analysis provides reconstruction functionals from first order corrections for the attenuating ef-

fect. Finally, a novel approach for higher order corrections is described.

▶ MS-Mo-D-46-3 14:30–15:00

A Stable Algorithm for Attenuation Correction in Photo-acoustic Imaging

Wahab, Abdul COMSATS Inst. of Information Tech.

Abstract: In this talk, a brief description of the time reversal algorithms in attenuating media is provided. Considering simple attenuated wave models, two algorithms are discussed. First an adjoint wave time reversal algorithm is established wherein the adjoint lossy wave is re-emitted into the medium. However, since the adjoint lossy wave is explosive in nature, indeed due to the exponentially growing nature of back-propagating waves with frequency, a regularization using frequency suppression of the attenuation maps

▶ MS-Mo-D-46-4 15:00–15:30

On Time Reversal in Photoacoustic Tomography for Tissue Similar to Water

Kowar, Richard Univ. of Innsbruck

Abstract: This talk is concerned with time reversal in photoacoustic tomography (PAT) of dissipative media that are similar to water. We consider an approach based on the non-causal thermo-viscous wave equation and another based on the dissipative wave equation of Nachman, Smith and Waag

MS-Mo-D-47 13:30–15:30 108

Analytical and algorithmic advances in the immersed boundary method - Part I of II

For Part 2, see MS-Mo-E-47

Organizer: Stockie, John Simon Fraser Univ.
Organizer: Lai, Ming-Chih National Chiao Tung Univ.

Abstract: The immersed boundary method is a well-known approach for modelling fluid- structure interaction (FSI) problems involving highly deformable elastic structures. Applications include a wide range of biofluid mechanical systems and the method is increasingly being applied to engineering problems as well. Recently, major advances have been achieved in algorithms (fast and robust solvers), theoretical results (convergence and stability analyses) and model extensions intended to capture a wider spectrum of FSI phenomena (multiphase flows, membrane transport, stochastic effects). This minisymposium will highlight these recent advances and survey some of the complex fluid flows that can be simulated using the method.

▶ MS-Mo-D-47-1 13:30–14:00

Overview of the Immersed Boundary Method and Recent Developments in Algorithms, Analysis and Applications

Stockie, John Simon Fraser Univ.

Abstract: This talk will begin with an overview of the immersed boundary method for solving complex fluid-structure interaction problems, including recent developments in algorithms and model extensions that handle a much wider class of applications. I will then describe a novel computational approach based on a pseudo-compressible fluid solver that yields a simple and efficient parallel implementation. The capabilities of the method are illustrated with applications including spherical membranes, flexible particle suspensions and jellyfish swimming dynamics.

▶ MS-Mo-D-47-2 14:00–14:30

An Immersed Boundary Method for Rigid Bodies

Bhalla, Amneet Pal Singh Univ. of North Carolina - Chapel Hill
Griffith, Boyce Univ. of North Carolina at Chapel Hill
Donev, Aleksandar Courant Inst. of Mathematical Sci., New York Univ.

Abstract: In this work we develop an IB method that exactly enforces rigidity constraint for immersed solid bodies by solving a linear system coupling a standard semi-implicit discretization of the fluid equations with a rigidity constraint. An effective preconditioned iterative solver that combines an approximate multigrid solver for the fluid problem with an approximate direct solver for the Schur complement system is developed which works for both zero and moderate Reynolds number flows.

▶ MS-Mo-D-47-3 14:30–15:00

An Immersed Boundary Method for Mass Transfer Across Permeable Moving Interfaces

Huang, Huaxiong York Univ.

Abstract: We present an immersed boundary method for mass transfer across permeable deformable moving interfaces interacting with the surrounding fluids. One of the key features of our method is the introduction of the mass flux as an independent variable, governed by a non-standard vector transport equation.

▶ MS-Mo-D-47-4 15:00–15:30

Interactions of Micro-organisms Near A Wall in Stokes Flow Using A Regularized Image System

Huang, Jianjun Worcester Polytechnic Inst.
Olson, Sarah WPI

Abstract: We present an extension of the regularized image system for Stokeslets, where regularization functions and parameters are chosen to satisfy zero flow at the wall for several different fundamental solutions. Interactions of different representative microorganisms near a wall are studied. Sperm and bacteria flagella are described by a version of the Kirchhoff rod model, where intrinsic curvature and twist are prescribed. Results are presented for swimming speeds and attraction to a wall.

MS-Mo-D-48 13:30–15:30 212B

Computational learning and model optimization - Part I of II

For Part 2, see MS-Mo-E-48

Organizer: Schönlieb, Carola-Bibiane Univ. of Cambridge
Organizer: Chung, Matthias Virginia Tech
Organizer: De Los Reyes, Juan Carlos ModeMat

Abstract: Many scientific fields such as engineering, life sciences, and geophysics encounter large scale problems where observations are contaminated with noise. To infer reliable information from experiments novel modeling techniques and inversion methods are needed. Computational learning and optimized modeling approaches are essential. To target challenges in these fields we will discuss statistical learning methods, optimization and design techniques under uncertainty, and inverse problems of big data.

▶ MS-Mo-D-48-1 13:30–14:00

Designing A Realistic Image Denoising Model by Means of A Bilevel Optimization Approach.

Calatroni, Luca Univ. of Cambridge

Abstract: We consider a nonlinear PDE-constrained optimization approach to learn the optimal weights for a total variation image denoising model featuring different noise distributions possibly present in the data. The distribution of the noise is a-priori unknown, so we enforce sparsity in the weight vector for a blind selection of the correct model. A training set of images is considered for a robust estimation and a new modelling of multiple-noise distributions is presented as well.

▶ MS-Mo-D-48-2 14:00–14:30

How Generalised Singular Vectors Can Help to Develop New Regularisation Methods

Benning, Martin Univ. of Cambridge

Abstract: Singular value decomposition is the key tool in the analysis and understanding of linear regularisation methods. Recently, the notion and concept of singular vectors has been generalised to non-linear regularisation methods like l1- or total variation- regularisation. In this talk we want to present some of the important properties of singular vectors of one-homogeneous regularisation functionals, and discuss how these generalised singular vectors can be helpful to develop novel, data-driven regularisation methods.

▶ MS-Mo-D-48-3 14:30–15:00

Variational Nonlinear Eigenfunction Analysis for Signal Representation and Processing

Gilboa, Guy Technion

Abstract: Linear eigenfunction decomposition is a powerful technique used broadly for processing signals and images. In this talk a generalization based on convex variational principles will be discussed. It extends transforms and eigenfunction analysis to the nonlinear setting. As a canonical example, a spectral total-variation framework will be presented. It will be shown how similar principles are valid for general one-homogeneous functionals. Applications for image decomposition and texture analysis will illustrate benefits of this framework.

▶ MS-Mo-D-48-4 15:00–15:30

Derivative-free Nonlinear Constrained Optimization under Uncertainty Using NOWPAC

Augustin, Florian Massachusetts Inst. of Tech.
Marzouk, Youssef Massachusetts Inst. of Tech.

Abstract: We present the derivative-free optimization procedure NOWPAC (Nonlinear Optimization With Path-Augmented Constraints) for nonlinear constrained programming. The algorithm is based on a trust region framework that maintains feasibility at all intermediate designs. We incorporate uncertainty using risk measures that are approximated with sampling schemes. A noise indicator in NOWPAC detects when no further progress towards an optimal design is expected due to sampling noise. We close with numerical examples demonstrating the efficiency of NOWPAC.

MS-Mo-D-49 13:30–15:30 107

Rare Events in Complex Physical Systems - Part I of IV

For Part 2, see MS-Mo-E-49
For Part 3, see MS-Tu-D-49
For Part 4, see MS-Tu-E-49

Organizer: Cameron, Maria Univ. of Maryland
Organizer: Li, Tiejun Peking Univ.
Organizer: Lu, Jianfeng Duke Univ.
Organizer: Weare, Jonathan Univ. of Chicago
Organizer: Zhou, Xiang City Univ. of Hong Kong

Abstract: Many problems arising from chemistry, physics and materials science involve rare but significant exit events and/or transition events between stable states. The transitions happen on a time scale much longer than the intrinsic time scale of the dynamical system. Examples of such events are conformational changes of biomolecules, chemical reactions, etc. The purpose of this minisymposium is to bring together experts working in theory, numerical algorithms and application issues, such as analysis of models for metastable systems, free energy calculation, importance sampling, accelerated dynamics, and sampling of transition pathways.

▶ MS-Mo-D-49-1 13:30–14:00

Metastability, Spectra and Eigencurrents of Networks Representing Energy Landscapes

Cameron, Maria Univ. of Maryland

Abstract: Computational tools for spectral analysis of large stochastic networks representing energy landscapes of atomic and molecular clusters are proposed: (i) an efficient algorithm for computing zero-temperature asymptotics for eigenvalues and eigenvectors of the generator matrices, and (ii) a continuation technique for computing selected eigenpairs of interest at finite temperatures and corresponding eigencurrents. Applications to Wales group's networks representing Lennard-Jones clusters of 38 and 75 atoms whose energy landscapes have double-funnel structures will be presented.

▶ MS-Mo-D-49-2 14:00–14:30

An Adaptive Step-size String Method and Its Convergence to the Minimum Energy Path

Zhang, Lei Peking Univ.

Abstract: Finding minimum energy path (MEP) on a potential energy surface is of great interest in understanding the barrier-crossing events. We develop an adaptive step-size string (ASS) method by treating classical string method as a minimization process of the Friedlin-Wentzell functional. Optimization method can then be applied in the ASS to speed up the computation. Numerical analysis shows the action can measure how far from one path to MEP and proves the local convergence.

▶ MS-Mo-D-49-3 14:30–15:00

Evolving Junctions on Obstacle Boundaries (E-JOB) Method for the Shortest Path Problems

Zhou, Haomin Georgia Inst. of Tech.

Abstract: In this talk, I will use the shortest path problem, finding the shortest path connecting two points while avoiding obstacles in a region, as an example to illustrate how one can use stochastic differential equations (SDEs) to solve some challenging real world problems. On the other hand, the algorithm introduces new, but challenging, mathematical problems in dynamical systems and PDEs that have not been studied in the past. This presentation is based on joint work with Shui-Nee Chow (Math, Georgia Tech), Yancy Diaz-Mercado (ECE, Georgia Tech), Magnus Egerstedt (ECE, Georgia Tech), Wuchen Li (Math, Georgia Tech) Jun Lu (Wells Fargo).

▶ MS-Mo-D-49-4 15:00–15:30

The String Method for Saddle Point Search

REN, WEIQING National Univ. of Singapore & IHPC

Abstract: In this talk, we show how the string method, which was originally developed to compute minimum energy paths between two meta-stable states, can be used to compute saddle points for a given minimum of the potential or free energy. These saddle points act as bottlenecks (i.e. transition states) for barrier-crossing events. Application to the wetting transition on patterned surfaces will be presented.

MS-Mo-D-50 13:30–15:30 207

Mathematics for Industry 1: Analytical, geometrical and statistical methods to solids, fluids and plasmas

Organizer: Fukumoto, Yasuhide Inst. of Mathematics for Industry, Kyushu Univ.

Abstract: Mathematics for Industry (MI) has been born by amalgamating and reorganizing pure and applied mathematics, to serve as the foundation for developing future technologies. Institute of Mathematics for Industry (IMI) , Kyushu University, was founded in 2011 to develop MI, including fundamental research. This minisimposium starts with introduction of IMI' s activities. Mathematics finds its effective applications in manufacturing industry and global environmental problems. The symposium is followed by outstanding examples: modeling of interfacial phenomena of complex fluids, novel minimal surfaces, with their distinctive properties, of a solid body, and advanced statistical approach to predict magnetic storms caused by solar flares.

▶ MS-Mo-D-50-1 13:30–14:00

Modeling for Droplet Motion Driven by Interfacial Tension Gradient

Hiroyuki, Kitahata Chiba Univ.

Abstract: It is known that a droplet with surface tension gradient can deform and move through the Marangoni effect. We constructed a mathematical model for such droplet deformation and motion based on hydrodynamics with shear stress balance at its surface, and we discussed the droplet motion analytically and numerically using the model. We also made actual experiments and compared the results with the theoretical and numerical ones.

▶ MS-Mo-D-50-2 14:00–14:30

Generalized Autoregressive Model with Exogenous Variables and Its Application in Space Climate

Pan, Qin Dalian Univ. of Tech.

Abstract: We propose the generalized autoregressive model with exogenous variables on the basis of generalized linear models with location, scale and shape. The proposed model enables us to describe the non-Gaussian, non-stationary, and non-Markovian stochastic systems. The proposed model is used to predict the disturbance storm time index based on t-distribution, which characterizes the strength of disturbances caused to the geomagnetic field by solar wind plasma ejecta. The results indicate the outstanding performance of the models.

▶ MS-Mo-D-50-3 14:30–15:00

Initiative Taken by Institute of Mathematics for Industry, Kyushu University

Fukumoto, Yasuhide Inst. of Mathematics for Industry, Kyushu Univ.

Abstract: Mathematics for Industry (MI) has been born by amalgamating and reorganizing pure and applied mathematics, to serve as the foundation for future technologies. Various activities for MI were made in the Global COE Program offered by the Ministry of Education, Japan. Foundation of Institute of Mathematics for Industry (IMI), Kyushu University, is its product (2011). This talk presents IMI's initiatives for developing MI and nurturing young talents. The symposium is followed by outstanding MI researches.

▶ MS-Mo-D-50-4 15:00–15:30

On Bifurcation and Local Rigidity of Triply Periodic Minimal Surfaces in the Three-dimensional Euclidean Space

Koiso, Miyuki Kyushu Univ.

Abstract: Minimal surfaces are equilibrium surfaces of the area. Triply periodic minimal surfaces in the three-dimensional Euclidean space (TPMS's) sometimes appear in self-assembly of nanoscale matters. We construct general criteria for existence and nonexistence of bifurcation for TPMS's. By applying these criteria, we determine the local dimension of the space of all TPMS's, and moreover, we prove the existence of unknown examples of TPMS's which are close to known examples.

MS-Mo-D-51 13:30–15:30 209A

Vaccination behavior as equilibrium between personal and societal views

Organizer: Turinici, Gabriel Ceremade, Universite Paris DAUPHINE

Abstract: Vaccination coverage in developed countries weakens significantly over concerns regarding the side-effects of the vaccines. As a consequence the non-compulsory vaccination programs have to take into account the willingness of the people to vaccinate (and not only the general, societal, interest to do so). This perspective is very recent and has only been addressed in research works in the last 10-15 years. The goal of this mini-symposium is to present the state of the art of the field through intervention by researchers with very different background: applied mathematics, medicine, economics and physics, etc.

▶ MS-Mo-D-51-1 13:30–14:00

Introduction to Mathematical Models of Individual Vaccination Behavior

Turinici, Gabriel Ceremade, Universite Paris DAUPHINE

Abstract: The problem of finding the optimal vaccination as response to an ongoing epidemic has been traditionally addressed in the framework of optimal control theory. These tools give the best vaccination policy optimizing the overall, societal outcome. However adherence to the prescribed vaccination program is not always optimal at the individual level. To address this situation,

new models, coming from the game theory have been introduced. This talk will give an introduction to such models.

▶MS-Mo-D-51-2 14:00–14:30
Analysis and Control of Epidemic Models with Information Dependent Vaccination
Buonomo, Bruno Univ. of Naples Federico II

Abstract: In recent years, there have been significant developments in the field of mathematical theory of the spread of infectious diseases. These developments concern the so called behavioral-epidemic models. Such models include feedbacks that the information and rumours about the spread of an infectious disease have on the spreading itself.
In this talk, we will focus on the analysis and control of some behavioral-epidemic models. In particular, we will deal with the effects of information feedbacks

▶MS-Mo-D-51-3 14:30–15:00
Mean Field Games Equilibrium in A SIR Vaccination Model
Laguzet, Laetitia Univ. Paris-Dauphine

Abstract: Recent debates concerning the innocuity of vaccines with respect to the risk of the epidemic itself lead to vaccination campaign failures. We analyze, in a SIR model, whether individuals driven by self interest can reach an equilibrium with the society.
We show, in a Mean Field Games context, that an equilibrium exists and discuss the price of anarchy. Finally, we apply the theory to the 2009-2010 Influenza A (H1N1) vaccination campaign in France.

▶MS-Mo-D-51-4 15:00–15:30
Dual Dilemma of Vaccination
Fu, Feng ETH Zurich

Abstract: Massive vaccination is beneficial on the population level to suppress the overall epidemic prevalence, but in the mean time, the presence of high vaccination level intensifies the selective pressure favoring the emergence of vaccine-resistant pathogen strains. This gives rise to the notion of “dual dilemma of vaccination”. Here we address this problem with a combination of game theory and an evolutionary epidemiological model.

MS-Mo-D-52 13:30–15:30 212A
Mathematics in population genetics and evolution - Part I of II
For Part 2, see MS-Mo-E-52
Organizer: Yang, Ziheng Univ. College London
Organizer: Ma, Zhiming AMSS, CAS

Abstract: Population genetics provides mechanistic interpretations of Charles Darwin's theory of evolution by natural selection. It is a discipline in the life sciences that has a strong interplay with statistics, computer science and applied mathematics, founded by R.A. Fisher, S. Wright, and J. B. S. Haldane.It is essential both for understanding biological evolution and forinterpreting the ever-increasing genomic datasets, and has thus gained momentum in the last few decades because of the rapid accumulation of genetic data, driven by the various genome projects. This symposium will focus on probabilistic modeling and statistical analysis of modern genetic and genomic data, and the statistical and computational challenges that we face. The symposium will provide a forum for statisticians and computer scientists interested in this exciting field of biology to exchange ideas and experiences with evolutionary biologists, and to discuss various problems at the cutting edge of the field.

▶MS-Mo-D-52-1 13:30–14:00
The Multispecies Coalescent Model and Its Applications in Analysis of Genomic Sequence Data
Yang, Ziheng Univ. College London

Abstract: The multiple species model is a natural extension of the single-population coalescent to the case of multiple species. It accounts for the polymorphism and coalescent within each population as well as the phylogenetic relationships among the species. It provides a natural framework for the analysis of genomic sequence data to address a number of important questions in evolutionary biology, such as estimation of population sizes and species divergence times, species tree estimation, and species delimitation. Computation is achieved using Bayesian Markov chain Monte Carlo (MCMC) algorithms. In this talk I will provide an overview of the multispecies coalescent model and discuss its many applications.

▶MS-Mo-D-52-2 14:00–14:30
Bayesian Species Delimitation Using DNA Sequences
Rannala, Bruce Univ. of California Davis

Abstract: A Bayesian inference method for joint species delimitation and species tree estimation using multilocus sequence data under the multi-species coalescent model is described. It eliminates the need for a user-specified guide tree. Computation is achieved through MCMC which moves between different species trees and rjMCMC which moves between different delimitation models. The method is found to have good statistical properties. Real datasets are often found to be informative about delimitation but not about phylogeny.

▶MS-Mo-D-52-3 14:30–15:00
Voodoo or Real Inference? ABC Meets Machine Learning
Corander, Jukka Univ. of Helsinki

Abstract: We consider machine learning techniques for significantly accelerating simulator-based approximate inference. The first strategy introduces classification for discrimination between representative and poor simulated data sets, such that consistent estimators can be obtained. The second strategy uses Bayesian optimization to guide a search in the parameter space, which can result in several orders of magnitude faster convergence to a point estimate. We illustrate both concepts using several types of dynamic models involving genetic data.

▶MS-Mo-D-52-4 15:00–15:30
Stochastic Modeling and Analysis of DNA Sequence Data from Follicular Lymphoma
Wiuf, Carstens Univ. of Copenhagen

Abstract: In this talk I present a coalescent model with stochastic population size, growing from a single individual/cell in the past to a random number of individuals at the present time. The model is based on a birth-death process. The model will be applied to samples of DNA sequences from Follicular Lymphoma, a cancer disease, with the aim of estimating the time of origin of the disease.

MS-Mo-D-53 13:30–15:30 311B
Challenges in Financial Modelling: Numerics, Statistics, and Calibration.
Organizer: Zubelli, Jorge IMPA

Abstract: Modeling of financial markets leads to a plethora of challenging problems that range from analytic to numerical ones. They are characterized by massive quantities of data and unobservable variables that are fundamental in the model interpretation.
This mini-symposium concerns large-scale and ill-posed problems arising or motivated by financial applications. Typical examples appear in risk management and volatility calibration. We shall start with an overview of the relevant problems such as volatility calibration and correlation.
Then, we will discuss discretization and iterative techniques that have impact on risk management and volatility modeling. In particular, we focus on discrepancy principles and on the issue of stopping criteria for iterative algorithms. Another highly used group of techniques is associated to state space methods and Kalman filtering. Finally, we present specific examples coming from commodity markets and multi-factor stochastic volatility models.

▶MS-Mo-D-53-1 13:30–14:00
Robust Time-consistent Dynamic Utility Maximization under Stochastic Volatility
Li, Bin Univ. of Waterloo

Abstract: We consider a financial market with a risk-free asset and a risky asset, with the latter's price following a diffusion with stochastic volatility. Under the robust time-consistent dynamic utility introduced by Bion-Nadal and Delbaen, utilizing time-consistency and g-expectation, a closed-form optimal strategy is obtained for the incomplete market with either full uncertainty or partial uncertainty. The convergence of the associated optimal strategy is also proved when the market is approaching from partial uncertainty to full uncertainty.

▶MS-Mo-D-53-2 14:00–14:30
Local Volatility Calibration in Commodity Markets and Practical Simplifications
Albani, Vinicius Univ. of Vienna

Abstract: We adapt Dupire's local volatility model to price European options on commodity Futures, applying Tikhonov regularization to the corresponding calibration problem, under a discrete setting. We also present two simplifications. The first one is a parametric local volatility surface. In the second one, we make use of the Bayes theorem to find a simplified pricing technique, reducing the dimension of the inverse problem. We perform numerical tests with synthetic as well as market data.

▶MS-Mo-D-53-3 14:30–15:00
Calibration Problems in Finance: from State Space Models to Iterative Algorithms
Zubelli, Jorge IMPA

Yang, Xu Instituto Nacional de Matematica Pura e Aplicada

Abstract: We shall start with a brief overview of the importance of calibration methods in mathematical finance in general and risk management in particular. After that we shall focus on the problem of recovering the local volatility (not the implied one) from observed market prices.Here we shall compare competing approaches to handle such problem, including iterative methods and state space methods. This will set the stage for the other talks in this mini-symposium.

▶ MS-Mo-D-53-4 15:00–15:30

Data Completion

Ascher, Uri Univ. of BC

Abstract: The lagged steepest descent (LSD) method for convex quadratics challenges basic notions in PDE discretization and general orderly convergence. It is chaotic, it occasionally takes steps that cannot be too small, and its convergence rate remains unproved. More in the talk.

MS-Mo-D-54 13:30–15:30 VIP1-2

Minisymposium Computational Finance - Part I of III

For Part 2, see MS-Mo-E-54

For Part 3, see MS-Tu-D-54

Organizer: Teng, Long Bergische Universität Wuppertal

Organizer: Guenther, Michael Bergische Universität Wuppertal

Organizer: Ehrhardt, Matthias Univ. of Wuppertal

Abstract: In recent years the variety and complexity of financial mathematics models has witnessed a tremendous growth. For the resulting computational complexity, advanced numerical techniques are imperative for the applications in financial industry. The aim is to deeper understand complex financial models and to develop effective and robust numerical schemes for solving linear and nonlinear problems arising from the mathematical theory of pricing financial derivatives and related financial products. The motivation for this minisymposium is to exchange and discuss current insights and ideas, and to lay groundwork for future collaborations. Finally, it should serve as a kick-off for the special interest group (SIG) Computational Finance within ECMI (European Consortium for Mathematics in Industry).

▶ MS-Mo-D-54-1 13:30–14:00

Rare Event Simulation Using Reversible Shaking Transformations

LIU, GANG Ecole Polytechnique

Gobet, Emmanuel Ecole Polytechnique

Abstract: We introduce random transformations called reversible shaking transformations which are used to design two schemes for estimating rare event probability. One is based on interacting particle systems (IPS) and the other on time-average on a single path (POP) using ergodic theorem. We discuss their convergence rates and provide numerical experiments including continuous stochastic processes and jump processes. Both schemes have good performance with a seemingly better one for POP.

▶ MS-Mo-D-54-2 14:00–14:30

High-order Compact Finite Difference Methods for Parabolic Problems with Mixed Derivative Terms and Applications in Computational Finance

During, Bertram Univ. of Sussex

Abstract: We present a high-order compact finite difference approach to parabolic partial differential equations with mixed second-order derivative terms and time- and space-dependent coefficients in arbitrary spatial dimension. Problems of this type arise frequently in computational fluid dynamics and computational finance. We give some results on the stability of the scheme and present numerical examples for pricing of European basket options. Analytical and numerical results suggest unconditional stability of the scheme.

▶ MS-Mo-D-54-3 14:30–15:00

ADE Methods - Numerical Analysis and Application to Linear and Nonlinear Black-Scholes Models

Buckova, Zuzana Bergische Universität Wuppertal

Ehrhardt, Matthias Univ. of Wuppertal

Guenther, Michael Bergische Universität Wuppertal

Abstract: We are dealing with numerical methods for linear and nonlinear Black-Scholes model. We apply finite difference method, esp. Alternating direction explicit methods (ADE), which were suggested in 1957 by Saul'ev. Our work includes detailed numerical analysis consisting of stability and consistency proofs.

Numerical results of the ADE method for nonlinear Black-Scholes models, where the nonlinearity is caused by illiquid markets, are provided.

We compare our method to alternative numerical approaches for solving the nonlinear Black-Scholes.

▶ MS-Mo-D-54-4 15:00–15:30

An Accurate Simulation-based Approach to the Dynamic Portfolio Management Problem

Cong, Fei TU Delft

Oosterlee, Cornelis CWI -center for mathematics & computer Sci.

Abstract: We enhance a well-known dynamic portfolio management algorithm, the BGSS algorithm, proposed by Brandt, Goyal, Santa-Clara and Stroud (Review of Financial Studies, 18, 831-873, 2005). We equip this algorithm with the components from a recently developed method, the Stochastic Grid Bundling Method, for calculating conditional expectations. When solving the first-order conditions for an optimum, we implement a Taylor series expansion based on a nonlinear decomposition to approximate the utility functions.

MS-Mo-D-55 13:30–15:30 106

Multi-Physical modeling and multi-scale methods for nano-optics

Organizer: Liu, Di Michigan State Univ.

Abstract: The main objective of the proposed minisymposium is update recent progress on robust, efficient and accurate numerical methods for multiphysical models of nanoscale optical devices that are able to bridge multiple time and space scales. Application will be focused on photon driven nano devices and atto-second pulse physics.

▶ MS-Mo-D-55-1 13:30–14:00

A Multiscale Method for Study of Metal-enhanced Fluorescence

Cui, Tao ICMSEC, AMSS, CAS

Abstract: We introduce a new framework for the multiphysical modeling and multiscale computation of metal-enhanced fluorescence. The semi-classical theory treats the evolution of the electromagnetic field and the motion of the charged particles self-consistently by coupling Maxwell equations with Quantum Mechanics. Numerical examples are presented to illustrate the distance dependence of metal-enhanced fluorescence.

▶ MS-Mo-D-55-2 14:00–14:30

Mathematics of Super-resolution in Resonant Media

Zhang, Hai ENS, Paris

Abstract: We first introduce some background of super-resolution. We then focus on the particular super-resolution technique where resonant media are used. Two cases are analyzed: one is Helmholtz resonators and the other is high contrast material. In both cases, we developed rigorous mathematical theory to explain the mechanism of super-resolution achieved.

▶ MS-Mo-D-55-3 14:30–15:00

On Accurately Calculating Ionic Force with Finite Element Methods

Bao, Gang Zhejiang Univ.

Hu, Guanghui Univ. of Macau

Liu, Di Michigan State Univ.

Abstract: The spurious oscillation of the total energy can be observed when using finite element methods to simulate the translational and/or rotational move of an electronic structure. Such oscillation can negatively affect the calculation of the ionic force acting on the nucleus. We will present the results of using adaptive finite element methods to keep the translational invariance of the total energy, and related applications on geometry relaxation of molecules with Born-Oppenheimer molecular dynamics.

▶ MS-Mo-D-55-4 15:00–15:30

A Maxwell-Ehrenfest Model for Optical Responses of Nano-structures

Luo, Songting Iowa State Univ.

Abstract: To simulate the light-matter interactions with nano-structures, we introduced a numerical trackable semi-calssical model where the waves are determined classically by Maxwell equations, and the motion of the matter is described with Ehrenfest molecular dynamics. Density Functional Theory is further adopted to resolve the difficulty of describing electronic motion, and classical mechanics is used to describe the nuclear motion in the semi-classical limit. Multiscale schemes are designed to solve the system.

MS-Mo-D-56 13:30–15:30 403

Numerical and Analytical aspects in Semiconductor Theory.

Organizer: Rotundo, Nella Weiestrass Inst.

Organizer: Schilders, Wil TU Eindhoven

Abstract: The mathematical modeling of semiconductor devices plays a fundamental role both in studying the effects of decreasing the dimension of the devices with respect to their efficiency and in pushing forward the research on new materials as well as improving the behavior and efficiency of well-known materials. On the one hand, mathematical modeling should be investigated and validated from the analytical point of view. On the other hand, numerical simulations are becoming a fundamental tool to validate the models and re-

duce the time of the design creation. This minisymposium aims at providing a vision on recent advances on semiconductor theory and simulations and to encourage the communication between experts in fields of applied analysis and numerics of aspects of semiconductor theory.

▶ MS-Mo-D-56-1 13:30–14:00

Generalisations of the Scharfetter-Gummel Scheme to Non-Boltzmann Statistics

Farrell, Patricio Weierstrass Inst. (WIAS)

Abstract: We discuss how the Scharfetter-Gummel scheme can be adapted to more complicated distribution functions (in particular to non-Boltzmann statistics). Our main goal is to discretely preserve important properties from the continuous system such as existence and uniqueness of the solution, consistency with the thermodynamical equilibrium and unconditional stability. We also show how these numerical methods can be efficiently implemented for 2D and 3D applications.

▶ MS-Mo-D-56-2 14:00–14:30

Analytical Methods for Doping Optimization for Semiconductor Devices

Rotundo, Nella Weiestrass Inst.

Abstract: We present an optimal design problem for semiconductor devices.We consider the van Roosbroeck' s system of equations which comprises different kinds of generation and recombination terms. It includes radiative, spontaneous and stimulated recombinations.The optimal doping problem can be seen as a PDE-constrained optimization problem in which we minimize an objective functional depending upon the electron and hole densities, the electrostatic potential and the doping profile.We discuss the case where the doping profile serves as the control.

▶ MS-Mo-D-56-3 14:30–15:00

Analysis for Edge-emitting Semiconductor Heterostructures

Thomas, Marita Weierstrass Inst. for Applied Analysis & Stochastics (WIAS Berlin)

Abstract: This contribution discusses results on the existence of local-in-time classical solutions for edge-emitting semiconductor heterostructures both in 2D and 3D. Electrics of the semiconductor is governed by the Poisson equation for the electrostatic potential and a system of drift-diffusion equations for the carrier transport, nonlinearly coupled with the equations of optics, given by a Helmholtz-type eigenvalue problem and an ODE for the photon balance. 2D-simulations based on this coupled system will be presented.

▶ MS-Mo-D-56-4 15:00–15:30

Numerical Methods for the Simulation of Semiconductor Devices

Schilders, Wil TU Eindhoven

Abstract: In this talk, an overview will be given of numerical methods that have been developed specifically for the simulation of semiconductor devices. Special methods for the discretization and nonlinear solution will be discussed, and it will be shown why standard methods fail. The methods developed can be formulated in an abstract mathematical way. The methodology can also be used for organic devices like OLEDs.

MS-Mo-D-57 13:30–15:35 402A

Recent advances in modeling, analysis, and methodology for interface and free boundary problems and applications - Part I of V

For Part 2, see MS-Mo-E-57
For Part 3, see MS-We-D-26
For Part 4, see MS-We-E-26
For Part 5, see MS-Th-BC-26

Organizer: Li, Zhilin North Carolina State Univ.
Organizer: Lai, Ming-Chih National Chiao Tung Univ.

Abstract: In recent years, there is increasing interest in the development and application of advanced computational techniques for interface problems, problem with free boundary and moving interface, fluid-structure interactions driven by applications in physiology, fluid mechanics, material sciences, porous media flow, and biology. There are also many numerical approaches developed in recent years. The aim of this mini-symposium is to bring together scientists in the field to exchange their recent research discoveries and future directions, to stimulate novel ideas, and to nurture collaborations. The focus would be on Cartesian grid method such as the immersed boundary/interface methods, the level set methods, fluid-structure interactions, and applications.

▶ MS-Mo-D-57-1 13:30–13:55

A Treecode-Accelerated Boundary Integral Poisson-Boltzmann Solver for Solvated Proteins

Krasny, Robert Univ. of Michigan
Geng, Weihua Southern Methodist Univ.

Abstract: We present a treecode-accelerated boundary integral (TABI) solver for electrostatics of solvated proteins described by the linear Poisson-Boltzmann equation. We compare TABI results with those obtained using the grid-based APBS code. The TABI solver exhibits good serial and parallel performance combined with relatively simple implementation, efficient memory usage, and geometric adaptability.

▶ MS-Mo-D-57-2 13:55–14:20

Simple Eulerian Methods for Compressible Fluids in Domains with Moving Boundaries

Alina, Chertock North Carlina State Univ.

Abstract: We introduce a simple Eulerian method for treatment of moving boundaries in compressible fluid computations. The fluid domain is placed in a computational domain, which is divided into internal, boundary, and external cells. The numerical solution is evolved in internal cells only. The numerical fluxes at other cells are computed using a ghost-cell extrapolation and an interpolation in the phase space. The computational framework may be used in conjunction with one's favorite finite-volume method.

▶ MS-Mo-D-57-3 14:20–14:45

A Weak Formulation for Solving Elliptic and Elasticity Interface Problems

Hou, Songming Louisiana Tech Univ.

Abstract: Interface problems occur in many multi-physics and multi-phase applications in science and engineering. An accurate and efficient method is desired. We proposed a non-traditional finite element method for solving elliptic and elasticity interface problems using non-body-fitted mesh. Some theoretical discussions and numerical studies are presented in both 2D and 3D.

▶ MS-Mo-D-57-4 14:45–15:10

Mathematical Modeling and Computational Methods for the Tumor Microenvironment

Dillon, Robert Washington State Univ.

Abstract: We describe a hybrid/cells-based model for the emergence of ductal carcinoma in situ and the transition to invasive ductal carcinoma both in vivo and in microfluidic cell-culture devices. We present preliminary results using simplified models of metabolism as well as the cellular response and production of diffusible growth factors such as TGF-beta. In this model, the cells are represented as discrete entities in which the fluid mechanical component is represented in an immersed boundary framework, the transport of ions and proteins by an immersed interface methods, coupled with systems of ODE's for the intracellular processes.

▶ MS-Mo-D-57-5 15:10–15:35

A Numerical Method for A Quasi-incompressible Variable Density Phase-field Model with A Discrete Energy Law

Lin, Ping Univ. of Dundee

Abstract: We consider two-phase flows with variable densities. The Quasi-Incompressible NSCH model with the gravitational force being incorporated in the thermodynamically consistent framework will be investigated. We design a continuous finite element method and a special temporal scheme such that the energy law is accurately preserved at the discrete level. Such a discrete energy law for a variable density two-phase flow model has not been established - a joint work with Z.L.Guo and J Lowengrub.

MS-Mo-D-58 13:30–15:30 401

Surface diffusion and related problems and flows. - Part I of III

For Part 2, see MS-Mo-E-58
For Part 3, see MS-Tu-D-58

Organizer: Novick-Cohen, Amy Technion IIT

Abstract: Motion by surface diffusion, in which the normal velocity of an evolving surface is proportional to minus the surface Laplacian of its mean curvature, constitutes a geometric motion which plays a critical role in many technological applications, from thin film drug delivery, optical coatings, printing, and spray technology. While surface diffusion has been discussed in the material science literature to 1950s, much concerning its mathematical theory remains to be developed. The aim of the proposed minisymposium is consider surface diffusion and related problems from a variety of aspects, including existence, uniqueness, self-similarity, numerical methods, and issues related to applications. SIAG-MS sponsored.

(Comment: the actual area might best reflect A04 as well as A24, and the organizer is a member of two siags: SIAG-APDE as well as SIAG-MS)

▶ MS-Mo-D-58-1 13:30–14:00

Quadruple Junctions and Hole Formation in Thin Films: A Numerical Study

Derkach, Vadim Technion IIT

Novick-Cohen, Amy — Technion IIT
Rabkin, Eugen — Technion

Abstract: In my lecture I shall report on 3D numerical studies of the motion of quadruple junctions and thermal grooves in thin polycrystalline films, where the mean curvature motion of the grain boundaries and the surface diffusion evolution of the exterior surfaces couple along the thermal grooves. Our algorithms could also be used to study hole evolution in thin monocrystalline and polycrystalline films, where only the motion of the exterior surface needs to be considered.

▶ MS-Mo-D-58-2 — 14:00–14:30
Self-similar Solution for Fourth Order Curvature Flow Equation: A Problem with Incompatible Initial Data
Asai, Tomoro — Hiroshima City Univ.

Abstract: Our study is the problem of the existence of the self-similar solution for the surface diffusion flow in one-dimensional case with nonlinear boundary conditions. This problem was proposed by W. W. Mullins in 1957 to describe the thermal grooving. In this talk, we show the existence of self-similar solution of the differential form of the surface diffusion flow with linearized boundary conditions.

▶ MS-Mo-D-58-3 — 14:30–15:00
Sharp Interface Models for Solid-state Dewetting Problems
Bao, Weizhu — National Univ. of Singapore

Abstract: I will present sharp interface models with anistropic surface energy for simulating solid-state dewetting and the morphological evolution of patterned islands on a substrate. The sharp interface model tracks the moving interface explicitly and it is very easy to be handled in two dimensions via arc-length parametrization. Numerical methods are proposed and are applied to study numerically different setups of solid-state dewetting including including short and long island films, pinch-off, hole dynamics, semi-infinite film, etc.

▶ MS-Mo-D-58-4 — 15:00–15:30
Shape-changing Diffusion Along the Interfaces between Dissimilar Materials
Kllinger, Leonid — Technion-Israel Inst. of Tech.

Abstract: Until now, theoretical treatments of chemical interdiffusion along the interface between two immiscible solids were based on assumption that chemical potentials of atoms scale with the interface curvature. We employed a variational principle for calculating the chemical potentials and demonstrated that they contain non-local contributions determined by the global geometry of the system and by the energy of all interfaces. We proposed an algorithm for treating interface diffusion-controlled shape and morphology evolution of solids.

MS-Mo-D-59 — 13:30–15:30 — 402B
Analysis and modelling of dislocations and plasticity - Part I of II
For Part 2, see MS-Mo-E-59

Organizer: Garroni, Adriana — Sapienza, Univ. of Rome
Organizer: Ortiz, Michael — CALTECH

Abstract: Dislocations are line defects in crystals. Their motion and interaction is considered the fundamental mechanism for plastic deformation in metals. Effective models for plasticity have to take into account the collective behavior of many dislocations whose response is influenced by their microscopic arrangement. Considerable effort has been recently devoted to observing, modelling, analyzing and simulating large ensembles of dislocations. This effort involves multiple communities, including applied physics, materials science, solid mechanics and applied mathematics. We propose a minisymposium in three sessions, with the aim of bringing together experts from those diverse communities to share their understanding of the problem from their respective perspectives.

▶ MS-Mo-D-59-1 — 13:30–14:00
A Introduction to the Variational Multi-scale Analysis of Dislocations
Garroni, Adriana — Sapienza, Univ. of Rome

Abstract: The variational multi-scale analysis for dislocations is a first very important step in order to better understand the continuum models for material defects and plasticity. I will present some of the main issues arising in this analysis (e.g., the difficulty of formulating a discrete model and the need for regularization in the linearized semi-discrete theories) and some of the mathematical tools used to formulate the problem.

▶ MS-Mo-D-59-2 — 14:00–14:30
A Possible Approach to Modelling Dislocation Dynamics
Thomas, Hudson — ENPC/INRIA

Abstract: A possible approach to modelling dislocation dynamics at low temperature is presented based upon Kramer's rule for the rate of transitions between states.

▶ MS-Mo-D-59-3 — 14:30–15:00
Discrete Dislocation Dynamics: Application to Graphene
Ariza, Pilar — Univ. of Seville
Arca, F. — Univeristy of Seville
Mendez, J.P. — Univeristy of Seville
Ortiz, Michael — CALTECH

Abstract: In the ﬁeld of electronics, due to its excellent mechanical and electrical properties, graphene has become the most promising material for the production of next generation thin and ﬂexible graphene-based electronic components. Pristine defect-free graphene has no band-gap and is of limited use for semiconductor-based electronics. It was found experimentally that the Stone-Wales defects could change the local density of states. Also, it has been shown theoretically that grain boundaries might insert band gaps.

▶ MS-Mo-D-59-4 — 15:00–15:30
Variational Dynamics for Discrete Screw Dislocations Along Glide Directions
De Luca, Lucia — Technical Univ. Munich

Abstract: We consider a basic zero temperature model for screw dislocations in discrete lattices. Using a discrete-in-time variational scheme, we study the motion of dislocations in the dilute regime, towards low energy configurations. Letting the spacing and time parameters go to zero, we deduce an effective fully overdamped dynamics predicting motion along the glide directions of the crystal. The results are obtained in collaboration with Adriana Garroni, Roberto Alicandro and Marcello Ponsiglione.

IM-Mo-D-60 — 13:30–15:30 — 310
Industrial Mathematics Around the World - Part I of VIII
Activities on Industrial-Mathematics in China
For Part 2, see IM-Mo-E-60
For Part 3, see IM-Tu-D-60
For Part 4, see IM-Tu-E-60
For Part 5, see IM-We-D-60
For Part 6, see IM-We-E-60
For Part 7, see IM-Th-BC-60
For Part 8, see IM-Th-D-60

Organizer: Cai, Zhijie — Fudan Univ.
Organizer: Chen, Gui-Qiang G. — Univ. of Oxford
Organizer: Huang, Huaxiong — York Univ.
Organizer: LU, Liqiang — Fudan Univ.
Organizer: Ockendon, Hilary — Univ. of Oxford
Organizer: Ockendon, John — Univ. of Oxford
Organizer: Peng, Shige — Shandong Univ.
Organizer: Tan, Yongji — Fudan Univ.
Organizer: Wake, Graeme — Massey Univ.,
Organizer: Zhu, Yichao — The Hong Kong Univ. of Sci. & Tech.
Organizer: CHENG, JIN — Fudan Univ.

Abstract: The aim of this section is to boost the use of mathematics as an industrial resource in China and around the world. It will highlight (i) the global experience in industrial mathematics and (ii) the new mathematical ideas that these activities have created as well as the exploitation of existing technologies to new applications. Participants will come from both academia and industry and, for this purpose, the section is proposed to consist of eight minisymposia. Four of them will overview the identification and solution of industrially-driven mathematical problems and the mechanisms that have evolved to deal with them in different regions: China, other Asia-Pacific countries, Europe and North America. Three of the remaining minisymposia will focus on the problems coming from different industrial sectors: financial industry, petroleum industry and industrial areas in which wave propagation is important. The last minisymposium will involve an open discussion on how the global mathematics community can best respond to the increasing demand from industry for applied and computational mathematics; the agenda will include both the mechanisms for academic / industrial collaboration and the areas where it will be most fruitful.

▶ IM-Mo-D-60-1 — 13:30–14:00
Study Group in China
Tan, Yongji — Fudan Univ.

Abstract: Nine study groups in industry have been held in main land and Hong Kong of China since 2000 . In this talk we describe the industry problems and some solutions of those study group

▶ IM-Mo-D-60-2 — 14:00–14:30
My Experience at the Chinese Study Groups

Huang, Huaxiong — York Univ.

Abstract: I have been to several Chinese Study Groups with Industry, including the ones in Hong Kong. In this talk I will discuss some of the problems I have worked on. The first problem was presented by Bao Steel, on the temperature control inside a steel sheet during the hot rolling process. The second problem was submitted by the Royal Bank of Canada on estimating counter party risks.

▶ IM-Mo-D-60-3 — 14:30–15:00

Application of Mathematical Models in the Steel Making Process

Guo, Zhaohui — Baosteel
Gao, Wenwu — Anhui Univ.

Abstract: Mathematical models have been widely used in the steel making process . This talk will present developments of its application in steel making process .Some new trends and challenges of building mathematical models for steel making process will be also covered. Moreover, we shall demonstrate some ideas of how to couple together metallurgical mechanism and big data to develop simulation models for new steel grade delevlopmrent .

▶ IM-Mo-D-60-4 — 15:00–15:30

Power Allocation Strategy of Hybrid Electric Bus

Zhonggeng, Han — Zhengzhou Information Engineering Univ.
Du, Jianping — Zhengzhou Information Engineering Univ.

Abstract: The strategy of power allocation is one of the key techniques in the designing of a Hybrid Electrical Bus (HEB). In this article, a Bayesian forecasting model is firstly proposed to predict the future power demand based on the historical data of driving circles. Then a two-phase model is developed so that the original large-scale Stochastic Dynamic Program (SDP) can be decomposed to several small-scale SDPs and a Deterministic Dynamic Program (DDP). Since it is time-consuming to solve an SDP by the traditional iterative method, the sparse representation of an SDP solution and the S-tochastic Simulation Optimization (SSO) are implemented to accelerate the SDP solver. Further, an Estimation of Distribution Algorithm (EDA) is applied to reduce the searching scope, and an Optimal Computing Budget Allocation (OCBA) method is also used for the purpose of improving the precision and decreasing the computational cost. Finally, a table-based strategy is given as the solution of the online power allocation problem.

CP-Mo-D-61 — 13:30–15:30 — 101
Ordinary Differential Equations
Chair: Guezane-Lakoud, Assia — Univ. Badji Mokhtar Annaba
Abstract:

▶ CP-Mo-D-61-1 — 13:30–13:50

Solution for the Initial-value Problem of A Nonlinear Differential Equation

Guezane-Lakoud, Assia — Univ. Badji Mokhtar Annaba
Khaldi, Rabah — Badji Mokhtar Annaba Univ.

Abstract: This talk concerns the existence and uniqueness of solution of an initial value problem for differential equation involving Riemann -Liouville fractional derivatives. Many problems in sciences are described by initial value problems for nonlinear fractional differential equations such in the study of models of viscoelasticity, electrochemistry, control, porous media, electromagnetic, etc.. Under Krasnoselskii-Krein type conditions, successive approximations, some existence and uniquenee results are established.

▶ CP-Mo-D-61-2 — 13:50–14:10

Existence Results for Fractional Boundary Value Differential Equations in Non-reflexive Banach Space via Pettis Integral

Ur Rahman, Ghaus — Univ. of Swat, Khyber Pakhtunkhwa, Pakistan

Abstract: The purpose of the present paper is to discuss Pseudo solution of fractional boundary value problem in nonreflexive Banach space. Furthermore, using weak measure of non compactness measure we find the existence of solution FBVP in abstract spaces.

▶ CP-Mo-D-61-3 — 14:10–14:30

Large Deviations for Stochastic Integrodifferential Equations

Balachandran, Krishnan — Bharathiar Univ.
Suvinthra, Murugan — Bharathiar Univ., Coimbatore

Abstract: In this work we establish a Freidlin-Wentzell type large deviation principle for stochastic integrodifferential equations. Large deviation theory is an interesting branch of probability theory which deals with the study of rare events. The study of rare events is essential as the impact of its occurrence may be large. The general large deviation principle (LDP) was formulated by Varadhan (1966) and LDP for stochastic differential equations was studied by Freidlin and Wentzell (1970). In this work, we implement the theory developed by Budhiraja and Dupuis (Probabability and Mathematical Statistics 20 (2000) 39-61) to establish the LDP for stochastic integrodifferential equations. The compactness argument is proved on the solution space of corresponding skeleton equation and the weak convergence is done for Borel measurable functions whose existence is asserted from the infinite dimensional version of Yamada-Watanabe theorem.

▶ CP-Mo-D-61-4 — 14:30–14:50

Existence Results of Abstract Impulsive Integro-differential Systems with Measure of Non-compactness

Kandasamy, Malar — Erode Arts & Sci. College
Annamalai, Anguraj — PSG College of Arts & Sci.,

Abstract:
In this Paper, we study the existence of solutions of the nonlocal integro-differential equations with interval impulse and measure of non compactness by using Mӧnch fixed point theorem. Finally, an example is given to illustrate our main result.

▶ CP-Mo-D-61-5 — 14:50–15:10

Stepanov Almost Automorphic Solution of Fractional Order Differential Equations

Syed, Abbas — IIT Mandi

Abstract: In this paper, we discuss the existence and uniqueness of Stepanov almost automorphic solution of fractional order differential equations. We use the tool of resolvent family and fixed point technique to establish our results. At the end an example is provided to illustrate the analytical findings.

▶ CP-Mo-D-61-6 — 15:10–15:30

Positive Solutions for Systems of Higher-order Nonlinear Multi-point Boundary Value Problems

Luca Tudorache, Rodica — "Gheorghe Asachi" Technical Univ. of Iasi

Abstract: We investigate a system of higher-order nonlinear differential equations with two parameters subject to multi-point boundary conditions. Under some assumptions on the parameters, we prove the existence and nonexistence of positive solutions by using the Guo-Krasnosel'skii fixed point theorem. In a special case, we also study the multiplicity of positive solutions by applying the fixed point index theory. For this problem, if the nonlinearities do not possess any sublinear or superlinear growth conditions and may be singular, we prove the existence of positive solutions. A system of higher-order differential equations with sign-changing nonlinearities and integral boundary conditions is also investigated. This is a joint work with Prof. Johnny Henderson (Baylor University, Waco, Texas, USA) and stud. Alexandru Tudorache (Gh. Asachi Technical University of Iasi, Romania).

CP-Mo-D-62 — 13:30–15:30 — 102
Partial Differential Equations
Chair: HERNANE-BOUKARI, DAHBIA — Univ. OF Sci. & Tech. HOUARI BOUMEDIENE (USTHB)

Abstract:

▶ CP-Mo-D-62-1 — 13:30–13:50

A Study of Free Surface Flow Problem over A Topography.

HERNANE-BOUKARI, DAHBIA — Univ. OF Sci. & Tech. HOUARI BOUMEDIENE (USTHB)

Abstract: In this work, we study theoretically and numerically a free surface flow problem, over an obstacle lying on the bottom of infinite channel. We take into account of the gravity but we neglect the effect of the superficial tension. An numerical method based on the minimization of the functional of the total energy of the system, is used to determinate the equilibrium free surface flow, which is the principal unknown.

▶ CP-Mo-D-62-2 — 13:50–14:10

NUMERICAL SOLUTION OF FRACTIONAL HEAT EQUATION WITH VARIABLE COEFFICIENTS

Prakash, Periasamy — Periyar Univ.

Abstract: In this paper we consider the one dimensional space and time fractional heat equation with variable coefficients with Dirichlet boundary condition. By using a second order discretization for spatial derivative, we transform the fractional heat equation into a system of fractional ordinary differential equations which can be expressed in integral form. Further the integral equation is transformed into a difference equation by modified trapezoidal method. Numerical results are provided to verify the accuracy and efficiency of the proposed method.

▶ CP-Mo-D-62-3 — 14:10–14:30

ELECTROMAGNETIC WAVE PROPAGATION IN HETEROGENEOUS LINES FOR ARBITRARY LARGE TIME INTERVALS

Dmitrieva, Irina Odessa National Acad. of Telecommunications (ONAT)

Abstract: The specific case of the differential Maxwell system is studied as mathematical model of electromagnetic wave propagation in heterogeneous lines under expofunctional excitations. It is shown, that such system is equivalent to the general wave PDE (partial differential equation) with respect to all electromagnetic field intensities. Solvability criterion of this system in the class of non generalized functions is proved, and the main types of corresponding boundary problems are suggested and solved explicitly.

▶ CP-Mo-D-62-4 14:30–14:50

The Neutron Transport Discrete Scheme of Preserving Physical Properties

Hong, Zhenying Institue of Applied Physics & Computational Mathematics
Yuan, Guang-wei Inst. of Applied Physics & Computational Mathematics, Beijing, China
Wei, Junxia Inst. of Applied Physics & Computational Mathematics

Abstract: There exit numerical solution oscillation and negative flux for typical discrete scheme when solving multi-group multi-media sophisticated time-dependent neutron transport equations which brings difficulty for mathematics and physics analysis. In this paper, the numerical solution oscillation for sophisticated problem is investigated. The influence of time discrete scheme and space discrete scheme on this oscillating phenomenon is analyzed for neutron transport equations. In addition, the preserving positive neutron transport scheme is studied. The new scheme can take 0 order moment and 1 order moment of the neutron transport equation. Numerical experiments show that second-order time evolution scheme and linear discontinuous finite element method yield more accurate results and provide very smooth physical quantity curves. Based on the non-oscillation scheme, the positivity scheme give the non negative neutron angular flux. These preserving physical properties neutron transport schemes maintain the smooth of neutron multiplication constant and positivity of neutron flux.

▶ CP-Mo-D-62-5 14:50–15:10

A Cell-centered Scheme for Solving Diffusion Equations on General Polygonal Meshes

Chang, Lina Inst. of Applied Physics & Computational Mathematics, Beijing, China

Abstract: Diffusion problems are encountered in a wide range of scientific fields such as heat transfer, plasma physics, and oil reservoir simulation. A finite volume scheme is given for solving diffusion equations on general polygonal meshes. It has only cell-centered unknowns. And local stencils are used for constructing normal flux across the interface. Moreover, the stencils can be chosen adaptively according to the diffusion coefficient and/or the mesh geometry. The scheme is suitable for arbitrary polygonal meshes including the nonconforming ones. Numerical results show that the convergence rate is close to second order for problems with or without discontinuities.

▶ CP-Mo-D-62-6 15:10–15:30

Multi-dimensional Discrete Convolutions, Difference Equations, and Boundary Value Problems

Vasilyev, Vladimir Lipetsk State Technical Univ.

Abstract: We consider discrete convolution operator in the Lebesgue spaces of square integrable functions both for a whole m-dimensional Euclidean space, and for certain canonical domains such as a half-space and a cone. It was found there are certain correlations between solvability of discrete equations and its continual analogue. More precisely, the symbol of a discrete convolution operator with Calderon – Zygmund kernel its symbol takes the same values, and its topological degree is the same both for a discrete case and the continual one [1-3]. For this purpose the authors have constructed the theory of periodic Riemann boundary problem, and this fact permits to consider more complicated case of a discrete equation in a multi-dimensional cone in Euclidean space. Moreover, the introduced methods are very useful for studying solvability of a wide class of difference equations. This talk is based on a joint work with A.V. Vasilyev. The reported study was partially supported by RFBR, research project No. 14-41-03595 a. [1] Vasilyev V.B. Elliptic equations and boundary value problems in non-smooth domains. Operator Theory: Advances and Applications. 2011, V.213. Birkhauser, Basel. P.105-121. [2] Vasilyev A.V., Vasilyev V.B. Discrete singular operators and equations in a half-space. Azerb. J. Math. 2013, V.3, No.1. P.84-93. [3] Vasilyev A.V., Vasilyev V.B. Discrete singular integrals in a half-space. arXiv:1410.1049.

CP-Mo-D-63 13:30–15:30 103

Geophysical, Atmospheric Oceanographic Science

Chair: CHOUDHARY, ARUN Indian Inst. of Tech. Ropar

Abstract:

▶ CP-Mo-D-63-1 13:30–13:50

Approximation to the Scattering of Surface Water Waves by Vertical Barrier over Undulating Bed Topography

CHOUDHARY, ARUN Indian Inst. of Tech. Ropar
Martha, Subash Chandra INDIAN Inst. OF Tech. ROPAR

Abstract: The problem involving the scattering of obliquely incident surface water waves by a submerged vertical barrier over the irregular bottom is analyzed. Perturbation analysis in conjunction with least-squares approximation and Green's integral theorem is employed to obtain the reflection and transmission coefficients up to the first order. These coefficients involve the shape function describing the bottom undulation and the solution of the scattering problem by the submerged barrier in a uniform finite depth of water. A particular shape of the bottom undulation namely a patch of sinusoidal ripples is considered to determine the numerical values of the above physical quantities. The energy identity relation is derived and used for correctness of the analytical and numerical results finding the above coefficients. The effect of some physical parameters on the first order reflection coefficient is also discussed.

▶ CP-Mo-D-63-2 13:50–14:10

Atmospheric Boundary Layer Dispersion Modeling Using the Finite Element Method

Albani, Roseane Universidade Federal do Rio de Janeiro

Abstract: We apply the Galerkin Least Square method jointly with adaptive mesh refinements to simulate the pollutant dispersion in the Atmospheric Boundary Layer (ABL). The mathematical model is described by a transient tri-dimensional advection-diffusion equation. We include in the model the dry deposition process as well as parametric models for the components of the mean wind speed and the vertical eddy diffusivity, which regard the influence of turbulent boundary layer structure.

▶ CP-Mo-D-63-3 14:10–14:30

Wave Transmission and Reflection at Fluid-solid Interface under Coupling Interaction of Multiple Mechanism

Yang, Lei China Univ. of Mining & Tech.
Yang, Dinghui Tsinghua Univ.
Li, Jingshuang China Univ. of Mining & Tech. (Beijing)

Abstract: The Biot mechanism, Squirt-flow mechanism and multiphase flow are the most important factors that affect the wave dispersion and attenuation. So it is very import for the reservior prediction to study their influenc on the wave transmission and reflection at the solid-fluid interface. We derive that the partial different equations which the the P-wave and S-wave lame potential satisfies at the fluid-solid interface under the coupling action of Biot mechanism, Squirt-flow mechanism and multiphase flow. Then the relationship of the reflection and transmission coefficients at the interface is gived to study the influence of incident angle, permeability and the gas content on the relection and refraction. It is discovered that critical angle of the fast P-wave decreases with gas content increasing.

▶ CP-Mo-D-63-4 14:30–14:50

Important Factors Affecting Numerical Simulation of Geological Carbon Dioxide Sequestration

Hao, Yanjun Department of Mathematical Sci., Tsinghua Univ.
Yang, Dinghui Tsinghua Univ.

Abstract: During reservoir simulation of carbon dioxide sequestration, there are still some problems in multiphase flow theory that have not been thoroughly studied, such as capillary pressure and hysteresis of relative permeability. These factors increase the difficulty of modeling CO2 sequestration and deserve to be studied carefully. Numerical modeling should study what factors are important and what could be ignored. Using the reservoir parameters get from multiphase flow modeling, we can get synthetic seismograms at different times after sequestration. During seismic simulation, a key issue is to determine the seismic velocity of the geological model using rock physics models. Many rock physics models are examined, such as Gassmann equation, Biot model, BISQ model and White's patchy saturation model. The differences of calculated velocities and signature of attenuation and dispersion between these models can be huge. When we choose which model to use, we must carefully examine what models can be used.

▶ CP-Mo-D-63-5 14:50–15:10

A Fast Algorithm for A Class of Minimization Problem Arising from the Com-

pressed MR Image Recovery
Zhang, Jianjun — Shanghai Univ.

Abstract: We consider to solve a class of minimization model arising from the compressive Magnetic Resonance image recovery. This model is one of the most powerful models in compressive Magnetic Resonance image recovery, , which involves a composite rugularization.
In this lecture, we propose a fast algorithm for this minimization modelm and give some theoretically results. Numerical results show the effectiveness of our proposed algorithm.

CP-Mo-D-64 13:30–15:30 104
Probability and Statistics
Chair: Jun, He — Univ. of Electronic Sci. & Tech. of China
Abstract:

▶ CP-Mo-D-64-1 13:30–13:50
Dempster-Shafer (D-S) Evidence Theory and Some Key Problems
Jun, He — Univ. of Electronic Sci. & Tech. of China

Abstract: As one of the most important mathematical methods, Dempster-Shafer (D-S) evidence theory has been widely used in many fields. This paper summarizes the development and recent study of the explanations of D-S model, evidences combination algorithms, the improvement of the conflict during evidences combination, and compares all explanation models, algorithms and improvements and their applicable conditions. We try to provide a reference for future research and application through this summarization.

▶ CP-Mo-D-64-2 13:50–14:10
MATHEMATICAL MODELLING OF PATIENT PROFILES AND EFFICIENCY OF GENERALIZED TARGETED CLINICAL TRIALS IN THE ERA OF PREDICTIVE MEDICINE
MAITOURNAM, Aboubakar — Univ. Abdou Moumouni of Niamey, Niger, Faculty of Sci. & Techniques, Department of mathematics & Computer Sci.

Abstract: The mathematical modelling of patient profiles in the era of individualized medicine sketched and the previously introduced efficiency of targeted clinical trials, are here extended. This extension is done by considering on one hand patient profiles as a multidimensional heterogeneous vector with deterministic and random components; and on the other hand by proceeding to a further stratification of responder patients. That stratification is accomplished by assuming that in the case of conventional (untargeted) clinical trials, both the control and treatment groups, are mixtures of k+1 strata defined by their k+1 genotypes and noted, respectively R0, R1, R2, R3,......Rk (k¿=1) with R0 being the non responder patients stratum and (Ri, i = 1.....k) be the k strata of responder patients. Ri patients (i = 1.....k) are thus assumed to be more likely to respond to a molecularly targeted therapy than R0 patients.

▶ CP-Mo-D-64-3 14:10–14:30
Sufficiency and Adequacy of the T-ratio in Determining the Presence of Multicollinearity in A Regression Model
Agunbiade, Adebayo — Olabisi Onabanjo Univ.

Abstract: This research focuses on the diagnostic of multicollinearity and so investigates the sufficiency and adequacy of the t-ratios only to confirm its presence. To achieve this, a three-equation simultaneous model with three multicollinear exogenous variables is presented. Monte Carlo simulation indicates that the asymptotic results provide a better estimate with the Variance Inflation Factor, however a combination of the factors will suffice and not just the t-ratio only in determining the presence of multicollinearity.

▶ CP-Mo-D-64-4 14:30–14:50
Multidimensional Scaling Using Factor Scores
PICAR, JOY — DAVAO DEL NORTE STATE COLLEGE

Abstract: In this paper, we show how the modified factor scores obtained from factor analysis can be used as inputs to the classical multidimensional scaling problem. Some optimality theorems related to the Takane stress function are stated and proved. The use of factor scores in multidimensional scaling is justified on the basis of easy interpretability. Simulation results showed that PCA on Factor Scores gave a better value of the stress measure compared to the classical method of the multidimensional scaling.

▶ CP-Mo-D-64-5 14:50–15:10
Optimal Experimental Design for Estimating the Effective Window Based on Triple Response
Tian, Yubin — Beijing Inst. of Tech.

Abstract: In some explosive tests, the testing specimens are subjected to a variety of stress levels to generate nonresponse, response, or over response. These data are used to estimate the effective window of stress levels for response. Based on binary response (response or nonresponse), several sensitivity testing procedures have been proposed. Among them, Jeff Wu and Yubin Tian’s three-phase optimal design which is dubbed 3pod performs well in terms of efficiency and robustness. In this paper, we extend the 3pod to triple response and propose an optimal design to estimate the effective window for response. Illustration shows that the optimal design is locally concentrated on four levels. The efficiency and the robustness of the design are studied through extensive simulations.

CP-Mo-D-65 13:30–15:30 105
Materials Science and Solid Mechanics
Chair: Singh, Baljeet — Department of Mathematics, Post Graduate Government College, Sector 11, Chandigarh-160011, India

Abstract:

▶ CP-Mo-D-65-1 13:30–13:50
Rayleigh Wave in An Incompressible Transversely Isotropic Fibre-reinforced Elastic Solid with Impedance Boundary Conditions
Singh, Baljeet — Department of Mathematics, Post Graduate Government College, Sector 11, Chandigarh-160011, India

Abstract: The paper is concerned with the propagation of Rayleigh waves in an incompressible fibre-reinforced elastic half-space with impedance boundary conditions. The half-space is assumed to be transversely isotropic. The explicit secular equations of the Rayleigh wave is derived, which is an irrational equation. In absence of impedance parameters, this equation reduces to the secular equation of Rayleigh wave with traction-free boundary conditions. The dependence of non-dimensional wave speed on non-dimensional material parameter and impedance parameters

▶ CP-Mo-D-65-2 13:50–14:10
Elastic Waves in Thermoelastic Saturated Porous Medium
Singh, SS — Mizoram Univ.

Abstract: The problem of reflection of plane waves due to an incident longitudinal wave at a plane free boundary of thermoelastic saturated porous half space has been investigated. There exist four types of plane waves in thermoelastic saturated porous medium in which three of them are attenuating longitudinal waves and another one is non-attenuating transverse wave. The amplitude and energy ratios for the reflected waves are derived analytically and computed numerically.

▶ CP-Mo-D-65-3 14:10–14:30
Effect of Rotation on Time Harmonic Waves in A Thermoelastic Solid with Microtemperatures
Singh, Jaswant — Thakur Sen Negi Govt College Reckong Peo, Kinnaur, Himachal Pradesh

Abstract: The present paper deals with the effect of rotation on the propagation of time harmonic waves in a thermo-elastic medium with microtemperatures. The theory developed by (Iesan and Quintanilla 2000) has been employed for this investigation. It has been found that there exists a single transverse and three sets of coupled longitudinal waves in a rotating thermoelastic material with microtemperatures. The phase speed of single transverse wave is dominated by the rotation of the body while remains independent by the thermal and mictrotemperature properties of the medium. On the other hand, the coupled longitudinal waves are influenced by rotation, microtemperature and thermal properties of the medium. The speed of the transverse wave in rotating thermoelastic medium with microtemperates is found to be less than the speed of this wave in classical elasticity. The results of some earlier papers have also been reduced as a special cases of the present formulation.

▶ CP-Mo-D-65-4 14:30–14:50
Free Axisymmetric Vibration of Two Directional Functionally Graded Annular Plate Resting on Variable Elastic Foundation
Kumar, Yajuvindra — M.K. Government Degree College Ninowa, Farrukhabad

Abstract: This work deals with free axisymmetric vibration characteristics of two direccional functionally graded annular plates resting on variable Winkler foundation. Differential quadrature method has been used to obtain charactristic equation for the plate. First three natural frequencies have been obtained. The effects of volume fraction index, aspect ratio, boundary conditions and foundation parameter have been studied on natural frequencies. The results show efficiency and accuracy of the method for axisymmetric vibration of functionally graded annular plate resting on variable foundation. Natural frequencies have been compared, wherever possible, and a close agreement

of results is observed. Corresponding mode shapes are also drawn.

▶ CP-Mo-D-65-5 14:50–15:10

Couple Stresses, Discrete Models and the Fracture of Rock

Atkinson, Colin imperial college
Coman, Ciprian schlumberger gould research

Abstract: The cracked Brazilian disc test is considered for both sandstone and marble rocks and comparisons made with an analysis based on a discrete model.A detailed comparison is made of the fracrure path in these experiments and also with experiments of uncracked samples. The discrete theory is also compared with micropolar and couple-stress continuum theories via exact analysis of crack tip behaviour in these continuum theories.

▶ CP-Mo-D-65-6 15:10–15:30

STRESS OF A TRUNNION JOINT

Liu, Zhonghua Xi'an Jiaotong Univ.
Feng, Sheng Xi'an Jiaotong Univ.
Geng, Haipeng Xi'an Jiaotong Univ.
Cai, Yandong Xi'an Jiaotong Univ.
Yu, Lie Xi'an Jiaotong Univ.

Abstract: A trunnion joint is modeled as a circular plate with a rotational spring at the outer peripheral portion to resist rotation. Asymmetrical bending deflection is produced when an external moment acts on the inner side of the circular plate. The equations of the circular plate with a special outer peripheral boundary condition are derived. Choosing the stiffness of the rotational spring and the ratio of the outer radius and inner radius of the circular plate as two parameters, the stresses consist of the radial stress, hoop stress and tangential stress are calculated. The effect of the stiffness of the rotational spring on the radial stress and hoop stress becomes obvious for a larger ratio of the outer radius and inner radius. However, the tangential stress is independent of the stiffness of the rotational spring.

MS-Mo-D-66 13:30–15:30 VIP4-3

Current Trends in Wavelet Methods - Part I of II

For Part 2, see MS-Mo-E-66

Organizer: Manchanda, Pammy Guru Nanak Dev Univ., Amritsar
Organizer: Siddiqi,Prof., Abul Sharda Univ.,NCR

Abstract: A formal development of wavelet methods was initiated by a geophysicist Morlet and subsequently Meyer, Mallat, Daubechies, Donoho, Coifman et al played important role in providing a solid mathematical foundation of this theme. Several variants of wavelets such as wavelet packets, wave packets, complex wavelets, dyadic wavelets, curvelets, shearlets, framelets, vector valued wavelets have been studied along with their interesting applications. Relevance of wavelet methods to computerized tomography specially to the Radon transform and its variants have been studied in the recent years. It is well known by now that radon transform plays a significant role in medical imaging. In this mini symposium, updated results in the above mentioned fields will be presented including the results of the speakers in this area.

▶ MS-Mo-D-66-1 13:30–14:00

Representation of Scaling Functions by Walsh Series

Farkov, Yuri Russian Presidential Acad. of National Economy & Public Administration

Abstract: We give a review of recent results on compactly supported scaling functions which can be written as the Walsh series. Among the main subject to be discussed are sufficient conditions for the uniform convergence of the corresponding gap series with applications to wavelet approximation and signal processing. [1] Yu. A. Farkov, Wavelet expansions on the Cantor group, Math. Notes (96) (2014), 996-1007.

▶ MS-Mo-D-66-2 14:00–14:30

Wavelet Analysis of EEG

Zahra, Noore Sharda Univ.
Naz, Shaheen SET,SHARDA Univ.
Parveen, Nazia SRMS,BAREILLY

Abstract: The aim of this study is to predict epileptic seizures based on the analysis of EEG spectrum. This study can be done by recording the EEG data of seizures and non-seizures and then analyze the data set using wavelet transform tool. EEG signals exhibit several patterns of rhythmic or periodic activity in different frequency bands. This may include computation of entropy, energy and statistical parameters of the signal such as mean, variance, standard deviation

▶ MS-Mo-D-66-3 14:30–15:00

Sampling Expansion

Skopina, Maria St.Petersburg State Univ.

Abstract: The well-known sampling theorem (called also Kotel'nikov or Shannon formula) is very useful for engineers. Up to now, an overwhelming diversity of digital signal processing applications and devices are based on it and more than successfully use it. We study approximation by multivariate Kotel'nikov- Shannon type expansions with exact and falsified values. For the one-dimensional case, we also constructed ' ' sampling wavelet decompositions' ' , i.e. frame-like wavelet expansion with coefficients interpolating a signal at the dyadic points.

▶ MS-Mo-D-66-4 15:00–15:30

On Construction of H-symmetric Wavelets

Krivoshein, Aleksandr Saint Petersburg State Univ.

Abstract: A symmetry is one the most desirable properties for wavelet systems in applications. For an arbitrary symmetry group H, we give explicit formulas for refinable masks that are H-symmetric and have sum rule of order n. The description of all such masks is given. Several methods for the construction of H-symmetric wavelets (and multi-wavelets) providing approximation order n in different setups are developed.

EM-Mo-E-01 16:00–18:00 311A

Third Workshop on Hybrid Methodologies for Symbolic-Numeric Computation - Part II of VIII

For Part 1, see EM-Mo-D-01
For Part 3, see EM-Tu-D-01
For Part 4, see EM-Tu-E-01
For Part 5, see EM-We-D-01
For Part 6, see EM-We-E-01
For Part 7, see EM-Th-BC-01
For Part 8, see EM-Th-D-01

Organizer: Giesbrecht, Mark Univ. of Waterloo
Organizer: Kaltofen, Erich North Carolina State Univ.
Organizer: Safey El Din, Mohab Univ. Pierre & Marie Curie
Organizer: Zhi, Lihong Acad. of Mathematics & Sys. Sci.

Abstract: Hybrid symbolic-numeric computation methods, which first appeared some twenty years ago, have gained considerable prominence. Algorithms have been developed that improve numeric robustness (e.g., in quadrature or solving ODE systems) using symbolic techniques prior to, or during, a numerical solution. Likewise, traditionally symbolic algorithms have seen speed improvements from adaptation of numeric methods (e.g., lattice reduction methods). There is also an emerging approach of characterizing, locating, and solving "interesting nearby problems", wherein one seeks an important event (for example a nontrivial factorization or other useful singularities), that in some measure is close to a given problem (one that might have only imprecisely specified data). Many novel techniques have been developed in these complementary areas, but there is a general belief that a deeper understanding and wider approach will foster future progress. The problems we are interested are driven by applications in computational physics (quadrature of singular integrals), dynamics (symplectic integrators), robotics (global solutions of direct and inverse problems near singular manifolds), control theory (stability of models), and the engineering of large-scale continuous and hybrid discrete-continuous dynamical systems. Emphasis will be given to validated and certified outputs via algebraic and exact techniques, error estimation, interval techniques and optimization strategies.
Our workshop will follow up on the seminal SIAM-MSRI Workshop on Hybrid Methodologies for Symbolic-Numeric Computation held in November 2010 and the Fields Institute Workshop on Hybrid Methodologies for Symbolic-Numeric Computation, November 16-19, 2011 at the University of Waterloo, Canada. We will provide a forum for researchers on all sides of hybrid symbolic-numeric computation.

▶ EM-Mo-E-01-1 16:00–16:30

At the Interface between Symbolic and Numeric Computation

Watt, Stephen Univ. of Waterloo

Abstract: We explore various areas where symbolic and numeric computation touch, and how the computation changes as it becomes more symbolic or more numeric. The placement of this boundary can open new ways to think about problems, for example by allowing many cases to be considered simultaneously (as with symbolic domain decomposition), or by combining analytic and algebraic methods (as with approximate polynomial algorithms). This paper will present current work on problems in this area.

▶ EM-Mo-E-01-2 16:30–17:00

How Sub-sampling Can Lead to More Robustness and Higher Resolution in Parametric Spectral Analysis

Lee, Wen-shin — Univ. of Antwerp
Cuyt, Annie — Univ. of Antwerp

Abstract: The problem of uncovering high-resolution frequency information of a signal can be extremely ill-posed. Meanwhile, sampling a signal uniformly below the Shannon-Nyquist rate leads to aliasing, an unwanted effect causing different signals to become indistinguishable.
We develop a parametric method to retrieve fine-scale information from coarse-scale measurements. We exploit, rather than avoid, aliasing to regularize the problem and increase the frequency resolution. Our technique is used to tackle some difficulties encountered in magnetic resonance spectroscopy.

▶ EM-Mo-E-01-3 — 17:00–17:30
On Integer Relation Finding Problem
Chen, Jingwei — CIGIT, CAS

Abstract: Given a real vector x, an integer relation for x is a nonzero integer vector m such that m and x are orthogonal to each other. The integer relation finding problem is quite old and is very useful in many kinds of applications in mathematics, computer science and mathematical physics. In this talk, we report some recent progress on computing integer relations. This talk is based on joint work with Damien Stehle and Gilles Villard.

▶ EM-Mo-E-01-4 — 17:30–18:00
A Quadratically Convergent Algorithm for Structured Low-Rank Approximation
Spaenlehauer, Pierre-Jean — Inria

Abstract: Given an input matrix M, Structured Low-Rank Approximation (SLRA) is the problem of computing a matrix of given rank r in a linear/affine subspace of matrices such that the Frobenius distance to M is small. We present a Newton-like iteration for SLRA, whose main feature is that it converges locally quadratically to such a matrix under mild transversality assumptions. Joint work with Eric Schost.

EM-Mo-E-02 — 16:00–18:00 — 309A
Differential Algebra and Related Topics - Part II of VIII
For Part 1, see EM-Mo-D-02
For Part 3, see EM-Tu-D-02
For Part 4, see EM-Tu-E-02
For Part 5, see EM-We-D-02
For Part 6, see EM-We-E-02
For Part 7, see EM-Fr-D-02
For Part 8, see EM-Fr-E-02

Organizer: Feng, Ruyong — Acad. of Mathematics & Sys. Sci.,CAS
Organizer: Guo, Li — Rutgers Univ. at Newark, USA
Organizer: Gao, Xiao-Shan — Acad. of Mathematics & Sys. Sci., Chinese Acad. of Sci.

Abstract: This meeting is to offer an opportunity for participants to present original research , to learn of reserch progress and new developments on differential algebra and related topics, particularly, the applications of differential algebra to control theory, physics, chemistry, biology and so on.

▶ EM-Mo-E-02-1 — 16:00–16:30
On the Hypertranscendence of Solutions of Mahler Equations
Hardouin, Charlotte — Mathematical Inst. of Toulouse

Abstract: An omnipresent question in combinatorics is the question of nonholonomy and more generally of differential algebraic independence of generating series. In this talk, we will present a systematic strategy to study this question, where the generating series satisfies a linear Mahler difference equation. We use the parametrized Galois theory to find a general criteria that guaranty an affirmative positive answer to this question and generate series attached to the so-called Baum-Sweet and Rudin-Shapiro automatic sequences.

▶ EM-Mo-E-02-2 — 16:30–17:00
Defining Ideal for A Parameterized Picard-Vessiot Group
Minchenko, Andrei — Weizmann Inst.

Abstract: An important problem in the differential Galois theory is to describe the Galois group of a linear differential equation of order n with parameters. It is a subgroup of GL(n) defined by a differential ideal I. For every integer r, one can find the generators of I up to order r, but one does know if these differentially generate I. Under a reasonable assumption on parameters, we will see how to solve this problem.

▶ EM-Mo-E-02-3 — 17:00–17:30
Differential Galois Groups over Laurent Series Fields
Maier, Annette — TU Dortmund Univ.

Abstract: This talk is about joint work with David Harbater and Julia Hartmann on the inverse differential Galois problem over function fields with field of constants k((t)). We use patching methods to show that any linear algebraic group over k((t)) is the differential Galois group of some differential equation over such a function field.

▶ EM-Mo-E-02-4 — 17:30–18:00
Difference Algebraic Groups
Wibmer, Michael — RWTH Aachen Univ.

Abstract: Difference algebraic groups, i.e., groups defined by algebraic difference equations occur naturally as the Galois groups of linear differential equations depending on a discrete parameter. I will discuss basic properties of difference algebraic groups and explain how certain numerical invariants can be used to prove a decomposition theorem for difference algebraic groups.

MS-Mo-E-03 — 16:00–18:00 — 306A
Applied Integrable Systems - Part II of V
For Part 1, see MS-Mo-D-03
For Part 3, see MS-Tu-D-03
For Part 4, see MS-Tu-E-03
For Part 5, see MS-We-D-03

Organizer: Hu, Xing-Biao — Inst. of Computational Mathematics, Chinese Acad. of Sci. (CAS), China
Organizer: Kajiwara, Kenji — Kyushu Univ.
Organizer: Kakei, Saburo — RIkkyo Univ.
Organizer: Maruno, Kenichi — Waseda Univ.

Abstract: In recent years, there have been major developments in applications of integrable systems. Originally, integrability has been recognized through solitons, which are particle-like nonlinear waves in various physical systems. Thanks to rich mathematical structure of integrable systems, recent applications of integrable systems extend to a wide range of pure/applied mathematics and physical sciences, such as algebraic geometry, combinatorics, probability theory, numerical algorithms, cellular automata, (discrete) differential geometry, computer visualizations, statistical physics, nonlinear physics and so on. The purpose of this minisymposium is to bring together researchers to discuss recent advances on various aspects of applied integrable systems.

▶ MS-Mo-E-03-1 — 16:00–16:30
Darboux Transformations for Lax Operators Associated with Kac-Moody Algebras
Mikhailov, Alexander — Univ. of Leeds

Abstract: Together with V.V.Sokolov we consider Lax operators for two–dimensional “periodic” Toda type systems corresponding to classical series of Kac-Moody algebras and $G_2^{(1)}$. For these Lax operators we construct systematically elementary Darboux transformations. Thus, with every classical Kac-Moody algebra and $G_2^{(1)}$ we associate an integrable Toda type system, a pair of differential-difference systems and a partial difference system.

▶ MS-Mo-E-03-2 — 16:30–17:00
Darboux Transformation of the Vector Sine-Gordon Equation and Its Soliton Solutions
Wang, Jing Ping — Univ. of Kent

Abstract: In this talk, we construct the Darboux transformation with the reduction group for the vector sine-Gordon equation, which results integrable vector differential-difference equations. Using it, we also construct its multi-soliton solutions and discuss soliton interactions. This is the joint work with Alexander V. Mikhailov and Georgios Papamikos.

▶ MS-Mo-E-03-3 — 17:00–17:30
Conservation Laws and Symmetries of Hunter-Saxton Equation Revisited
Liu, Q P — China Univ. of Mining & Tech.

Abstract: Through a reciprocal transformation , the Hunter-Saxton equation is shown to possess conserved densities involving arbitrary smooth functions, which have their roots in infinitesimal symmetries of a simple differential equation. Hierarchies of commuting symmetries of the Hunter-Saxton equation, discoovered by J. P. Wang, are understood by bring them into either linear hierarchies or familiar integrable hierarchies.

▶ MS-Mo-E-03-4 — 17:30–18:00
New 2-component Peakon Equations Arising from Hirota and Sasa-Satsuma Hierarchies
Anco, Stephen — Brock Univ.

Abstract: In this talk, I will discuss some new peakon equations that arise in a natural way (by tri-Hamiltonian duality) from the integrable hierarchies of the

Hirota and Sasa-Satsuma equations.

IM-Mo-E-04 16:00–18:00 308
Mathematics and Algorithms in Computer-Aided Manufacturing, Manufacturing Systems and Numerical Control - Part II of VI

For Part 1, see IM-Mo-D-04
For Part 3, see IM-Tu-D-04
For Part 4, see IM-Tu-E-04
For Part 5, see IM-We-D-04
For Part 6, see IM-We-E-04

Organizer: Li, Hongbo Acad. of Mathematics & Sys. Sci., Chinese Acad. of Sci.
Organizer: Shpitalni, Moshe Technion, Israel

Abstract: The fast development of advanced manufacturing technology has witnessed the growing importance of mathematical methods and algorithms, ranging from algebraic geometry, discrete geometry and differential geometry to differential equations, computational mathematics and computer mathematics. Conversely, problems arising from the field of advanced manufacturing have also stimulated the development of such branches in pure and applied mathematics as computational geometry and mathematics mechanization.
Mathematics and Algorithms for Computer-Aided Manufacturing, Engineering and Numerical Control is intended to be an interdisciplinary forum focusing on the interaction between the side of mathematical methods and algorithms, and the other side of computer-aided manufacturing (CAM), computer-aided engineering (CAE) and computer numerical control (CNC). It concentrates on (but is not restricted to) the following topics: tool path planning, multiscale simulation, feature-based process chain with CAM/CNC coupling, interpolation for CNC controllers.
The proposed industrial mini-symposium of 20 talks will provide an excellent platform for the participants to get acquainted with new research results, to exchange new ideas, and to create new collaboration.
To ensure full success of the proposed mini-symposium, we have invited 8 speakers from abroad. All are knowledgeable world experts in their fields, with impressive records of research, publications and awards, as well as solid background of mathematics. The invited speakers are from various countries and represent different aspects in Manufacturing, Manufacturing Systems and Computer Numerical Control.

▶ IM-Mo-E-04-1 16:00–16:45
Machine Tool Vibrations and Machined Surface Quality
Stepan, Gabor Budapest Univ. of Tech. & Economics

Abstract: The lecture summarizes the free, forced, self-excited, regenerative and parametrically forced machine tool vibrations together with their different combinations. The relation to machined surface quality is demonstrated in industrial case study. The stability of milling and especially the high-speed milling processes are explained and the development of the related surface quality parameters are presented. As an inverse application, vibration based experimental methods are also introduced to identify the nonlinear characteristics of cutting forces.

▶ IM-Mo-E-04-2 16:45–17:30
Application of Field-based Optimization Methods in NC Tool-path Computation
Lee, Chen-Han Huazhong Univ. of Sci. & Tech.

Abstract: NC tool-path research has evolved from computing acceptable toolpaths to finding optimal ones. NC machining is a multi-objective problem and the various optimization objectives often compete with each others. We propose a field-based framework in order to work with various objectives together. We present our recent works in: well-behaving path trajectories, smooth and gouge-free tool-axis distribution, automated machining region subdivision, B-spline tool-path fitting, machine-kinematic tensor, global tool-path shape optimization, and spatial path error compensation.

▶ IM-Mo-E-04-3 17:30–18:00
Double Spiral Tool Path Generation and Linking Method for Complex Pocket Machining
Zhou, Bo SIA
JiBin, Zhao SIA

Abstract: We propose a new double spiral tool-path generation and linking method for complex pockets with islands which can be used for high speed machining(HSM). Taking into account the path interval, step length and other processing parameters, precise milling can be achieved without retraction operations to ensure optimal processing performance and shorter processing time. For the application of the above algorithm, the simulation results indicate that this method is superior to existing machining methods.

MS-Mo-E-05 16:00–18:30 215
Compressed Sensing, Extensions and Applications - Part II of III

For Part 1, see MS-Mo-D-05
For Part 3, see MS-Tu-D-05

Organizer: Kutyniok, Gitta Technische Universität Berlin
Organizer: Holger, Rauhut RWTH Aachen Univ.

Abstract: Compressed sensing has seen an enormous research activity in recent years. The key principle is that (approximately) sparse signals can be recovered efficiently from what was previously believed to be vastly incomplete information. For this reason, compressed sensing and its algorithms (often convex optimization approaches) have a large range of applications such as magnetic resonance imaging, radar, wireless communications, and more. Remarkably, all provably optimal measurement schemes are based on randomness and therefore, compressed sensing connects various mathematical fields such as random matrix theory, optimization, approximation theory, and harmonic analysis. Recent developments have extended the theory and its algorithms to the recovery of low rank matrices from incomplete information, to the phaseless estimation problem, and to low tensor recovery. The minisymposium aims at bringing together experts in the field and to provide an overview of its most recent results.

▶ MS-Mo-E-05-1 16:00–16:30
Analysis of Low Rank Matrix Recovery via Mendelson's Small Ball Method
Terstiege, Ulrich RWTH Aachen Univ.
Holger, Rauhut RWTH Aachen Univ.
Kabanava, Maryia RWTH Aachen Univ.

Abstract: We study low rank matrix recovery from undersampled measurements via nuclear norm minimization. We aim to recover a matrix X from few linear measurements (Frobenius inner products with measurement matrices). For different scenarios of independent random measurement matrices we derive bounds for the minimal number of measurements sufficient to uniformly recover any rank r matrix with high probability. Our results are stable under passing to only approximately low rank matrices and under noisy measurements.

▶ MS-Mo-E-05-2 16:30–17:00
Tensor Completion in Hierarchical Tensor Formats
Schneider, Reinhold Inst. for Mathematics

Abstract:
Hierarchical Tucker tensor format (HT - Hackbusch tensors) and Tensor Trains (TT- Tyrtyshnikov tensors, I.Oseledets) have been introduced recently for low rank tensor product approximation. Hierarchical tensor decompositions are based on sub space approximation by extending the Tucker decomposition into a multi-level framework. Therefore they inherit favorable properties of Tucker tensors, e.g they offer a stable and robust approximation, but still enabling low order scaling with respect to the dimensions. For many high dimensional problems, hard to be handled so far, this approach may offer a novel strategy to circumvent the curse of dimensionality.
For uncertainty quantification we cast the original boundary value problem, with uncertain coefficients problem into a high dimensional parametric boundary value problem, discretized by Galerkin method. The high dimensional problem is cast into an optimization problems, constraint by the restriction to tensors of prescribed ranks $\mathbf{r}$. This problem could be solved by optimization on manifolds, or more simply by alternating least squares. Since the norm of the underlying energy-space is a cross norm preconditioning is required only for the spatial part and e.g. performed by standard multi grid approaches, e.g BPX. Moreover residual based error estimators can be applied to estimate the (total) error of the parameter dependent BVP. These estimators can be use to balance FEM discretization, chaos polynomial expansion and low rank approximation. Of importance is, that this leads to a modification of the orthogonality of the used component tensors.

▶ MS-Mo-E-05-3 17:00–17:30
Hierarchical Tensors Approximation for Uncertainty Quantification
Schneider, Reinhold Inst. for Mathematics

Abstract: Hierarchical Tucker tensor format (HT - Hackbusch tensors) and Tensor Trains (TT- Tyrtyshnikov tensors, I.Oseledets) have been introduced recently for low rank tensor product approximation. Hierarchical tensor decompositions are based on sub space approximation by extending the Tucker decomposition into a multi-level framework. Therefore they inherit favorable properties of Tucker tensors, e.g they offer a stable and robust approximation, but still enabling low order scaling with respect to the dimensions. For many high dimensional problems, hard to be handled so far, this approach may offer

a novel strategy to circumvent the curse of dimensionality.
For uncertainty quantification we cast the original boundary value problem, with uncertain coefficients problem into a high dimensional parametric boundary value problem, discretized by Galerkin method. The high dimensional problem is cast into an optimization problems, constraint by the restriction to tensors of prescribed ranks $\mathbf{r}$. This problem could be solved by optimization on manifolds, or more simply by alternating least squares. Since the norm of the underlying energy-space is a cross norm preconditioning is required only for the spatial part and e.g. performed by standard multi grid approaches, e.g BPX. Moreover residual based error estimators can be applied to estimate the (total) error of the parameter dependent BVP. These estimators can be use to balance FEM discretization, chaos polynomial expansion and low rank approximation. Of importance is, that this leads to a modification of the orthogonality of the used component tensors.

▶MS-Mo-E-05-4 17:30–18:00

Non-Linear ℓ_p-Residual Minimization in A Greedy Algorithm for Phase Retrieval

Sigl, Juliane Technical Univ. Munich

Abstract: Motivated by a very efficient greedy algorithm we introduced recently for solving phase retrieval problems with convergence guarantees, we present a modification to iteratively reweighted least squares to solve nonlinear residual minimizations in ℓ_p-norms.

▶MS-Mo-E-05-5 18:00–18:30

On Deterministic Structured Sampling of Structured Signals in Compressed Sensing

Adcock, Ben Simon Fraser Univ.

Abstract: Recent theoretical developments in CS reveal that in many applications the optimal random sampling strategy depends on the structure of the signal itself. Thus, we are faced with the intriguing problem of designing optimal sampling strategies for classes of signals. However, in tomography problems the sampling patterns are mostly deterministic (although highly structured), yet using standard l1 recovery works very well, but only on certain structured signals. We will discuss a new theory explaining this.

MS-Mo-E-06 16:00–18:00 201

Delay Systems and Applications - Part II of II

For Part 1, see MS-Mo-D-06

Organizer: Braverman, Elena Univ. of Calgary

Abstract: The purpose of the minisymposium is to provide a wide forum for presentations and discussions on the recent trends in the theory of differential and difference equations with deviating arguments. The topic includes delayed and advanced systems, as well as various applications of such models, for example, in mathematical biology.

▶MS-Mo-E-06-1 16:00–16:30

Delayed Feedback in the Haematopoietic System

Belair, Jacques Universite de Montreal

Abstract: The production and control of mammalian blood cells is regulated through an intertwined system of feedback mechanisms involving differentiation of cell lines and hormonal interactions between circulating cells and cells at different stages of maturation. Time delays naturally occur as maturation time of the latter, and lifetime of the former. We present some recent results, on the influence of distributions of delay in maturation time , and also on stability in coupled negative feedback loops.

▶MS-Mo-E-06-2 16:30–17:00

On Neutral First Order Delay Differential Equations with M Commensurate Delays

Cahlon, Baruch oakland Univ.

Abstract: In this paper we derive a robust algorithmic stability test to determine asymptotic stability of a first linear delay differential equations with Constant coefficients and constant delays. A new necessary condition For asymptotic stability is obtained. In proving our results we make use of Pontryagin’s theory for quasi-polynomials and Chebyshev polynomials of the first and second kind.

▶MS-Mo-E-06-3 17:00–17:30

Characterizing the Multiplicity of Spectral Values for Time-Delay Systems

Islam, BOUSSAADA IPSA& LSS, Supelec-CNRS-U PSUD
Irofti, Dina Univ. Paris Sud
Niculescu, Silviu-Iulian CNRS

Abstract: A standard approach in analyzing the stability of Time-delay systems consists in characterizing the associated spectrum. By characterization it is meant; the identification of the spectral values as well as their associated multiplicities. Efficient approaches for identifying such spectral values exist. However, the multiplicity issue was not deeply investigated. This contribution provides an answer to the multiplicity problem.

▶MS-Mo-E-06-4 17:30–18:00

Frequency-Sweeping Stability Test for Linear Systems with Multiple Delays

Li, Xu-Guang Northeastern University, China
Niculescu, Silviu-Iulian CNRS
Cela, Arben UPE, ESIEE Paris

Abstract: We study the stability of time-delay systems with multiple delays, by extending a recently proposed frequency-sweeping framework. First, we consider the case where one delay parameter is free and the other ones are fixed. Such a case can be systematically investigated by proving the invariance property. Next, we will propose a method to compute the number of unstable roots for any given combination of multiple delays.

MS-Mo-E-07 16:00–18:00 202A

Mathematics of Climate: From the Tropics to Antarctica - Part II of III

For Part 1, see MS-Mo-D-07
For Part 3, see MS-Tu-D-07

Organizer: Stechmann, Samuel Univ. of Wisconsin-Madison
Organizer: Golden, Kenneth Univ. of Utah

Abstract: The Earth offers a multitude of modeling challenges, from the dynamics of the atmosphere and oceans, to the melting of the polar ice caps. To understand and model these climate processes, a wide range of mathematics is needed, such as differential equations, multiscale modeling, and stochastic processes. In this minisymposium, the presentations span a broad range of climate processes and mathematical areas, and will be accessible to a more general audience. They include a blend of modeling, experiments, and data analysis, and demonstrate how mathematics is being employed to address fundamental problems of climate science.

▶MS-Mo-E-07-1 16:00–16:30

Modeling the Madden-Julian Oscillation: Nonlinear Waves, Stochastic Dynamics, and Data Analysis

Stechmann, Samuel Univ. of Wisconsin-Madison

Abstract: The Madden-Julian Oscillation (MJO) is a planetary-scale wave envelope of tropical clouds and precipitation. In this presentation, a system of nonlinear PDEs is presented as a model for the MJO (the MJO Skeleton Model). Three aspects are described: nonlinear traveling wave solutions, a stochastic version of the model, and a method for identifying the MJO in observational data.

▶MS-Mo-E-07-2 16:30–17:00

Effect of Stratiform Heating on the Planetary Scale Organization of Tropical Convection

Khouider, Boualem Univ. of Victoria

Abstract: It is now widely recognized that stratiform heating contributes significantly to the tropical rainfall and to the dynamics of tropical convective systems. In particular, it has been established that stratiform anvils forming in the wake of deep convection play a central role in the dynamics of tropical mesoscale convective systems through the wide spread of downdrafts from the evaporation of stratiform rain in the lower troposphere strengthening the recirculation of subsiding air towards and away from the convection centre, which in turn triggers cold pools and gravity currents in the boundary layer leading to further lifting thus helping the mesoscale organization of convection. Here, aquaplanet simulations with a warm pool like surface forcing and using a coarse resolution GCM coupled with a stochastic multicloud parameterization, which has beed previously proved to simulate well tropical convective systems on a wide range of scales, including the Madden-Julian oscillation and the monsoon intra-seasonal oscillation, as well as the spectrum of convectively coupled waves, are used to demonstrate the sensitivity and importance of stratiform heating for the organization of convection on the MJO scale. More precisely, it is shown that when some key model parameters are set to produce higher stratiform heating fractions, the model produces mainly low-frequency and planetary scale MJO-like wave disturbances while lower to moderate stratiform heating fractions yield mainly synoptic scale convectively coupled Kelvin-like waves. Furthermore, it is shown that when the effect of stratiform downdrafts are switched off in the model, the MJO-scale organization is destroyed despite the use of larger stratiform heating parameters. It is thus conjectured here that it is the strength and extend of stratiform downdrafts that sets the preferred scale for convection organization with mechanisms that are in essence similar to mesoscale convective systems.

▶MS-Mo-E-07-3 17:00–17:30

Atmospheric Flow Regimes on Planetary Scales

Klein, Rupert — Freie Universität Berlin

Abstract: The atmospheric compressible flow equations admit a wide range of different flow regimes distinguished by their characteristic length and time scales. In climate research we are interested in large-scale features involving the internal Rossby radius, the Oboukhov scale (or external Rossby radius), and the planetary scale and in their mid-latitude–tropical interactions. In this lecture I will summarize various pertinent asymptotic limit regimes that have been identified over the past decade and discuss their implications.

▶ MS-Mo-E-07-4 17:30–18:00

Ocean Dynamical Adjustment and Atmospheric CO2 Feedback

Zanna, Laure — Univ. of Oxford

Abstract: Our work assesses the role of wind and buoyancy forcing in setting the surface ocean pCO2 and the uptake of natural and anthropogenic carbon. We will examine the Southern Ocean mixed-layer budget and the role of the ocean circulation in determining the long-term levels of atmospheric CO2 using idealised and complex GCM experiments. We will propose a set of scalings to quantify the feedbacks of ocean dynamics on atmospheric CO2 under climate change.

MS-Mo-E-08 16:00–18:00 202B

Numerical methods for compressible multi-phase flows - Part II of VI

For Part 1, see MS-Mo-D-08
For Part 3, see MS-We-E-47
For Part 4, see MS-Th-BC-47
For Part 5, see MS-Th-D-47
For Part 6, see MS-Th-E-47

Organizer: Deng, Xiaolong — Beijing Computational Sci. Research Center
Organizer: Wei, Suhua — Inst. of Applied Physics & Computational Mathematics
Organizer: Tian, Baolin — Insitute of Applied Physics & Computational Mathematics
Organizer: Tiegang, Liu — Beihang Univ.
Organizer: Sussman, Mark — Florida State Univ.
Organizer: Wang, Shuanghu — IAPCM

Abstract: Compressible multi-phase flows appear in many natural phenomena, and are very important in many applications, including space science, aerospace engineering, energy, homeland security, etc. Numerical calculation is a key for understanding many related problems. More and more numerical methods are being developed and improved. In this mini-symposium, novel numerical methods will be presented to show the progress in the area of compressible multi-phase flows, including interface capturing/tracking methods, phase change calculations, mixing methods, fluid-structure interaction methods, multi-physics calculations, adaptive mesh refinement, and high performance computing.

▶ MS-Mo-E-08-1 16:00–16:30

A Remapping-free High-order ALE Method Based on Undistorted Temporal-spatial Control Volumes

Jin, Qi — Inst. of Applied Physics & Computational Mathematics
Li, Jiequan — Beijing Normal Univ.

Abstract: This work develops a remapping-free high-order ALE method based on undistorted temporal-spatial control volumes. According to the Hodge decomposition theorem, mesh moving velocities are generated by the irrotational component of fluid’s velocity. Then based on the finite volume framework, 2-D Euler equations in integral form are discretized in such undistorted hexahedral temporal-spatial control volumes. Besides numerical fluxes are computed by GRP solver to get a high-precision approximation. Typical numerical examples verify the new method.

▶ MS-Mo-E-08-2 16:30–17:00

Numerical Simulations of Free Surface Flows Based on CLSVOF Method, Multi-moment Methods and Density-scaled Balanced CSF Model

Yokoi, Kensuke — Cardiff Univ.

Abstract: We propose a practical numerical framework for free surface flows. The numerical framework consists of the CLSVOF method, the THINC/WLIC (tangent of hyperbola for interface capturing/weighted line interface calculation) scheme, multi-moment methods (CIP-CSL and VSIAM3) and the density-scaled balanced CSF (continuum surface force) model. The numerical results have shown that the numerical framework is highly reliable and can well capture free surface flows with complex interface geometries like droplet splashing.

▶ MS-Mo-E-08-3 17:00–17:30

An Improved Compressible, Multiphase Semi-implicit Method with Moment of Fluid Interface Representation

Sussman, Mark — Florida State Univ.

Abstract: We present improvements made to our algorithm first reported in Journal of Computational Physics (2014). The improvements enable more accurate simulation of compressible multiphase flows, but with the same cost. Examples are presented for high pressure atomization of liquid in gas and for multiphase problems consisting of materials with large viscosity. As with our 2014 method, our improved method is asymptotically preserving, conservative, simulates materials with disparate material properties, and does not require Riemann solvers.

▶ MS-Mo-E-08-4 17:30–18:00

High Resolution Numerical Simulation of Explosion Problems

Wang, Cheng — Beijing Inst. of Tech.

Abstract: In this paper, A high resolution large scale parallel computation software is developed based on positivity preserving for finite difference WENO method, high order boundary treatment method, multi-medium interface treatment. The software can simulate some explosion problems such as flame acceleration and DDT, explosion in air and water and concrete, shaped charge jet, jet penetration and etc. By constructing artificial solutions and comparison with experimental results, the accuracy and computation results are validated and verified.

MS-Mo-E-09 16:00–18:00 203A

Free Boundary Problems: Theory, Numerics, and Applications - Part II of II

For Part 1, see MS-Mo-D-09

Organizer: Walker, Shawn — Louisiana State Univ.

Abstract: This mini-symposium will be on moving interface and free-boundary problems that occur in a variety of applications, such as two-phase flows, biology, shape optimization, and multi-physics. Talks will range from theory and computations to applications, or a combination.

▶ MS-Mo-E-09-1 16:00–16:30

Free Boundary Problems from A Model for Receptor-ligand Dynamics

Venkataraman, Chandrasekhar — Univ. of Sussex
Ranner, Thomas — Univ. of Leeds

Abstract: We consider a simplified model for receptor-ligand dynamics consisting of a system of coupled bulk-surface PDEs. We show that in the fast reaction limit one obtains free boundary problems. We discuss the existence and uniqueness of solutions to the problems. We also comment on connections with classical free boundary problems. The theoretical results are supported with a number of numerical simulations. Based on joint work with C. Elliott (Warwick) and T. Ranner (Leeds).

▶ MS-Mo-E-09-2 16:30–17:00

Unfitted Finite Element Methods Using Bulk Meshes for Surface Partial Differential Equations

Ranner, Thomas — Univ. of Leeds

Abstract: I introduce a family of novel finite element methods for partial differential equations on surfaces. The key idea is that the finite element space is based on continuous piecewise linear finite element functions on a bulk triangulation which is independent of the surface. I will present robust numerical analysis for a simple model elliptic problem and provide computational examples to show the flexibility and efficiency of the methods to the evolving and coupled bulk-surface

▶ MS-Mo-E-09-3 17:00–17:30

On Contact Line Dynamics with Van Der Waals Forces

Afkhami, Shahriar — NJIT

Abstract: We present an approach to model fluid/fluid moving interfaces in contact with solid boundaries. The method includes the fluid/solid interaction forces of a general van der Waals type in a direct solver of the Navier-Stokes equations. We show that this explicit inclusion of the fluid/solid interactions into the governing equations leads to an equilibrium contact angle as well as dewetting of thin films for arbitrary contact angles.

MS-Mo-E-10 16:00–18:00 206B

Ultradiscretization and its application in modeling - Part II of II

For Part 1, see MS-Mo-D-10

Organizer: Tokihiro, Tetsuji — the Univ. of Tokyo
Organizer: Willox, Ralph — the Univ. of Tokyo
Organizer: Matsukidaira, Junta — Ryukoku Univ.

Abstract: A cellular automaton (CA) is a discrete dynamical system composed of an array of cells that only take a finite number of states. CAs can exhibit complex time evolution patterns and are used as mathematical models for a

variety of natural and social phenomena. Ultradiscretization is a mathematical tool for constructing CAs from continuous systems. It has been successfully used to obtain CA models that share important features with continuous phenomena. The purpose of this organized session is to offer researchers the opportunity to discuss recent advances in ultradiscrete systems and in particular their application to fundamental biology.

▶ MS-Mo-E-10-1 16:00–16:30

Max-min-plus Analysis for One-dimensional Particle Cellular Automata

Matsukidaira, Junta — Ryukoku Univ.

Abstract: We investigate one-dimensional cellular automata with higher order conserved quantities, of which fundamental diagrams are expressed as a max-min-plus expression of conserved quantities. We show that evolution equations for some rules are expressed in the form of a max-min-plus expression by introducing addition operation on $\mathbb{Z}_n$

▶ MS-Mo-E-10-2 16:30–17:00

Mathematical Modeling for Angiogenesis

Tokihiro, Tetsuji — the Univ. of Tokyo

Abstract: Angiogenesis is the morphogenetic phenomenon in which new blood vessels emerge from an existing vascular network and configure a new network. Based on recent experiments with time-lapse fluorescent imaging, we propose mathematical models for the dynamics of vascular endothelial cells (ECs) in angiogenic morphogenesis. The model successfully reproduces cell mixing behavior, elongation and bifurcation of blood vessels and suggest that the two-body interaction between ECs is essential to the dynamics of ECs.

▶ MS-Mo-E-10-3 17:00–17:30

Modeling Natural Phenomena Through Discretisation and Ultradiscretisation

Willox, Ralph — the Univ. of Tokyo

Abstract: We shall explain how to construct discrete models that are guaranteed to exhibit local and global dynamics similar to that of continuous models for specific systems. Local faithfulness of the discrete models will be ensured using techniques that originated in the study of integrable mappings. The ultradiscretisation technique, which also originated in the study of solitonic cellular automata, will prove to be crucial for ascertaining the faithfulness of the global behaviour of these discrete models.

▶ MS-Mo-E-10-4 17:30–18:00

Gaps on the Flow of the Simplified Path-preference Cellular Automaton Model

Yoichi, Nakata — The Univ. of Tokyo

Abstract: The path-preference model is a cellular-automaton model to describe the dynamics of RNA polymerase II in transcription. We found that the number of particles is dominant to the dynamics of simplest version of this model and observed that there are not only expected phase shift but also several non-continuous gaps as the number of particles increases. By considering limit cycles, we discuss the condition where such gaps appear.

MS-Mo-E-11 16:00–18:00 203B

Recent advances in matrix computations for extreme-scale computers - Part II of II

For Part 1, see MS-Mo-D-11

Organizer: Li, Xiaoye — Lawrence Berkeley National Laboratory

Organizer: Duff, Iain — STFC Rutherford Appleton Laboratory

Abstract: Numerical linear algebra is at the heart of scientific and industrial discoveries. The forthcoming arrival of the exascale era provides tremendous opportunities and challenges for further development of algorithms and software extreme-scale computing. This minisymposium emphasizes problem reformulations, algorithm redesigns and code refactorings for the efficient use of high performance computers. Topics range from direct methods, iterative methods, preconditioning, and the emerging fast algorithms for both dense and sparse algebraic systems. The speakers will present various techniques to reduce communication, synchronization and memory footprint. Performance of the new algorithms will be demonstrated on modern manycore parallel machines.

▶ MS-Mo-E-11-1 16:00–16:30

Numerical Methods for Linear Complementary Problem

Yin, Jun-Feng — Tongji Univ.

Abstract: We studied project LU(UL) matrix decomposition method and Modulus-based matrix splitting method for the linear complementary problem discreted from the model for pricing American option. Theoretical analysis are given to show the conditions to grantee the convergence. Numerical experiments are presented to show their efficiency.

▶ MS-Mo-E-11-2 16:30–17:00

Efficient Deadlock-free Asynchronous Approaches for A Distributed-memory Sparse Direct Solver

Sid-Lakhdar, Wissam M. — Texas A&M Univ.

L'Excellent, Jean-Yves — Inria & Univ. of Lyon

Amestoy, Patrick — INPT-IRIT Univ. of Toulouse

Abstract: We describe how to enhance parallelism in an asynchronous distributed-memory environment with limited memory dedicated to communication. In order to maximize asynchronism, we characterize deadlock situations and establish global properties to prevent or avoid them. We also characterize some communication patterns and define a class of broadcast trees ensuring good efficiency for series of successive asynchronous broadcasts. The impact of this work is illustrated on asynchronous sparse multifrontal solvers but has a larger scope.

▶ MS-Mo-E-11-3 17:00–17:30

Fine-grained Parallel Incomplete LU Factorization

Chow, Edmond — Georgia Inst. of Tech.

Abstract: We present a highly parallel algorithm for computing incomplete LU factorizations. All nonzeros in the factorization are computed in parallel, using one or more sweeps that iteratively improve the accuracy of the factorization. Numerical tests show that very few sweeps are needed to construct a factorization that is an effective preconditioner. The approach can also update an existing factorization, giving it a potential niche in the solution of sequences of linear systems.

▶ MS-Mo-E-11-4 17:30–18:00

Preconditioners and Solvers for CFD Applications on GPU-based Supercomputers

De Sturler, Eric — Virginia Tech

Abstract: We discuss relevant issues to obtain high performance for solvers and especially preconditioners on GPUs. Fine grained parallelism is essential. We demonstrate results for several CFD applications.
This is joint work with Katarzyna Swirydowicz, Chris Roy, Amit Amritkar, and Danesh Tafti

MS-Mo-E-12 16:00–18:00 208B

Extremal Combinatorics, Probabilistic Combinatorics, and their applications - Part II of III

For Part 1, see MS-Mo-D-12
For Part 3, see MS-Tu-D-12

Organizer: Ma, Jie — Univ. of Sci. & Tech. of China

Organizer: Huang, Hao — Inst. for Mathematics & its Applications, Univ. of Minnesota

Organizer: Chen, Guantao — Georgia State Univ.

Abstract: Combinatorics is a fundamental discipline of modern mathematics which studies discrete objects and their properties. This minisymposium we propose will focus on the subfield of extremal and probabilistic combinatorics, which has witnessed an exciting development over the past decades, and also has many striking practical applications in mathematical optimization, computer science, statistical physics and voting society. We aim to bring the top researchers to the minisymposium, where they will present the recent progress, discuss open challenges, exchange research ideas, and initiate new collaborations. We expect a minisymposium of this nature to have a lasting impact on the future of the subject.

▶ MS-Mo-E-12-1 16:00–16:30

Minimum Degree and Cycles of Specific Lengths

Liu, Chun-Hung — Princeton Univ.

Ma, Jie — Univ. of Sci. & Tech. of China

Abstract: We prove that every graph of minimum degree at least k+1 contains at least (k-1)/2 cycles with consecutive even lengths. In addition, we prove that every graph of minimum degree at least k+4 contains k cycles of either consecutive lengths, or consecutive even lengths, or consecutive odd lengths. It confirms one of Thomassen's conjecture when k is even and provides the best known result for this conjecture when k is odd.

▶ MS-Mo-E-12-2 16:30–17:00

Permutation Codes, Secure Codes and Hash Families Related to Extremal and Probabilistic Combinatorics

Ge, Gennian — Capital Normal Univ.

Abstract: A code can be regarded as a subset of its underlying base set satisfying some restrictions. In this talk, we will discuss the bounds and constructions for several classes of combinatorial codes, which are closely related to extremal and probabilistic combinatorics. These codes include: permutation codes, separable codes, frameproof codes and some related hash families for security protection. For the lower bounds, by regarding a code as an independent set of a graph or a hypergraph, we are able to improve the known lower bounds for permutation codes, 3-perfect hash families, 2- frameproof codes and 2-separable codes. In addition, we extend the construc- tions for separable codes and frameproof codes by applying the probabilistic method. Particularly, we obtain asymptotically optimal 2-separable codes by the deletion method. For the upper bounds, by considering some typical configurations of codes and applying combinatorial counting skills, we are able to improve the known upper bounds for separable codes and frameproof codes. Furthermore, using a result of Erdos and Gallai on hypergraph match- ing, we approve partially a well-known conjecture on an old problem of the disjunctive code theory.

▶ MS-Mo-E-12-3 17:00–17:30

Maximum Matchings in 3-partite 3-uniform Hypergraphs

Yu, Xingxing Georgia Inst. of Tech.

Abstract: For a hypergraph H, let $\delta_1(H)$ denote the minimum number of edges of H containing a given vertex, and $\nu(H)$ denote the maximum size of a matching in H. For integers $n \geq m \geq 1$, let

$$d_3(n,m) = \begin{cases} n^2 - (n - \lfloor m/3 \rfloor)(n - \lfloor (m+1)/3 \rfloor) \& \text{if } m \neq 1 \pmod 3, \\ n^2 - (n - (m-1)/3)^2 + 1 \& \text{if } m = 1 \pmod 3. \end{cases}$$

Lo and Markström proved that if H is a 3-partite 3-uniform hypergraph with $n \geq 3^7 m$ vertices in each partition class and $\delta_1(H) > d_3(n,m)$ then $\nu(H) > m$, and asked if the condition $n \geq 3^7 m$ can be replaced by $n > m$. In this paper, we show that there exists a positive integer n_0 such that if H is a 3-partite 3-uniform hypergraph with $n \geq n_0$ vertices in each partition class and if $n > m$ and $\delta_1(H) > d_3(n,m)$, then $\nu(H) > m$.

▶ MS-Mo-E-12-4 17:30–18:00

The Threshold Probability for Long Cycles

Naves, Humberto IMA - Inst. for Mathematics & its Applications

Abstract: For a given graph G of minimum degree at least k, let G_p denote the random spanning subgraph of G obtained by retaining each edge independently with probability $p = p(k)$. In this talk, we prove that if $p \geq \frac{\log k + \log\log k + \omega_k(1)}{k}$, where $\omega_k(1)$ is any function tending to infinity with k, then G_p asymptotically almost surely contains a cycle of length at least $k+1$. When G is the complete graph

MS-Mo-E-13 16:00–18:00 VIP3-2

Analysis and algorithm for coupling of kinetic and fluid equations - Part II of III

For Part 1, see MS-Mo-D-13
For Part 3, see MS-Tu-D-13

Organizer: Lu, Jianfeng Duke Univ.
Organizer: Sun, Weiran Simon Fraser Univ.

Abstract: Kinetic equations are widely used to model complex systems occurring in gas dynamics and transport phenomenon, as examples. In these applications, it is common that dense and dilute parts coexist in the system. This leads to multiple spatio-temporal scales which introduce difficulties in both analysis and numerics. Kinetic-fluid coupling hence has received intensive studies in recent years. This minisymposium aims to bring together experts in analysis and algorithm in kinetic equations to discuss the current status and future developments of the field. It also provides a platform for further interaction and collaboration for researchers in this and related areas.

▶ MS-Mo-E-13-1 16:00–16:30

MULTISCALE SCHEMES FOR THE BGK-VLASOV-POISSON SYSTEM IN THE QUASI-NEUTRAL AND FLUID LIMITS.

Dimarco, Giacomo Univ. of Ferrara

Abstract: We discuss the development of asymptotic stable and consistent schemes in the joint quasi-neutral and fluid limits for the collisional Vlasov-Poisson system. In these limits, the classical explicit schemes suffer from time step restrictions due to the small plasma period and Knudsen number. To solve this problem, we propose a new scheme stable for choices of time steps independent from the small scales dynamics and with comparable computational cost with respect to standard explicit schemes.

▶ MS-Mo-E-13-2 16:30–17:00

Uniformly Accurate Numerical Schemes for Kinetic Equations in the Diffusion and Anomalous Diffusion Asymptotics

Lemou, Mohammed CNRS & Univ. of Rennes 1

Abstract: We propose numerical schemes to solve linear kinetic equations in the diffusion and anomalous diffusion scalings. It is known that anomalous diffusion appears when the equilibria is heavy-tailed or when the collision frequency is singular in velocity. In this case the numerical schemes which are known to correctly capture the diffusion scaling cannot be used. Suitable numerical schemes are therefore constructed in order to undertake the effect of large and small velocities.

▶ MS-Mo-E-13-3 17:00–17:30

Spectral Methods for Linear Half-space Kinetic Equations

Li, Qin Caltech
Lu, Jianfeng Duke Univ.
Sun, Weiran Simon Fraser Univ.

Abstract: Understanding the coupling of physical models at different scales is important and challenging. In this talk, we focus on the issue of kinetic-fluid coupling, in particular, the half-space problems for kinetic equations coming from the boundary layer. We will present some recent progress in algorithm development and analysis for the linear half-space kinetic equations, and its application in coupling of neutron transport equations with diffusion equations. (joint work with Jianfeng Lu and Weiran Sun)

▶ MS-Mo-E-13-4 17:30–18:00

Finding 13-Moment System Beyond Grad

Ruo, Li Peking Univ.

Abstract: We point out that the thermodynamic equilibrium is not an interior point of the hyperbolicity region of Grad's 13-moment system. With a compact expansion of the phase density, which is compacter than Grad's expansion, we derived a modified 13-moment system. The new 13-moment system admits the thermodynamic equilibrium as an interior point of its hyperbolicity region. We deduce a concise criterion to ensure the hyperbolicity, thus the hyperbolicity region can be quantitatively depicted.

MS-Mo-E-14 16:00–18:30 111

Mathematical Theories and Computational Aspects of Complex Fluids - Part II of III

For Part 1, see MS-Mo-D-14
For Part 3, see MS-Tu-D-14

Organizer: Wang, Changyou Purdue Univ.
Organizer: Liu, Chun Penn State Univ.
Organizer: LIn, Fanghua Courant Inst./NYU

Abstract: Complex fluids, fluids with microstructure, are ubiquitous in our daily life and modern day engineering and biology applications. We are facing new challenges in mathematical theories and techniques in order to resolve issues such as ensemble of micro-elements, intermolecular interactions, coupling to hydrodynamics and applied electric or magnetic fields. The multiphysics-multiscale nature of these complicated materials also provide the best testing ground for new techniques and ideas.
In these mini-symposium sessions, we will bring some of the most active researchers in this field, together with postdocs and students. The purpose is to present the most current results, provoking new ideas, as well as motivate the young researchers to work in the field.

▶ MS-Mo-E-14-1 16:00–16:30

Some Results on the Oldroyd-B Model

Fang, Daoyuan Zhejiang Univ.

Abstract: In this talk, we will present some results on Oldroyd-B model. We first give the global solution to incompressible Oldroyd-B model with non-small coupling constant in L^p scaling invariant spaces.Secondly, global solution to compressible Oldroyd-B model with non-small coupling constant in L^2 scaling invariant spaces is estalished. Finally, we consider the relation between compressible and incompressible model.

▶ MS-Mo-E-14-2 16:30–17:00

AN ENERGETIC VARIATIONAL APPROACH FOR ION TRANSPORT

Xu, Shixin Soochow Univ.
Liu, Chun Penn State Univ.
Sheng, Ping Hong Kong Univ. of Sci. & Tech.

Abstract: The transport and distribution of charged particles are crucial in the study of many physical and biological problems. In this talk, we employ an Energy Variational Approach to derive the coupled Poisson-Nernst-Planck-Navier-Stokes system. All of the physics is included in the choices of corresponding energy law and kinematic transport of particles. The variational derivations give the coupled force balance equations in a unique and deterministic fashion. We also discuss the situations with different types boundaries.

▶ MS-Mo-E-14-3 17:00–17:30

A Blow Up Analysis of Brakke Mean Curvature Flow

Tonegawa, Yoshihiro Tokyo Inst. of Tech.

Abstract: Starting with the definition of mean curvature flow in the setting of

Geometric Measure Theory due to Brakke, I describe our regularity results of recent years. They include partial regularity theorems for unit density Brakke flow which corresponds to the parabolic extension of Allard regularity theory, and a regularity theorem of triple junction which is a partial extension of Simon's regularity theorem of singular sets of minimal submanifolds.

▶ MS-Mo-E-14-4 17:30–18:00

The Mathematical Problems of Isotropic-Nematic Interface

Zhang, Pingwen — Peking Univ.

Abstract: Liquid crystals represent a vast and diverse class of anisotropic soft matter materials which are intermediate between isotropic liquids and crystalline solids. The various liquid crystal phases can be characterized by the type of ordering, one of the most common liquid crystal phases is the isotropic phase, another is the nematic phase. In this talk, a wide spectrum of mathematical problems of isotropic-nematic interface will be considered. One set of problems to be considered is the relationship between these different levels of modeling, for example how one can make a rigorous passage from molecular/statistical descriptions to continuum theories. Special consideration will be given to the existence, uniqueness and regularity of the solutions of the Landau-de Gennes theory.

▶ MS-Mo-E-14-5 18:00–18:30

Structure of Helicity and Global Solutions of Incompressible Navier-Stokes Equation Jointly with Zhen Lei and Fanhua Lin

Zhou, Yi — Fudan Univ.

Abstract: In this paper we derive a new energy identity for the general three-dimensional incompressible Navier-Stokes equations by the virtue of a special structure of helicity. The new energy identity is critical with respect to its natural scaling. Moreover, it is conditionally coercive. As an application we construct a family of finite energy smooth large solutions to the Navier-Stokes equations whose critical norms can be arbitrarily large.

MS-Mo-E-15 16:00–18:00 213B

Evolution of interfaces driven by anisotropic laws - Part II of II

For Part 1, see MS-Mo-D-15

Organizer: Rybka, Piotr — The Univ. of Warsaw

Organizer: Giga, Yoshikazu — Univ. of Tokyo

Abstract: The minisymposium presents the state of art of rigorous analysis and numerical simulations of interfacial motions. We have in mind problems, where diffusion or anisotropy play a key role: 1) The multigrain motion, where the interaction between grains are the main issue. 2) Models of crystal growth and other phenomena in physics and industrial applications, where singular diffusion (or fractional diffusion) equations play the major role. Other approaches to crystal growth like the BCF models are in the scope of the minisymposium. 3) Image analysis and its subtle relation to the singular parabolic problem appearing in the crystal growth models.

▶ MS-Mo-E-15-1 16:00–16:30

Kobayashi-Warren-Carter Type Models of Grain Boundary Motions with Anisotropies

Shirakawa, Ken — Faculty of Education, Chiba Univ.

Abstract: In this talk, coupled systems of parabolic type PDEs including anisotropic singular diffusions are considered. These systems are modified versions of the Kobayashi-Warren-Carter model of planar grain boundary motion, and are derived by taking into account the effect such that the Wulff shape rotates in response to the change of crystalline orientation. After the presentation of modelling ideas, the mathematical approaches to our systems will be discussed on the basis of the time-discretization methods.

▶ MS-Mo-E-15-2 16:30–17:00

Motion of Surfaces by Crystalline Mean Curvature: Viscosity Solutions Approach

Pozar, Norbert — Kanazawa Univ.

Abstract: In this talk we will introduce an extension of the notion of viscosity solutions in the context of very singular parabolic problems that arise in particular as the level-set formulation of the surface evolution driven by a crystalline mean curvature. We will discuss comparison principle, stability under approximation by regularized problems, and existence of solutions. This talk is based on joint work with Mi-Ho Giga and Yoshikazu Giga from University of Tokyo.

▶ MS-Mo-E-15-3 17:00–17:30

An Implicit Interface Boundary Integral Method for Mullins-Sekerka Problem

Tsai, Richard — The Univ. of Texas at Austin

Abstract: We introduce a boundary integral method defined in a tubular neighborhood of an interface without the need for explicit parametrization. This method is applied to evolve an implicit interface according to Mullins-Sekerka dynamics.

▶ MS-Mo-E-15-4 17:30–18:00

Stability of Crystalline Curvature Flow of A Graph-like Curve

Nakayasu, Atsushi — The Univ. of Tokyo

Abstract: We study motion of a graph-like curve by crystalline curvature with inhomogeneous driving force. Reflecting the singularity of the anisotropy the equation is non-local. In this talk we will show some results on stability of this equation from a viscosity solutions point of view. A central idea is to find the effective region to determine the quantity of the non-local curvature.

MS-Mo-E-16 16:00–18:00 205A

Data-driven mathematical models for production and traffic flow - Part II of II

For Part 1, see MS-Mo-D-16

Organizer: HERTY, MICHAEL — RWTH AACHEN Univ.

Organizer: Goettlich, Simone — Univ. of Mannheim

Abstract: We bring together researchers working on macroscopic models based on partial differential equations for modeling nonlinear phenomena in traffic or production. Contrary to existing approaches we emphasize mathematical models obtained from empirical or measured data. The models may be obtained by mean field limits, statistical approaches or by phenomenological approaches. We are interested in mathematical differential models of either kinetic or hyperbolic type commonly observed in the field of traffic and production. The exchange between those two applications should lead to new insights and mathematical techniques.

▶ MS-Mo-E-16-1 16:00–16:30

Model Fidelity of Data-Fitted Second-Order Traffic Models

Seibold, Benjamin — Temple Univ.

HERTY, MICHAEL — RWTH AACHEN Univ.

Abstract: We investigate whether second-order macroscopic traffic models can reproduce the behavior of real traffic flow better than the first-order Lighthill-Whitham-Richards (LWR) model. First, suitable types of second-order models are selected that systematically generalize the LWR model, and thus inherit data-fitting strategies from it. Second, the predictive accuracy of the various models is compared using a version of the three-detector problem test, considering vehicle trajectories and loop sensor data.

▶ MS-Mo-E-16-2 16:30–17:00

Optimization for Supply Chain Network with Resilient Policy

Wang, Xinping — Southeast Univ.

Zhao, Lindu — Inst. of Sys. Engineering, School of Economics & Management, Southeast Univ.

Sun, Shengnan — Inst. of Sys. Engineering, School of Economics & Management, Southeast Univ.

Abstract: We establish a continuum model with partial differential equations of conservation laws to simulate material flow in supply chain networks. Optimal inflow profile and distribution policy are derived to satisfy a given customer demand in normal operation. Taken the optimal setup in normal operation as initial values, we then study resilient polices against possible disruptions of supply chain members. Numerical examples explore influence of different parameters on the optimal decisions of resilient polices.

▶ MS-Mo-E-16-3 17:00–17:30

Data Based Intersection Modeling with Higher Order Traffic Flow Models of the GSOM Family.

Lebacque, Jean-Patrick — IFSTTAR

Khoshyaran, Megan — ETC Economics Traffic Clinic

Abstract: GSOM traffic models are macroscopic models which combine traffic conservation, fundamental diagram and individual driver behavior. They are expressed as systems of conservation equations, for which the inhomogeneous Riemann problem can be solved analytically, allowing efficient numerical solutions and intersection modeling. The object of the paper is to develop intersection models for GSOM models based on the traffic data of the Cipebus project. This data is extensive, includes control information and is density based.

▶ CP-Mo-E-16-4 17:30–17:50

How Gestures and Diagrams Facilitate Emergence of Mathematical Creations in Supervisor-Graduate Student Research Meetings

Menz, Petra — Simon Fraser Univ.

Abstract: In this paper I present the preliminary findings of data collected from the mathematics research meetings of two supervisor-graduate student pairs. My study is based on the ideas of the philosopher Gilles Châtelet (Figuring Space – Philosophy, Mathematics, and Physics, 2000) that diagrams are the connection and gestures are the articulation between the virtual and the actual. Through this work, insights into abstract thinking and diagramming as the creative ground for expert mathematicians are provided.

MS-Mo-E-18 16:00–18:30 209B
Nonlinear Dispersive Wave Equations - Part II of II
For Part 1, see MS-Mo-D-18

Organizer: Yanzhi, Zhang Missouri Univ. of Sci. & Tech.
Organizer: Cai, Yongyong Beijing Computational Sci. Research Center
Organizer: Lakoba, Taras Univ. of Vermont

Abstract: Nonlinear dispersive wave equations have applications in various fields, such as quantum mechanics, nonlinear optics, fluid dynamics, electromagnetic theory and so on. This mini-symposium focuses on both theoretical and numerical studies on various nonlinear dispersive wave equations. The topics include, but not limited to, existence of traveling wave solutions, orbital stability of solitary waves, numerical algorithms to solve nonlinear wave equations, and numerical computations.

▶MS-Mo-E-18-1 16:00–16:30
Numerical Methods for (fractional) Schrodinger Equations
Duo, Siwei Missouri Univ. of Sci. & Tech.
Yanzhi, Zhang Missouri Univ. of Sci. & Tech.

Abstract: Recently, one debate in the literature is whether the fractional Schrodinger equation in an infinite potential well has the same eigenfunctions as those of its standard (non-fractional) counterpart. Due to the nonlocality of the fractional Laplacian, it is challenging to find the eigenvalues and eigenfunctions of the fractional Schrodinger equation analytically. In this talk, we numerically study the eigenfuctions of the fractional Schrodinger equation.

▶MS-Mo-E-18-2 16:30–17:00
Split-step Method for Nonlinear Schrodinger Equation
Yanzhi, Zhang Missouri Univ. of Sci. & Tech.
Duo, Siwei Missouri Univ. of Sci. & Tech.

Abstract: Split-step methods have been widely used in solving time-dependent PDEs. In this talk, we discuss the numerical stability of the split-step method for solving the (fractional) nonlinear Schrodinger (NLS) equation. The stable conditions are analyzed for the plane wave solutions, and numerical experiments are provided to verify our analytical results. In addition, the performance of the split-step method is studied and compared in solving the standard and fractional NLS.

▶MS-Mo-E-18-3 17:00–17:30
Ground States and Dynamics of Spin-orbit-coupled Bose-Einstein Condensates
Cai, Yongyong Beijing Computational Sci. Research Center
Bao, Weizhu National Univ. of Singapore

Abstract: We study analytically and asymptotically as well as numerically ground states and dynamics of two-component spin-orbit-coupled Bose-Einstein condensates (BECs) modeled by the coupled Gross-Pitaevskii equations (CGPEs).In fact, due to the appearance of the spin-orbit (SO) coupling in the two-component BEC with a Raman coupling, the ground state structures and dynamical properties become very rich and complicated.

▶MS-Mo-E-18-4 17:30–18:00
Kinetic Nonlocal Interaction Models and Zero Inertia Hydrodynamic Limit
Tan, Changhui Univ. of Maryland

Abstract: In this talk, we introduce nonlocal interaction models, which arises from modeling the emergence of complex biological systems. Interactions includes attraction, repulsion and alignment. We study the wellposedness of the kinetic system and its zero inertia hydrodynamic limit. The uniqueness of the limiting system is proved by imposing momentum conservation condition. This is a joint work with Razvan Fetecau and Weiran Sun.

▶MS-Mo-E-18-5 18:00–18:30
Numerical Methods for Shallow Water Waves Using the Green-Naghdi Equation
Xu, Liwei Chongqing Univ.

Abstract: In this talk, we first introduce a numerical model for the Green-Naghdi equation. Two numerical schemes, including spectral methods and discontinuous Galerkin (DG) methods, are developed to solve the model, and numerical solutions are presented to show the efficiency and accuracy of both numerical models and methods.

MS-Mo-E-19 16:00–18:00 307B
Multiscale methods with applications in fluid mechanics and materials modeling. - Part II of III
For Part 1, see MS-Mo-D-19
For Part 3, see MS-Tu-D-19

Organizer: Brown, Donald Univ. of Bonn
Organizer: Henning, Patrick Univ. of Muenster

Abstract: With this Minisymposium we aim to gather leading researchers in the field of numerical multiscale methods, i.e. methods that are constructed to efficiently tackle differential equations with a large spectrum of length and time scales. The speakers present a wide range of different applications and approaches resulting in an extensive exchange of ideas. Among others, parabolic and hyperbolic multiscale problems are discussed, as well as Maxwell's equations or the two-phase flow equations in porous media. The minisymposium focuses on the practical aspects of the methods, as well as on questions regarding a corresponding numerical analysis.

▶MS-Mo-E-19-1 16:00–16:30
Multiscale Methods for Perforated Domains with Applications to Li-Ion Batteries Modeling.
Brown, Donald Univ. of Bonn
Peterseim, Daniel Universität Bonn

Abstract: Many porous media applications exhibit complex microstructure and are multiscale in nature. The possible applications include heat conduction in metallic foams and lithium ion batteries, We develop a multiscale method to solve problems in complicated porous microstructures. Using a coarse-grid quasi-interpolation operator to define a fine detail space and local orthogonal decomposition, we construct multiscale corrections to coarse-grid basis functions with microstructure. By truncating the corrector functions we produce a computationally efficient scheme.

▶MS-Mo-E-19-2 16:30–17:00
Model Reduction for Multi-phase Flow in Heterogeneous Media with POD-DEIM
Yang, Yanfang Texas A&M Univ.

Abstract: We propose a global-local model reduction method for fast multiscale reservoir simulations in highly heterogeneous porous media. We introduce an auxiliary variables in our model reduction that allows achieving a high degree of model reduction. The Discrete Empirical Interpolation Method is used to approximate the nonlinear functions in Newton iterations. Our numerical results, utilizing a two-phase immiscible flow show a substantial speed-up.

▶MS-Mo-E-19-3 17:00–17:30
Homogenization of the Stochastic Navier–Stokes Equation in Perforated Domains.
Bessaih, Hakima Univ. of Wyoming

Abstract: Some stochastic models are considered including the two dimensional Navier-Stokes equation in a perforated domain with a dynamical slip boundary condition. The dynamics are driven by a noise on the interior and on the boundary of the domain. Different scalings are considered that give rise to different limit problems.
For a particular scaling used on the Navier-Stokes equations, we obtain a Darcy' s law with memory. We mainly use the two scale convergence method to pass to the limit. Moreover, the passage to the limit is performed on the variational formulation.

▶MS-Mo-E-19-4 17:30–18:00
Multiscale Techniques for Parabolic Equations
Persson, Anna Chalmers Univ. of Tech.

Abstract: We use the local orthogonal decomposition technique to derive a generalized finite element method for linear and semilinear parabolic equations with spatial multiscale diffusion coefficients. We consider nonsmooth initial data and a backward Euler scheme for the temporal discretization. Convergence of optimal order, depending only on the contrast, but not on the variations in the diffusion coefficient, is proven in the $L_\infty(L_2)$-norm.

MS-Mo-E-20 16:00–18:10 210B
Low-rank Tensor Approximation in Multi-parametric and Stochastic PDEs - Part II of II
For Part 1, see MS-Mo-D-20

Organizer: Litvinenko, Alexander KAUST, UQ & ECRC Centers
Organizer: Matthies, Hermann TU Braunschweig, Inst. of Scientific Computing
Organizer: Nouy, Anthony Ecole Centrale Nantes

Abstract: Approximations of stochastic and multi-parametric differential equations may lead to extremely high dimensional problems that suffer from the so

called curse of dimensionality. Computational tractability may be recovered by relying on adaptive low-rank/sparse approximation. The tasks are 1) to keep a low-rank approximation of the high-dimensional input data through the whole computing process, 2) compute the solution and perform a post-processing in a low-rank tensor format. The post-processing may include computation of different statistics, visualization of a small portion of large data, large data analysis. The aim is to develop numerical methods which will reduce the computational cost as well as the storage requirement from $O(n^d)$ to $O(knd)$, where k is a small integer (related with the rank). The purpose of this minisymposium is to bring together experts in adaptive discretization/solution of stochastic/multi-parametric problems, experts in multi-linear algebra and experts in uncertainty quantification methods.

▶ MS-Mo-E-20-1 16:00–16:30

Hierarchical Tensor Approximation of Parameter-dependent PDEs

Ballani, Jonas EPF Lausanne

Abstract: In this talk, we discuss low-rank tensor techniques for the solution of parameter-dependent PDEs. In particular, our aim is to adaptively construct approximations in the hierarchical tensor format from a relatively small set of data samples. Once this approximation from an offline computation is available, the evaluation of quantities of interest becomes a cheap online task. Moreover, the explicit tensor representation can be used to compute stochastic properties of the solution in a straightforward way.

▶ MS-Mo-E-20-2 16:30–17:00

Tensor Train Approximation of Moment Equations for the Log-Normal Darcy Problem

Nobile, Fabio MATHICSE - EPFL
Bonizzoni, Francesca Faculty of Mathematics, Univ. of Vienna
Kressner, Daniel EPFL

Abstract: We study the Darcy problem with log-normal permeability. A perturbation approach around the mean permeability is adopted. The resulting recursive deterministic problem satisfied by the expected value of the stochastic solution is discretized on a tensor product of finite element spaces and the solution is sought in a low-rank Tensor Train format. We develop an algorithm for solving the recursive first moment problem in TT format and show its effectiveness with numerical examples.

▶ MS-Mo-E-20-3 17:00–17:30

On the Convergence of Alternating Optimisation in Tensor Format Representations

Espig, Mike RWTH Aachen Univ.

Abstract: During the last years, tensor format representation techniques were successfully applied to the solution of high-dimensional problems like stochastic and parametric partial differential equations. The most popular approach to low-rank approximation is alternating optimisation like the alternating least squares (ALS) method. The convergence of alternating optimisation for tensor format approximation is analysed in this talk. Our theoretical results are illustrated on explicit examples.

▶ CP-Mo-E-20-4 17:30–17:50

Numerical Solution of the Infinite Dimensional Stochastic LQR Problem

Mena, Hermann Univ. of Innsbruck

Abstract: We consider a stochastic linear quadratic regulator (SLQR) control problem on Hilbert spaces. For a well-posed SLQR problem, the optimal control is given in terms of a stochastic Riccati equation and a backward stochastic differential equation. Existence and uniqueness of the solutions are available only for certain special cases. We investigate the numerical treatment of the SLQR problem, in particular, the convergence of the Riccati operators. In addition, we discuss efficient numerical methods for solving large-scale stochastic Riccati equations arising from the discretization. The performance of our approach is illustrated by numerical results.

▶ CP-Mo-E-20-5 17:50–18:10

An Algorithm for Finding the Spectral Radius of Nonnegative Tensor

Qingzhi, Yang Nankai Univ.

Abstract: In this talk, based on an algorithm proposed by Ng, Qi and Zhou for finding the spectral radius of nonneagtive irreducible tensor, we present a method to solve the spectral radius for general nonnegative tensor by using inexact inner loop strategy. And we give the convergence result and computing complexity of the algorithm.

MS-Mo-E-21 16:00–18:30 309B

Waves and tomography in geosciences and medical imaging

Organizer: Leung, Shingyu Hong Kong Univ. of Sci. & Tech.
Organizer: Chung, Eric The Chinese Univ. of Hong Kong
Organizer: Qian, Jianliang Michigan State Univ.

Abstract: Wave propagation and related tomography problems are essential components for many applications including geosciences and medical imaging. There are in literature various works that address some of the issues arising from these applications, such as discretization techniques, multiscale modeling, fast solvers and inversion algorithms. However, many challenging open problems remain. The aim of this minisymposium is therefore to bring together researchers in the fields to exchange recent advances and ideas, as well as to foster interdisciplinary collaborations.

▶ MS-Mo-E-21-1 16:00–16:30

Theory and Numerics of Wave-luminescenece Tomography

Ren, Kui Univ. of Texas at Austin

Abstract: In wave-luminescence imaging (WLI), we use waves such as ultrasound and microwaves to generate luminescent light inside a scattering medium. We then measure on the surface of the medium outgoing photon density. From this measurement, we intend to image the distribution of the luminescence source inside the medium. We present here some recent theoretical and numerical results on WLI in various simplified settings. We show how to construct “good” probing waves for stable reconstructions.

▶ MS-Mo-E-21-2 16:30–17:00

Multi-layer Structures for the Direct Solution of High Dimensional Problems

Xia, Jianlin Purdue Univ.

Abstract: We propose multi-layer hierarchically semiseparable (MHS) structures for the efficient factorizations of dense matrices arising from high dimensional discretized problems. The problems include discretized integral equations and dense Schur complements in the factorizations of discretized PDEs. Unlike existing work on hierarchically semiseparable (HSS) structures which is essentially 1D, the MHS framework integrates multiple layers of rank and tree structures. We lay theoretical foundations for MHS structures and justify the feasibility of MHS approximations for these dense matrices. Rigorous rank bounds for the low-rank structures are given. Representative subsets of mesh points are used to illustrate the multi-layer structures as well as the structured factorization. Systematic fast and stable MHS algorithms are proposed, particularly convenient direct factorizations. The new structures and algorithms can yield direct solvers with nearly linear complexity and linear storage for solving some practical 2D and 3D problems.

▶ MS-Mo-E-21-3 17:00–17:30

High-order Factorization of Traveltime and Amplitude with Applications in Geometrical Optics

Luo, Songting Iowa State Univ.

Abstract: We present an factorization approach to resolve the source singularities of traveltime and amplitude when solving the eikonal and transport equations that result from geometrical optics approximations of high frequency wave propagation governed by Helmholtz equation. The factorization approach facilitates efficient computation of high accuracy phase and amplitude, which in return are used to rebuild faithful waves. The approach is further utilized in the fast Huygens sweeping method that is designed to capture the caustics.

▶ MS-Mo-E-21-4 17:30–18:00

Advances in Seismic Diffraction Imaging

Fomel, Sergey The Univ. of Texas at Austin

Abstract: Unlike specular reflections, which are created by continuous reflectors, diffraction waves are caused by small discontinuities in reflectivity. Using recently developed techniques, it is possible to separate diffractions from specular reflections and to utilize them for high-resolution subsurface imaging and inversion. I will describe recent developments in the field of seismic diffraction imaging, including the use of dip-angle gathers, oriented velocity continuation, and double-path-integral imaging.

▶ MS-Mo-E-21-5 18:00–18:30

Reverse Time Migration Based on Generalized Multiscale Finite Element Forward Modeling

Fu, Shubin Texas A&M Univ.

Abstract: Wave equation migration methods provide accurate and detailed subsurface images by incorporating the influence of complex wave arrivals and features that are not included in solutions based on ray theory. We apply the generalized multiscale finite element method for reverse time migration. Results shows multiscale RTM produces accurate images with a significant

reduction in computation time.

MS-Mo-E-22 16:00–18:30 206A

Recent Advances in A Posteriori Error Estimation and Adaptive Methods - Part II of II

For Part 1, see MS-Mo-D-22

Organizer: Zhang, Shun — City Univ. of Hong Kong
Organizer: Cai, Zhiqiang — Purdue Univ.

Abstract: Self-adaptive numerical methods provide a powerful and automatic approach in scientific computing. In particular, Adaptive Mesh Refinement (AMR) algorithms have been widely used in computational science and engineering and have become a necessary tool in computer simulations of complex natural and engineering problems. The key ingredient for success of self-adaptive numerical methods is a posteriori error estimates that are able to accurately locate sources of global and local error in the current approximation. Talks in this mini-symposium will cover some recent advances in the development and analysis of both a posteriori estimators and (convergent) adaptive schemes, as well as indicate directions of future research.

▶ MS-Mo-E-22-1 16:00–16:30

Robust A Posteriori Error Analytical Techniques for Second and Fourth Order Elliptic Singularly Perturbed Problems

Shaohong, Du — Chongqing Jiaotong Univ./Beijing Computaional Sci. Research Center
Zhimin, Zhang — Beijing Computational Sci. Research Center, & Wayne State Univ.

Abstract: For singularly perturbed problems, a novel dual norm is introduced, under which robust residual-type and recovery-type a posteriori error estimators are analyzed. For fourth order elliptic singularly perturbed problems, a new size of the error for its mixed finite element methods is presented , and a novel analytical technique is developed to obtain robust residual-based a posteriori estimator in this size. Numerical experiments are reported to support theoretical results.

▶ MS-Mo-E-22-2 16:30–17:00

Functional A Posteriori Error Estimates and Incompletely Known Data

Mali, Olli — Univ. of Jyväskylä
Repin, Sergey — Univ. of Jyvaskyla
Neittaanmäki, Pekka — Univ. of Jyväskylä

Abstract: In this talk, the error estimates of functional type are used to study the effects of incompletely known data in problems generated by elliptic PDEs. PDEs typically contain parameters, which are known only up to some limited accuracy. The error estimates of functional type have suitable properties for a worst case scenario type analysis; they do not rely on any numerical method, they are guaranteed, and they depend explicitly on the problem data.

▶ MS-Mo-E-22-3 17:00–17:30

Local H(div) Recovery-based A Posteriori Error Estimators for Elliptic Equations

Zhang, Xu — Purdue Univ.
Cai, Zhiqiang — Purdue Univ.

Abstract: We present recovery-based a posteriori error estimators for finite element approximation of elliptic equations. The flux is recovered in H(div) finite element subspaces by approximating equilibrium and constitutive equations simultaneously in a weighted H(div) norm. The recovery techniques are performed locally on appropriate patches of triangular elements. A posteriori error estimators are constructed based on difference of numerical flux and recovered flux. We will discuss the reliability and efficiency bounds of these local error estimators.

▶ MS-Mo-E-22-4 17:30–18:00

Testing Computationally the Instance Optimality of Adaptive Finite Element Methods

Veeser, Andreas — Univ. of Milan
Fierro, Francesca — Univ. of Milan
Schmidt, Alfred — Univ. of Bremen, Centre for Industrial Mathematics

Abstract: Basing upon a localization of the error of the Ritz projection (Veeser, submitted) and adaptive tree approximation (Binev/DeVore '04), we approximately compute best errors with respect to the number of degrees of freedom and compare them with the corresponding errors of the adaptive finite element method. Our computational results complement the theoretical ones (e.g., Diening/Kreuzer/Stevenson '14) in which the error is augmented by the oscillation of the estimator.

▶ MS-Mo-E-22-5 18:00–18:30

Robust Adaptive Approximation for Singularly Perturbed Problems

Tantardini, Francesca — Ruhr-Universität Bochum
Veeser, Andreas — Univ. of Milan
Verfuerth, Ruediger — Ruhr-Universität Bochum

Abstract: We consider the approximation in the reaction-diffusion norm with continuous finite elements and prove that the best error is equivalent to a sum of local best errors on pairs of elements. The equivalence constants do not depend on the ratio between reaction and diffusion. This allows in particular to derive local error functionals that ensure robust performance of adaptive tree approximation, which is useful e.g. to set non-asymptotic benchmarks for the corresponding adaptive Galerkin method.

MS-Mo-E-23 16:00–18:10 208A

Recent Developments in Finite Element Methods for Variational Inequalities - Part II of II

For Part 1, see MS-Mo-D-23

Organizer: Nataraj, Neela — Indian Inst. of Tech. Bombay
Organizer: Gudi, Thirupathi — Indian Inst. of Sci., Bangalore

Abstract: Variational inequalities have been playing a key role in the modern scientific world. The theory of variational inequalities provides a generalization of the theory of boundary value problems and has applications in many fields like Applied Mathematics, Mechanics, Theory of Control and so on. Unlike variational equations, inequalities exhibit additional singularities due to occurrence of free boundaries, which limit the regularity of the solution. The study of computational methods for variational inequalities thus offers more challenges. The error analysis for the finite element methods of these problems should also be derived under the limited regularity assumptions. Adaptive finite element techniques are quite desirable for these class of problems. We would like to discuss and exchange some of the latest developments in the error analysis of finite element methods for variational inequalities.

▶ MS-Mo-E-23-1 16:00–16:30

Lagrange Multipliers in the A Posteriori Error Analysis for Obstacle Problems

Veeser, Andreas — Univ. of Milan

Abstract: Sharp a posteriori error estimators for obstacle problems rely on an approximation of the Lagrange multiplier associated with the exact solution. The construction of such approximate multipliers must consider structural conditions arising from the variational inequality, the associated potential and the request of computability. We shall discuss the interplay of tools like full contact (Fierro/Veeser '03) and positivity preserving interpolation (Chen/Nochetto '00, Nochetto/Wahlbin '01).

▶ MS-Mo-E-23-2 16:30–17:00

Adaptive Non-conforming FEM for the Obstacle Problem

Koehler, Karoline — Humboldt-Universitaet zu Berlin

Abstract: This talk considers the non-conforming Crouzeix-Raviart finite element method (NCFEM) for the discretisation of the obstacle problem. The presented a priori error analysis employs the standard regularity assumption and shows convergence even in the case of problems on polygonal domains with re-entering corners. The striking advantage of the NCFEM is the possibility to compute lower bounds for the exact minimal energy. This is a novel result and not possible with an conforming finite element method.

▶ MS-Mo-E-23-3 17:00–17:30

Optimal Convergence Rates of Adaptive Simulations in Elastoplasticity

Carstensen, Carsten — Humboldt-Universitaet zu Berlin

Abstract: An adaptive finite element algorithm for problems in elastoplasticity with hardening is of optimal convergence with respect to the notion of approximation classes. The results rely on the equivalence of the errors of the stresses and energies resulting from Jensen's inequality. Numerical experiments study the influence of the hardening and bulk parameters to the convergence behavior of the AFEM algorithm. This is the first optimal adaptive FEM for a variational inequality to appear in the online version in Nummer. Math. (2015) with Andreas Schroeder and Sebastian Wiedemann.

▶ CP-Mo-E-23-4 17:30–17:50

Computable Error Estimates for Monte Carlo Finite Element Approximation of Elliptic PDE with Lognormal Diffusion Coefficients

Hall, Eric — KTH Royal Inst. of Tech.
Hoel, Haakon — Univ. of Oslo
Sandberg, Mattias — KTH Royal Inst. of Tech.
Szepessy, Anders — KTH Royal Inst. of Tech.
TEMPONE, RAUL — KING ABDULLAH Univ. OF Sci. & Tech.

Abstract: The Monte Carlo (and Multi-level Monte Carlo) finite element method can be used to approximate observables of solutions to diffusion equations with lognormal distributed diffusion coefficients, e.g. modeling ground water flow. Typical models use lognormal diffusion coefficients with Hoelder regularity of order up to 1/2 a.s. This low regularity implies that the

high frequency finite element approximation error (i.e. the error from frequencies larger than the mesh frequency) is not negligible and can be larger than the computable low frequency error. We address how the total error can be estimated by the computable error.

▶CP-Mo-E-23-5 17:50–18:10

Finite Element Analyses on Optimal Control Problems Constrained by Stochastic PDEs

Sun, Tongjun School of Mathematics, Shandong Univ.

Abstract: We consider optimal control problem governed by PDEs with stochastic perturbation in its coefficients. The objective is to minimize the expectation of a cost functional with the constrained control. We represent the stochastic PDEs in term of the generalized polynomial chaos expansion and obtain the deterministic optimal problem. By applying the well-known Lions' Lemma, we obtain the necessary and sufficient optimality conditions. We establish a scheme to approximate the optimality system with respect to both the spatial space and the probability space by Stochastic Galerkin method. Then priori error estimates are derived for the state, the co-state and the control variables. Numerical examples are presented to illustrate our theoretical results.

MS-Mo-E-24 16:00–18:30 211

Recent Advances in Kinetic Equations: Numerical Methods and Their Applications - Part II of II

For Part 1, see MS-Mo-D-24

Organizer: Haack, Jeff Los Alamos National Laboratory
Organizer: Hu, Jingwei Purdue Univ.
Organizer: Tang, Min shanghai jiao tong Univ.

Abstract: Kinetic equations and related models play an important role in many science and engineering branches. Examples include: gas/plasma dynamics, radiative transfer, semiconductor modeling, complex systems in biological or social sciences, etc. Designing numerical methods in these applications present similar challenges, ranging from multiscale modeling, nonlinear analysis, to large computational expense requiring high performance computing. This minisymposium aims to report the recent progress in the development of numerical methods for various kinetic equations, and by bringing researchers from diverse fields, to stimulate new problems and methods.

▶MS-Mo-E-24-1 16:00–16:30

Rescaling Velocity Methods for Kinetic Equations Coming from Physics and Biology

Rey, Thomas Lille 1 Univ.

Abstract: Rescaling velocity methods have been widely used in the last years to solve numerically a large class of partial or even integro-differential equations exhibiting concentration or spreading, without the use of remeshing technique. In this talk, I will review the current litterature on the topic, and present some results obtained in collaboration with Francis Filbet and Changhui Tan.

▶MS-Mo-E-24-2 16:30–17:00

Multi-species BGK with Velocity Dependent Cross Section for Dense Plasmas

Haack, Jeff Los Alamos National Laboratory

Abstract: In this talk, I will present joint work with C. Hauck (ORNL) and M. Murillo (LANL) on velocity-dependent multi-species BGK models for dense plasmas. This model improves on the ad-hoc nature of 'traditional' BGK and can directly incorporate different cross section models.

▶MS-Mo-E-24-3 17:00–17:30

Convergence of Filtered Spherical Harmonic Equations for Radiation Transport

Kuepper, Kerstin RWTH Aachen Univ.
Frank, Martin RWTH Aachen Univ.

Abstract: We analyze the global convergence properties of the filtered spherical harmonic (FPN) equations for radiation transport. The well-known spherical harmonic (PN) equations are a spectral method (in angle) for the radiation transport equation and are known to suffer from Gibbs phenomena around discontinuities. The filtered equations include additional terms to address this issue that are derived via a spectral filtering procedure.

▶MS-Mo-E-24-4 17:30–18:00

Fast Semi-Lagrangian Schemes for Kinetic Equations.

Dimarco, Giacomo Univ. of Ferrara

Abstract: A new class of semi-Lagrangian schemes is discussed. The purpose is to drastically reduce the cost related to the discretization of the linear transport part by fixing the shape of the distribution function once for all avoiding reconstructions to find the feet of the characteristic. Hence, the cost of the solution of the original kinetic equation is almost entirely due to the projection of the solution onto the grid to compute the collision operator.

▶MS-Mo-E-24-5 18:00–18:30

A Phase Transition in A Kinetic Flocking Model

Barbaro, Alethea Case Western Reserve Univ.

Abstract: We discuss a kinetic Cucker-Smale-type flocking model with a preferred velocity and diffusion. We prove that a phase transition occurs at the kinetic level as we vary the diffusion coefficient. We use a Monte Carlo-like method to find the solutions of the kinetic equation, employing the Euler-Maruyama method to solve the SDEs. Numerically, we determine the location of the phase transition in parameter space and explore the temporal evolution of the average velocity and entropy.

MS-Mo-E-25 16:00–18:30 210A

Isogeometric methods and design-through-analysis tools in CAD/CAE - Part II of III

For Part 1, see MS-Mo-D-25
For Part 3, see MS-Tu-D-25

Organizer: BUFFA, Annalisa IMATI "E. Magenes", CNR
Organizer: Giannelli, Carlotta INdAM c/o Univ. of Florence

Abstract: The development process of industrial digital products relies on geometrical and numerical technologies provided by computer aided applications. The computational models are usually designed through commercial Computer Aided Design (CAD) systems and subsequently processed and approximated with Computer Aided Engineering (CAE) software tools.
In order to drastically improve the efficiency and robustness of this process, a deep interaction among scientists from geometric modeling and numerical analysis is needed. An active area of research in this context is related to isogeometric analysis, an emerging paradigm for the solution of partial differential equations which combines and extends finite element techniques with CAD methods related to spline technologies. The isogeometric perspective outlines new paths of research for the identification of geometric representations suitable for numerical simulation.
Indeed, isogeometric analysis is based on the idea that the exact geometry of the model should be preserved throughout the overall design-through-analysis process and numerical methods should be able to simulate physical phenomena directly on the CAD model. This is possible only if new, spline based, numerical techniques are designed and innovative schemes for geometric design are developed.
The minisymposium will address theoretical and computational issues that arise in the identification, characterization and use of advanced geometric and analytical methods that share the goal of promoting new paradigms for a better CAD/CAE integration.

▶MS-Mo-E-25-1 16:00–16:30

C1 Smooth Isogeometric Function Spaces over Domains of Arbitrary Shape

Takacs, Thomas Univ. of Pavia

Abstract: Isogeometric analysis provides smooth shape functions on a tensor product domain. However, on a multipatch geometry it is not trivial to construct optimally-accurate C1 isogeometric spaces. We show that constructions based on bilinear geometries are more or less the only ones for which it is possible to obtain optimally accurate C1 spaces. Second, we present approaches based on weak continuity using a Nitsche type method. We numerically compare the accuracy of strong and weak methods.

▶MS-Mo-E-25-2 16:30–17:00

Hierarchical LR-meshes

Bressan, Andrea Johannes Kepler Univ. Linz

Abstract: Both CAD and IGA applications require the use of function spaces that allow for local changes in spatial resolution. In this presentation we present a construction of a LR-spline space that allows the choice of a local mesh size and guarantees local linear independence and the partition of unity property of the basis.

▶MS-Mo-E-25-3 17:00–17:30

PetIGA-MF: A Multi-field Framework for Conforming B-splines Spaces

Sarmiento, Adel King Abdullah Univ. of Sci. & Tech.
Vignal, Philippe King Abdullah Univ. of Sci. & Tech.
Cortes, Adriano King Abdullah Univ. of Sci. & Tech.
Dalcin, Lisandro King Abdullah Univ. of Sci. & Tech.
Collier, Nathaniel King Abdullah Univ. of Sci. & Tech.
Calo, Victor King Abdullah Univ. of Sci. & Tech.

Abstract: PetIGA-MF is an extension of PetIGA, a high-performance framework for isogeometric analysis based on PETSc. PetIGA-MF implements the spaces coming from the discrete differential forms theory, providing gradient-, curl-, divergence- and integral-conforming B-spline spaces, for the discretization of multiphysics and multi-field analysis. We present optimal convergence

rates for divergence-conforming B-spline spaces, and applications including incompressible and mass transport coupled flows to illustrate the accuracy of our framework.

▶ MS-Mo-E-25-4 17:30–18:00

T-splines and Generalized T-splines

Bracco, Cesare — Univ. of Florence
Cho, Durkbin — Dongguk Univ.

Abstract: T-splines are a generalization of the classical tensor-product B-splines based on meshes (called T-meshes) which allow T-junctions, that is vertices which are endpoints of less than 4 edges, unlike in the tensor-product case. The use of such meshes is very relevant since it allows to adopt local refinement techniques. The talk will present several results about T-splines, in particular concerning their linear independence and their generalization to a noteworthy non-polynomial case (Generalized T-splines).

▶ MS-Mo-E-25-5 18:00–18:30

Regularization of Inverse Problems on Manifolds by Isogeometric Discretization

Dong, Guozhi — Univ. of Vienna

Abstract: In this talk, we will present some results on the regularization within inverse problems defined on a manifold domain. We do a comprehensive convergence analysis, including error estimates on both the regularization models and the numerical approximates. The analysis shows that when a so called isogeometric regularization may be applied. This is a joint work with Bert Juettler, Otmar Scherzer and Thomas Takacs.

MS-Mo-E-26 16:00–18:00 110

Perturbation theory for linear/nonlinear eigenvalue problems in action - Part II of II

For Part 1, see MS-Mo-D-26

Organizer: Nakatsukasa, Yuji — Univ. of Tokyo
Organizer: Miedlar, Agnieszka — EPF Lausanne

Abstract: In numerical analysis, perturbation theory has earned their fame as primarily theoretical contributions, but nonetheless their role in practical computations is crucial. Perturbation results are used extensively for analyzing stability of numerical algorithms or the accuracy of numerical approximation, and sometimes to inspire new algorithm design. Applications include solving PDEs, simulating dynamical systems and model reduction. With the goal to share its beauty and practical importance to a broader audience, this minisymposium reviews classical and recent outstanding results and open problems in eigenvalue perturbation theory, treating both matrices (linear, polynomial and general nonlinear eigenvalue problems) and linear operators.

▶ MS-Mo-E-26-1 16:00–16:30

Tropical Diagonal Scaling for Asymptotic Eigenvalue Problems

Marchesini, Andrea — Ecole polytechnique

Abstract: We study the behaviour of the eigenvalues of a parametric matrix polynomial P in a neighbourhood of zero. If we suppose that the entries of P have Puiseux series expansion, we can build an auxiliary matrix polynomial Q whose entries are the leading exponents of those of P. We show that preconditioning P via a diagonal scaling based on the tropical eigenvalues of Q can improve conditioning and backward error of the eigenvalues.

▶ MS-Mo-E-26-2 16:30–17:00

Moving A Specified Eigenvalue and Eigenvector

Nakatsukasa, Yuji — Univ. of Tokyo
Fukaya, Takeshi — Hokkaido Univ.
Miedlar, Agnieszka — TU Berlin

Abstract: Given a simple eigenvalue and its corresponding right/left eigenvectors, we derive a perturbation that moves the eigenvalue or/and the associated eigenvector, such that the other eigenvalues and eigenvectors stay unaffected by the perturbation. We discuss extensions to generalized and quadratic eigenvalue problems. Such perturbation can be useful for example for deflation techniques, increasing the spectral gap or determining the set of linearly independent eigenvectors and computing the matrix exponential.

▶ MS-Mo-E-26-3 17:00–17:30

Matrix Nearness Problems for Lyapunov-type Stability Domains

Kostic, Vladimir — Univ. of Novi Sad
Miedlar, Agnieszka — EPF Lausanne

Abstract: We consider Lyapunov-type domains in their general setting and formulate two appropriate matrix nearness problems - the distance to delocalization and distance to localization - which generalize the distance to instability and the distance to stability, in both, discrete and continuous sense. Then, we present numerical algorithms for their solution. Performed computations cover different cases for medium size and large sparse matrices that come from different scientific and industrial applications.

▶ MS-Mo-E-26-4 17:30–18:00

From Rellich-Kato Up to Now - Snaphots of Perturbation Theory for Eigenvalue Problems

Miedlar, Agnieszka — TU Berlin

Abstract: In this talk we shortly review some of the classical and recent results in perturbation theory. We motivate their practical relevance and present some new research directions in perturbation analysis, e.g., modifications of the spectrum.

MS-Mo-E-27 16:00–18:00 407

Numerical Simulations in Poromechanics - Part II of III

For Part 1, see MS-Mo-D-27
For Part 3, see MS-Tu-D-27

Organizer: Gaspar, Francisco — Univ. of Zaragoza
Organizer: Hu, Xiaozhe — Tufts Univ.
Organizer: Rodrigo, Carmen — Univ. of Zaragoza
Organizer: Zikatanov, Ludmil — The Pennsylvania State Univ.

Abstract: Poromechanics studies the interactions between fluid motion and deformation in porous media. It has important applications including consolidation, subsidence due to fluid withdrawal, and hydraulic fracturing. Many discretizations and solver schemes have been developed for poromechanics but the design of effective simulation techniques for handling the coupling between fluid motion and solid deformation is still a challenging task. The main theme of the minisymposium is on the advanced numerical algorithms for simulating poromechanics. The focus is on robust discretizations, adaptivity and efficient nonlinear and linear solvers for various poroelastic models and their applications.

▶ MS-Mo-E-27-1 16:00–16:30

A Mixed Finite Element Method for the Biot's Interface Problem

Yi, Son-Young — Univ. of Texas at El Paso

Abstract: We consider the Biot model in heterogeneous porous media. The discontinuities of the material coefficients give rise to an interface problem of the Biot model, with a physically consistent set of interface conditions. We discretize the equations using a mixed FEM that uses the pore pressure, fluid flux, displacement, and total stress as primary unknowns. We discuss the issue of locking and also present a block preconditioner for the resulting saddle point system.

▶ MS-Mo-E-27-2 16:30–17:00

Block Preconditioners for Poromechanics Problems

Blaheta, Radim — Inst. of Geonics CAS

Abstract: Numerical solution of poroelasticity problems discretized in space by Courant elements for solid, Raviart-Thomas elements for fluid velocities and piecewise constants for pressures is considered. Time discretization uses backward Euler or higher order methods. Schur complement based block preconditioners are investigated for the solution of the arising saddle point systems with a special emphasis on those using grad-div augmented blocks. The influence of inexact solution of subproblems, robustness and application to nonlinear poromechanics is discussed.

▶ MS-Mo-E-27-3 17:00–17:30

Auxiliary Space Multigrid Method for Poroelasticity Problem

Kraus, Johannes — Univ. of Duisburg-Essen

Abstract: We consider a poroelasticity problem which couples the elastic behavior of fully saturated porous media with flow of an incompressible fluid. For the arising linear system we study a family of block type preconditioners based on an additive approximation of the Schur complement resulting from elimination of the pressure unknown. The proposed method to solve the reduced system is an auxiliary space multigrid method that combines techniques from domain decomposition, multigrid, and auxiliary space preconditioning.

▶ MS-Mo-E-27-4 17:30–18:00

Solution of Stable Discretizations of the Biot's Consolidation Problem by Monolithic Multigrid Solvers

Gaspar, Francisco — Univ. of Zaragoza
Hu, Xiaozhe — Tufts Univ.
Rodrigo, Carmen — Univ. of Zaragoza
Zikatanov, Ludmil — The Pennsylvania State Univ.

Abstract: Numerical difficulties arise in the solution of the poroelasticity problem, appearing non-physical oscillations in the pressure field approximation when non stabilized discretizations are used. Besides, a very important aspect is the efficient solution of the resulting system after the discretization of

the model, for which fast numerical algorithms have to be designed. Here, we treat the stable numerical discretization of the system and the use of monolithic multigrid techniques for its efficient solution.

MS-Mo-E-28 16:00–18:00 109
Weak Galerkin Method and Its Applications - Part II of III
For Part 1, see MS-Mo-D-28
For Part 3, see MS-Tu-D-28

Organizer: Chen, Long — Univ. of California at Irvine
Organizer: Ye, Xiu — Univ. of Arkansas at Little Rock
Organizer: Zhang, Ran — Jilin Univ.

Abstract: The Weak Galerkin method is an extension of the standard Galerkin finite element method where classical derivatives were substituted by weakly defined derivatives on functions with discontinuity. As such, the WG methods have the flexibility in handling complex geometry and low regularity solutions, the simplicity in analyzing real-world physical problems, and the symmetry in reformulating the original PDEs. The aim of this mini-symposium is to bring together specialists in order to ex- change ideas regarding the development of WG-FEMs and its industry and research applications. Since women is an underrepresented group in mathematics and engi- neering, we pay a particular attention to attract female participants.

▶ MS-Mo-E-28-1 16:00–16:30
A Two-level Algorithm for Weak Galerkin Methods for Diffusion Problems
Xie, Xiaoping — Sichuan Univ.

Abstract: We develop a two-level algorithm for the weak Galerkin (WG) finite element methods based on local RT and BDM mixed elements for two- and three-dimensional diffusion problems. We first show the condition numbers of the stiffness matrices arising from the WG methods are of $O(h^{-2})$, then derive the convergence of the algorithm without any regularity assumption. Finally we provide some numerical results. This work is joint with Binjie Li.

▶ MS-Mo-E-28-2 16:30–17:00
The Lower Bounds of Eigenvalue Problems by Weak Galerkin Method
Zhang, Ran — Jilin Univ.

Abstract: This article is devoted to computing the eigenvalue and its lower bounds of the Laplace eigenvalue problem by a weak Galerkin (WG) finite element methods. The WG method is on the use of weak functions and their weak derivatives defined as distributions. The WG method is highly flexible by allowing the use of discontinuous functions on arbitrary polygons or polyhedra with certain shape regularity.

▶ MS-Mo-E-28-3 17:00–17:30
Development of C++ Libraries for the Weak Galerkin Finite Element Methods
Liu, Jiangguo — Colorado State Univ.

Abstract: In this talk, we present preliminary results on development of C++ libraries for the weak Galerkin (WG) finite element methods. We will show how inheritance and polymorphism are implemented in C++ code for the WG finite elements. Integration of the WG C++ libraries with other scientific computing libraries, e.g., PETSc and VisIt, will be demonstrated. We shall also present simulations of 3-dim Darcy flow computation using the WG C++ library.

▶ MS-Mo-E-28-4 17:30–18:00
BDDC Domain Decomposition Algorithms for Weak Galerkin Methods
Tu, Xuemin — Univ. of Kansas

Abstract: A Balancing domain decomposition by constraints (BDDC) algorithm is studied for solutions of large sparse linear algebraic systems arising from weak Galerkin discretization of second order elliptic boundary value problems. The condition number for the preconditioned system is estimated and numerical results are provided to confirm the results.

MS-Mo-E-29 16:00–18:00 305
Multilevel Monte Carlo methods and applications - Part II of III
For Part 1, see MS-Mo-D-29
For Part 3, see MS-Tu-D-29

Organizer: TEMPONE, RAUL — KING ABDULLAH Univ. OF Sci. & Tech.
Organizer: Giles, Michael — Univ. of Oxford
Organizer: Nobile, Fabio — MATHICSE - EPFL

Abstract: Monte Carlo methods are general, flexible sampling methods for the computation of expected values of observables arising in stochastic systems. Monte Carlo methods are very attractive since they are simple to implement and their rate of convergence is very robust. Still, in the context of random evolution of large systems arising from the discretization of differential equations subject to randomness, their cost can be too large for practical purposes. The recently created Multilevel Monte Carlo method extended, to multiple levels, the idea of using a coarse numerical approximation as a method for control variate to a finer one, reducing the variance and the required number of samples on the finer grid. Multilevel Monte Carlo changed the computational landscape of stochastic problems described in terms of differential equations, which are commonplace, for instance, when carrying out Uncertainty Quantification in applications. In this minisymposium we intend to present the latest algorithmic and theoretical contributions to Multilevel Monte Carlo methods, focusing also on novel applications arising in, among others, stochastic social, chemical and biological modeling, wireless communication networks, computational finance, stochastic particle systems and engineering modeling with random PDEs.

▶ MS-Mo-E-29-1 16:00–16:30
Multilevel Quasi-Monte Carlo Methods for Lognormal Diffusion Problems
Kuo, Frances — Univ. of New South Wales

Abstract: In this joint work with Rob Scheichl (Bath), Christoph Schwab (Zurich), Ian Sloan (UNSW), and Elizabeth Ullmann (Hamburg), we analyze a multilevel quasi-Monte Carlo scheme applied to linear functionals of solution of a model steady-state flow in porous media. The permeability is modeled as a lognormal random field, leading to Gaussian integrals. Much emphasis is placed on the design of QMC rules that achieve dimension-independent error bounds with good convergence rates and under weak assumptions.

▶ MS-Mo-E-29-2 16:30–17:00
Multi-level Simulation of SPDEs Arising from Large Particle Systems
Reisinger, Christoph — Oxford Univ.

Abstract: We present two multilevel algorithms for the simulation of large systems of exchangeable SDEs. The first one constructs a multilevel structure by nested systems of SDEs of smaller dimensionality, while the second one uses the limiting stochastic partial differential equation governing the infinite-dimensional system and applies the multilevel idea on the level of the spatial and time mesh. We prove optimal complexity bounds for a model problem and show applications to more complex models.

▶ MS-Mo-E-29-3 17:00–17:30
Estimation of Central Statistical Moments with MLMC and Applications
Chernov, Alexey — Univ. of Oldenburg
Bierig, Claudio — Univ. of Reading

Abstract: In this talk we review the general methodology of the Multilevel Monte Carlo method for estimation of the variance and higher order central statistical moments for forward uncertainty propagation, address convergence of the estimators and indicate possible extensions. We illustrate the performance of the proposed approach on a model problem of contact between an elastic membrane and a rigid rough random surface.

▶ MS-Mo-E-29-4 17:30–18:00
Improving MLMC for SDEs with Applications to the Langevin Equation and Atmospheric Dispersion
Mueller, Eike — Univ. of Bath
Scheichl, Robert — Univ. of Bath
Shardlow, Tony — Univ. of Bath

Abstract: We apply several well-known tricks to improve the efficiency of the Multilevel MC method for SDEs: modified equations analysis as an alternative to strong-approximation theory for the integrator; operator splitting techniques; extrapolation; and discrete random variables in place of Gaussian increments. We extend the MLMC complexity theorem to allow for bias between the levels and show that combined our modifications can lead to an increase in efficiency of almost two orders of magnitude in practice.

MS-Mo-E-30 16:00–18:00 VIP2-2
Recent Advances in the Solution of Least Squares Problems 2

Organizer: Hayami, Ken — National Inst. of Informatics

Abstract: Least squares problems appear in many important applications in science and engineering. Recently, there have been many developments in the solution of least squares problems of various kinds. Examples are fast and robust solvers for large scale least squares problems combining Krylov subspace methods with efficient preconditioners such as stationary inner iterations or balanced incomplete factorization. There are also advances in other kinds of least squares problems, such as nonnegative constrained least squares problems, nonlinear least squares problems, total least squares problems and integer least squares problems etc. This mini-symposium will address on recent advances in such areas.

▶ MS-Mo-E-30-1 16:00–16:30
Perturbation Analysis and Randomized Algorithms for Large-Scale Total Least Squares Problems
WEI, Yimin — Fudan Univ.

Abstract: In this talk, we present perturbation analysis for the total least

squares (TLS) problems and develop randomized algorithms for the TLS and the truncated total least squares (TTLS) solutions of large-scale discrete ill-posed problems.

▶ MS-Mo-E-30-2 16:30–17:00

Some Efficient Hybrid Algorithms for Large Scale Non-negative Constrained Least Squares Problems

Zheng, Bing Lanzhou Univ.
Zheng, Yu-Tao Lanzhou Univ.

Abstract: Inspired by the successive projection method, some efficient hybrid algorithms with active-set methods are presented, which make active-set methods suitable for solving large scale non-negative constrained linear least squares problems. The convergence analysis for the hybrid algorithms is discussed under some proper assumptions. The numerical experiments show that these hybrid algorithms can outperform the existing methods. This hybrid process is also applied for efficiently solving the problems with multiple right-hand terms.

▶ MS-Mo-E-30-3 17:00–17:30

Integer Least Squares Estimation: Theory and Algorithms

Chang, Xiao-Wen McGill Univ.

Abstract: Integer least squares (ILS) problems arise from many applications. We first review some theory about ILS estimation. In particular we present two theoretical results, which rigorously justify the use of the well-known LLL reduction as preprocessing for solving ordinary ILS problems. Then we review some numerical approaches for solving ILS problems. We will focus on the widely used discrete enumeration approach. Some lower bounds will be presented to prune the search tree.

▶ MS-Mo-E-30-4 17:30–18:00

Modulus Iterative Methods for Box Constrained Least Squares Problems

Zheng, Ning The Graduate Univ. for Advanced Studies
Hayami, Ken National Inst. of Informatics
Yin, Jun-Feng Tongji Univ.

Abstract: For the solution of large sparse box constrained least squares problems (BLS), a new iterative method is proposed by using CG method for inner iterations and the modulus iterative method in the outer iterations for the solution of linear complementarity problem resulting from Karush-Kuhn-Tucker conditions of BLS problem. Theoretical convergence analysis is presented. Numerical experiments show the efficiency of the proposed methods compared to projection methods with less iteration steps and CPU time.

MS-Mo-E-31 16:00–18:00 405

Numerical Computation with Functions and Chebfun - Part II of III

For Part 1, see MS-Mo-D-31
For Part 3, see MS-Tu-D-31

Organizer: Trefethen, Lloyd N. Univ. of Oxford
Organizer: Guettel, Stefan The Univ. of Manchester

Abstract: A recent theme in algorithms and software is efficient numerical computation with functions in a manner that "feels symbolic" since the accuracy is high and underlying discretizations (Chebyshev, Fourier,...) are hidden from the user. Projects of this kind include Chebfun, pychebfun, ApproxFun, and PaCAL. A pervasive theme in this work is the use of continuous analogues of familiar discrete mathematical objects and algorithms. This minisymposium will present new developments in the areas of (1) differential and integral equations, (2) working with functions, and (3) rootfinding and linear algebra.

▶ MS-Mo-E-31-1 16:00–16:30

A Fast and Well-conditioned Spectral Method for Solving Singular Integral Equations

Slevinsky, Richard Mikael Univ. of Oxford

Abstract: From fracture mechanics and fluid dynamics to acoustic and electromagnetic scattering, boundary integral equations reduce the dimensionality of the underlying partial differential equations by one. The tradeoff for this reduction in complexity is the introduction of singular integral kernels. In this work, we use several remarkable properties of Chebyshev polynomials including their spectral convergence, their Hilbert and Cauchy transforms, and low rank bivariate approximations to construct a fast and well-conditioned spectral method.

▶ MS-Mo-E-31-2 16:30–17:00

Rectangular Differentiation Matrices

Xu, Kuan Univ. of Oxford

Abstract: The emergence of rectangular spectral collocation methods offers a novel but more flexible and robust way to implement boundary conditions. Moreover, it has also changed the way we view and interpret differential operators – differential operators are, in fact, rectangular, not square. This talk will introduce the explicit constructions of rectangular differentiation matrices, followed by comparison with other construction methods. Properties and applications of rectangular differentiation matrices will also be discussed.

▶ MS-Mo-E-31-3 17:00–17:30

High Accuracy Chebyshev Coefficients via Contour Integrals

Austin, Anthony Universtiy of Oxford
Trefethen, Lloyd N. Univ. of Oxford

Abstract: Following Bornemann's work on computing Taylor coefficients to high precision by contour integrals over circles of large radius, Wang and Huybrechs have recently published a paper about computing Chebyshev coefficients to high precision by contour integrals over Bernstein ellipses of large parameter. Under certain circumstances, these methods make it possible to compute coefficients in ordinary floating-point arithmetic down at the level of 10^{-100} or below. We investigate the use of such methods for general-purpose computation with functions as in Chebfun, an in particular, the design of a simple if not optimal Chebfun "turbo" option.

▶ MS-Mo-E-31-4 17:30–18:00

Linearizations for Computing Roots of Rational Functions

Nakatsukasa, Yuji Univ. of Tokyo
Vanni, Noferini Univ. of Manchester
Townsend, Alex MIT

Abstract: The roots of a rational function in quotient form are simply those of the numerator polynomial, which can be computed via linearization. The situation is less straightforward when the rational function is given in other forms, such as partial or continued fractions. This work presents linearizations applicable to such rational functions. The linearizations have elements obtained directly from those of the rational function, resulting in significantly improved numerical stability compared with a polynomialization approach.

MS-Mo-E-32 16:00–18:00 307A

Reduced-order modeling in uncertainty quantification and computational fluid dynamics - Part II of III

For Part 1, see MS-Mo-D-32
For Part 3, see MS-We-E-03

Organizer: Chen, Peng ETH Zurich (Swiss Federal Inst. of Tech. in Zurich)
Organizer: Quarteroni, Alfio EPFL
Organizer: Rozza, Gianluigi SISSA, International School for Advanced Studies

Abstract: This proposed minisymposium is about the development and application of reduced-order modeling techniques in the fields of uncertainty quantification and computational fluid dynamics for control, optimization and design. Large-scale computing is commonly faced in these fields due to the high computational complexity of solving parametric and/or stochastic systems described by, e.g. partial different equations, which may lead to unaffordable computational burden for real-world application. In order to tackle this challenge, reduced-order modeling (e.g. RB, POD, EIM, PGD) techniques with the aim of capturing and utilizing the most important features of these systems are particularly in need for real-time and/or many-query computing.
This minisymposium focuses on the development and application of reduced-order modeling techniques in following themes: 1. efficient and reliable a posteriori error estimates for reduced solution and output; 2. forward uncertainty quantification problems, e.g. sensitivity analysis, risk prediction or reliability analysis with scientific and engineering applications; 3. stochastic inverse problems (model calibration, parameter identification) by variational or Bayesian approach; 4. control, optimization and design in computational fluid dynamics possibility under uncertainties.
Reduced-order modeling techniques have undergone fast development during the last decade and become a new frontier in scientific computing. Their increasing popularity is witnessed by many minisymposia at congress and conferences around the world, such as ICIAM, ICOSAHOM, WCCM, SIAM CSE, SIAM UQ, ECCOMAS, ENUMATH. The aim of this minisymposium is to discuss the most recent development of these techniques with emphasis in the field of UQ and CFD and identify new directions and perspectives. For this purpose we have invited 12 speakers with great expertise from several universities around the world, e.g. (MIT, Stanford, Paris VI, EPFL, TU Munich, CAS, Sandia National Laboratories, etc.)

▶ MS-Mo-E-32-1 16:00–16:30

Model Order Reduction for Uncertainty Quantification in Inverse Problems

Chen, Peng ETH Zurich (Swiss Federal Inst. of Tech. in Zurich)

Abstract: We present a computational reduction framework for efficien-

t and accurate solution of Bayesian inverse problems on high- or infinite-dimensional parameter spaces that commonly face the curse of dimensionality and large-scale computation. For the approximation of high or infinite dimensional integration, we take advantage of sparsity in the parametric solution maps in novel dimension-adaptive sparse grid interpolation and quadrature algorithms. For large scale problems, we also exploit intrinsic sparsity in the solution map and the high-fidelity approximation and propose a novel, goal-oriented reduced basis method. (This is a joint work with Christoph Schwab)

▶ MS-Mo-E-32-2 16:30–17:00

A Domain Decomposition Approach for Uncertainty Analysis

Liao, Qifeng — ShanghaiTech Univ.

Abstract: We propose a decomposition approach for uncertainty analysis of systems governed by partial differential equations (PDEs). The system is split into local components using domain decomposition. Our domain-decomposed uncertainty quantification (DDUQ) approach performs uncertainty analysis independently on each local component in an “offline” phase, and then assembles global uncertainty analysis results using pre-computed local information in an “online” phase.

▶ MS-Mo-E-32-3 17:00–17:30

Energy Corrected Schemes in Flow Problems for Optimal Control

Ruede, Ulrich — FA Univ. Erlangen
Wohlmuth, Barbara — Technische Universitaet Muenchen
Pustejovska, Petra — Technische Universitaet Muenchen
John, Lorenz — Technische Universitaet Muenchen

Abstract: Energy corrected schemes compensate the pollution effect for finite element problems where local point singularities otherwise lead to a globally reduced order of convergence. The energy correction recovers the optimal far-field convergence. This is achieved computationally by only a local change of a few coefficients of the standard stiffness matrix, whose structure remains otherwise unchanged. In this reduced order approach, no mesh grading is needed nor explicitly enlarging the the finite element space.

▶ MS-Mo-E-32-4 17:30–18:00

Stabilization and Fine-tuning of Projection-based Reduced Order Models for Compressible Flow via Minimal Subspace Rotation on the Stiefel Manifold

Tezaur, Irina — Sandia national Laboratories
Balajewicz, Maciej — Stanford Univ.

Abstract: For a ROM to be stable and accurate, the dynamics of the truncated subspace must be accounted for. This talk proposes an approach for stabilizing and fine-tuning projection-based fluid ROMs in which truncated modes are accounted for a priori via minimal rotation of the projection subspace. No empirical turbulence modeling terms are required. Mathematically, the approach formulates a quadratic matrix program on the Stiefel manifold. The method is evaluated on incompressible and compressible flow problems.

MS-Mo-E-33 16:00–18:00 406
Random Graphs and Complex Networks - Part II of II

For Part 1, see MS-Mo-D-33

Organizer: Han, Dong — Shanghai Jiao Tong Univ.
Organizer: Wu, Xian Yuan — School of Math. Sci., Capital normal Univ.
Organizer: Zhang, Xiao-Dong — Shanghai Jiao Tong Univ.

Abstract: We focus on the following questions of random graph and complex networks. How to classify the structure of different random growing networks? How do the dynamical processes taking place on a random network shape the network topology? Spectral theory of random graphs. Random matrix and its application. Stochastic processes on random graphs and complex networks.

▶ MS-Mo-E-33-1 16:00–16:30

Asymptotic Behavior for Long-Range Self-Avoiding Walks in High Dimensions

Chen, Lung-Chi — National Chengchi Univ.

Abstract: We consider long-range self-avoiding walk on $\mathbb{Z}^d$ whose 1-step distribution is given by D. Suppose that $D(x)$ decays as $|x|^{-d-\alpha}$ with $\alpha > 2$. The upper-critical dimension d_c is $2(\alpha \wedge 2)$ for self-avoiding walk. Assume certain heat-kernel bounds on the n-step distribution of the underlying random walk. In this talk, I present that the critical two-point function obeys various critical exponents take on their respective mean-field values if the dimension $d > d_c$.

▶ MS-Mo-E-33-2 16:30–17:00

Limiting Spectral Distribution of Random Birth-death Q Matrices

Han, Dong — Shanghai Jiao Tong Univ.
Zhang, Deng — Shanghai Jiao Tong Univ.

Abstract: This article studies the limiting spectral distributions of random birth-death Q matrices. Under the strictly stationary ergodic conditions, we prove that the empirical spectral distribution converges weakly to a non-random probability distribution. Furthermore, in the situations without strictly stationary ergodic conditions, we study a class of random birth-death Q matrices, corresponding to generalizations of the Beta-Hermite ensembles, and establish the existences as well as convolution formulations of their limiting spectral distributions.

▶ MS-Mo-E-33-3 17:00–17:30

Phase Transition on the Degree Sequence of A Random Graph Process with Vertex Copying and Deletion

Dong, Zhao — Acad. of Mathematics & Sys. Sci., CAS

Abstract: This paper focuses on the degree sequence of a random graph process with copying and vertex deletion. A phase transition is revealed as the following: when copying strictly dominates deletion, the model possesses a power law degree sequence; and when deletion strictly dominates copying, it possesses an exponential one; otherwise, the model possesses an intermediate degree distribution. Author: Kai-Yuan Cai, Zhao Dong, Ke Liu, Xian-Yuan Wu,

▶ MS-Mo-E-33-4 17:30–18:00

Interplay between Collective Behavior and Spreading Dynamics on Complex Networks

Fu, Xinchu — Shanghai Univ.

Abstract: Based on the dynamical characteristics and traditional physical models, we construct several new bidirectional network models of spreading phenomena. By theoretical and numerical analysis of these models, we find that the collective behavior can inhibit spreading behavior, but, conversely, this spreading behavior can accelerate collective behavior. The results show that an effective spreading control method is to enhance the individual awareness to collective behavior.

MS-Mo-E-34 16:00–18:10 112
Computational Methods and Applications for the Boltzmann Equations - Part II of II

For Part 1, see MS-Mo-D-34

Organizer: Wang, Yanli — Inst. of Applied Physics & Computational Mathematics

Abstract: The Boltzmann equation is very important in a number of high-tech fields such as the space exploration, plasma and the semiconductor simulations. However, the numerical cost of solving the Boltzmann equation directly in large systems is still unaffordable. The highly efficient numerical solvers are needed to solve this problem. Or, people may build the simplified models instead of directly solving the Boltzmann equation, where the moment method is the main method. The numerical difficulties in different application areas also vary greatly and are always hard to solve. Numerical methods to solve the Boltzmann equation are also widely used in these related application areas.
Recently, the research on direct Boltzmann solvers and moment methods together with their applications are very active. The purpose of this minisymposium is to gather most representative researchers and report their progress. It invites speakers from different parts of the world and provides a good opportunity to exchange ideas.

▶ MS-Mo-E-34-1 16:00–16:30

Direct Modeling for Computational Fluid Dynamics

Xu, Kun — Hong Kong Univ. of Sci. & Tech.

Abstract: Computational fluid dynamics (CFD) studies the flow motion in a discretized space. Its basic scale resolved is the mesh size and time step. The CFD algorithm can be constructed through a direct modeling of flow motion in such a space. This talk will present the principle of direct modeling for the CFD algorithm development, and the construction unified gas-kinetic scheme (UGKS). The UGKS accurately captures the gas evolution from rarefied to continuum flows.

▶ MS-Mo-E-34-2 16:30–17:00

Solution of Canonical Flow Problems Using A Robust Hyperbolic Moment Closure

McDonald, James — Univ. of Ottawa

Abstract: Flows existing at moderate levels of rarefaction are difficult to simulate. Traditional continuum models are physically inaccurate and methods tailored for higher rarefaction, such as particle methods and direct discretizations of the Boltzmann equation, can be prohibitively expensive. Moment closures offer the possibility of efficient and accurate models in the transition regime between continuum and free-molecular flow. This talk explores the predictive capabilities of robust hyperbolic moment closures for canonical transition-regime flow problems.

▶ MS-Mo-E-34-3 17:00–17:30

Moment Closure for Bolzmann Equation Based on Bi-Gaussian Distribution Function

Fan, Yuwei School of Mathematical Sci., Peking Univ.
Ruo, Li Peking Univ.

Abstract: Levermore's maximum entropy offered a landmark moment closure in gaskinetic theory. However, no closed-form expression for the fluxes are available if moments beyond second order. In this talk, a approximation 14 moment closure for the Bolzmann equation are proposed, based on Bi-Gaussian distribution function. The resulting equations not only possess almost all the advantages of maximum entropy, e.g. globally hyperbolic, convex entropy function, smooth shock structure, but also have a closed-form expression for the fluxes.

▶ CP-Mo-E-34-4 17:30–17:50

A New Lattice Boltzman Solver on Unstructured Grid and Study of Its Performance

Zhufu, Xiaohe The Inst. of Software, Chinese Acad. of Sci.
Weishan, Deng Inst. of Software, CAS
Xu, Jin Inst. of Software

Abstract: In this paper, we present a new solver for Lattice Boltzmann Equation (LBE) using Discontinuous Galerkin (DG) method on unstructured grid with nodal basis. The numerical method and parallel model are explained in detail, and benchmark results will be shown. Furthermore, in order to study its performance, another solver for Navier-Stokes (NS) equation using Continuous Galerkin (CG) method has been used for comparison. Similarly, both the numerical method and its parallel model are explained. Same benchmarks and simulations have been used in order to compare them. The advantages and shortcoming of this new slover will be discussed.

▶ CP-Mo-E-34-5 17:50–18:10

Calculations of Strong-Coupled Radiative Transfer Problems in 2D

Shuanggui, Li Institude of Applied Physics & computational mathematics

Abstract: On quadrilateral subcells in an arbitrarily connected grid of polygonal cells, subcell-balance methods methods have been developped for the Sn (discrete ordinate) equations approximation of the linear Boltzmann equations. In this work, we generaliz the simple conner-balance method to solve the nonliear radiative transfer equation and the associated eletron and ion conductive equations. These are integrated into a program architecture which requires zonally averaged quantities, and a subcell-cell temperature mapping method is proposed. Numerical results show the scheme presented is comparative to the diamond scheme in rectangle grid and feasible for transport dominated problems on non-orthogonal meshes such as might be generated by Lagrangian hydrodynamic distortions.

MS-Mo-E-35 16:00–18:10 408

Numerical methods improvements and large-scale computing techniques for electromagnetic simulations in different disciplines - Part II of II

For Part 1, see MS-Mo-D-35

Organizer: Xu, Jin Inst. of Software
Organizer: Liu, Jinjie Delaware State Univ.

Abstract: In order to simulate complicated EM phenomena, such as inhomogeneous medium, curve interface and boundary, complicated BCs, many new techniques need to be developed and old ones be extended, such as DG, Matched Interface and Boundary (MIB) method, high-order algorithms, Method of Moment (MOM), Fast Algorithms, etc. These methods are efficient and powerful in current EM simulations, but there are also many new challenges need to be solve. Therefore, new developments and extensions are needed. Furthermore, in order to use large-scale supercomputers, original algorithms need to be modified and efficient parallel models need to be developed. Combination of above techniques can dramatically improve the capability of electromagnetic simulations. This mini-symposium focuses on these new methods improvements, including high-order methods, algorithms and large-scale computing techniques, which can improve EM simulations dramatically.

▶ MS-Mo-E-35-1 16:00–16:30

Efficient High-Order Algorithms for Solving Drift-Diffusion Systems

HE, YING UC Davis
MIN, MISUN Argonne National Laboratory

Abstract: I will discuss about some recent developments of spectral element method(SEM) for solving the drift-diffusion equations, which have been used a lot in semiconductor device simulation, biological ion channels problems, etc. The drift-diffusion system is a non-linear system, involving the coupling of two transport equations for the carrier concentrations with the Poisson equation for the electric potential. I will present our SEM algorithms and demonstrate the computational results for the study of potassium channel.

▶ MS-Mo-E-35-2 16:30–17:00

FDTD Methods for Complex Media

Liu, Jinjie Delaware State Univ.

Abstract: The Finite-Difference Time-Domain (FDTD) method is a very popular numerical method for solving the Maxwell' s equations of electrodynamics. In this talk, we present some of the recently developed FDTD based methods for problems involving complex media, including the anisotropic media for simulating electromagnetic metamaterial cloaking devices, the magneto-electric material for spacetime cloak, and nonlinear metamaterials for second harmonic generation (SHG).

▶ MS-Mo-E-35-3 17:00–17:30

A RECOVERY BASED LINEAR FINITE ELEMENT METHOD FOR BIHARMONIC PROBLEMS

CHEN, HONGTAO Xiamen Univ.

Abstract: We analyze a gradient recovery based linear finite element method to solve bi-harmonic equations and the corresponding eigenvalue problems. Our method uses only C^0 element, which avoids complicated construction of C^1 elements and nonconforming elements. Optimal error bounds under various Sobolev norms are established. Moreover, after a post-processing the recovered gradient is superconvergent to the exact one. Finally, some numerical experiments are presented to validate our theoretical findings.

▶ CP-Mo-E-35-4 17:30–17:50

Non-overlapping Domain Decomposition Method for Full-wave Simulation

Back, Aurore IECL
Hattori, Takashi IECL,Univ. of Lorraine
Labrunie, Simon Univ. of Lorraine / CNRS / ANR CHROME
Roche, Jean Rodolphe Univ. of Lorraine / CNRS / ANR CHROME
Bertrand, Pierre IJL, Univ. of Lorraine

Abstract: We present a numerical method for the full-wave simulation of electromagnetic wave propagation in magnetized plasmas. A time-harmonic version of the anisotropic Maxwell equations is considered. A non-overlapping domain decomposition method is developed, where a mixed augmented variational formulation is considered to handle a divergence constraint and interface conditions. Well-posedness is proved. The Taylor-Hood finite element is used for numerical discretization. Several examples are presented for different wave frequencies.

▶ CP-Mo-E-35-5 17:50–18:10

Mathematics of the Faraday Cage

Trefethen, Lloyd N. Univ. of Oxford

Abstract: Everybody has heard of the Faraday cage effect, in which a wire mesh does a good job of blocking electric fields. Surely the mathematics of such a famous and useful phenomenon has been long ago worked out and written up in the textbooks?
It seems to be not so. One reason may be that that the effect is not as simple as one might expect: it depends on the wires having finite radius. Nor is it as strong as one might imagine: the shielding improves only linearly as the mesh spacing decreases. Mathematically, the subject is an appealing case study in the behaviour of harmonic functions, with links to Brownian motion and diffusion processes. Physically, Faraday cage shielding can be regarded as a process of electrostatic induction by a surface of limited capacitance. The talk will present results developed jointly with Jon Chapman and Dave Hewett.

MS-Mo-E-36 16:00–18:00 409

Structure-preserving methods for nonlinear Hamiltonian systems II-III

Organizer: Feng, Bao-Feng The Univ. of Texas-Pan American
Organizer: Hu, Xing-Biao Inst. of Computational Mathematics, Chinese Acad. of Sci. (CAS), China
Organizer: Shang, Zaijiu AMSS, CAS
Organizer: Hong, Jialin Inst. of Computational Mathematics, Chinese Acad. of Sci. (CAS)

Abstract: During the last 50 years, there has been a wide interest in the study of nonlinear Hamiltonian systems, especially Hamiltonian PDEs. Among which an important class are integrable, in the sense that they can be solved exactly, admit enough number of conservation laws. On the other hand, there have been major advances in the numerical methods of integrable Hamiltonian systems. Symplectic, multi-symplectic and energy-preserving methods have been popular in simulating these equations. Nevertheless, an important question still deserve to be explored is how to appropriately discretize

nonlinear Hamiltonian systems and to gain a superior performance for long time simulations while keeping their common features as many as possible. The purpose of this organized minisymposium is to bring together researchers from both integrable system and numerical analysis to discuss recent advances on numerical aspects of nonlinear Hamiltonian systems.

▶ MS-Mo-E-36-1 16:00–16:30

Totally Conservative Integrator for Integrable Hamiltonian Systems and Its Generalization to Holonomic Constrained Systems

Minesaki, Yukitaka — Tokushima Bunri Univ.

Abstract: Some holonomic constrained systems have the Hamiltonian, which is the sum of the Hamiltonian of an integrable system, Stäckel system and terms including a Lagrange multiplier and holonomic constraint. Applying canonical transformations and discrete variational derivative and then eliminating the multipliers, we give a new integrator. It can analytically reproduce equilibrium orbits for the N-body problem. As a special case, it accords with the totally conservative integrator retaining all conserved quantities of the Stäckel system.

▶ MS-Mo-E-36-2 16:30–17:00

Integrable Self-adaptive Moving Mesh Methods for A Class of Nonlinear Wave Equations with Hodograph Transformation

Feng, Bao-Feng — The Univ. of Texas-Pan American

Abstract: In the present talk, I will firstly report our recent work on integrable discretizations for a class of soliton equations with hodograph transformations such as the Camassa-Holm, the short-pulse (SP), the reduced Ostrovsky equations. Then, I will show how these integrable discretizations can be successfully used as a self-adaptive moving mesh method for the numerical simulation of these PDEs.
This is a joint work with Dr.Ohta at Kobe University and Dr. Maruno at Waseda University.

▶ MS-Mo-E-36-3 17:00–17:30

Lattice Boussinesq Equation and Convergence Acceleration Algorithms

He, Yi — Wuhan Inst. of Physics & Mathematics, Chinese Acad. of Sci.

Abstract: In this talk, we will give the molecule solution of an equation related to the lattice Boussinesq equation with the help of determinantal identities. It is shown that this equation can for certain sequences be used as a numerical convergence acceleration algorithm. Reciprocally, we will derive a non-autonomous form of the integrable equation related to the lattice Boussinesq equation by a new algebraic method.

▶ MS-Mo-E-36-4 17:30–18:00

SYMPLECTIC INTEGRATORS FOR NONSYMPLECTIC PROBLEMS

Sanz-Serna, J. M. — Universidad Carlos III de Madrid

Abstract: I shall show how symplectic Runge-Kutta and partitioned Runge-Kutta methods appear in a hidden but natural way in a number of areas. These include the computation of sensitivities, automatic differentiation, optimal control, Lagrangian mechanics, etc

MS-Mo-E-37 16:00–18:00 301B

A Statistical perspective of UQ: design, modeling and computations - Part II of III

For Part 1, see MS-Mo-D-37
For Part 3, see MS-Tu-D-37

Organizer: Wu, Jeff — Georgia Inst. of Tech.
Organizer: Woods, David — Univ. of Southampton
Organizer: Xiong, Shifeng — Chinese Acad. of Sci.

Abstract: This minisymposium consists of three sessions. Each co-organizer will organize one session. They will address the three aspects of the title: design, modeling, and computations. The focus will be on these problems from the statistical perspective but will also bring in interface with work in applied mathematics on UQ. In design, both space-filling designs and sparse grids are considered. In modeling, both stochastic kriging and generalized polynomial chaos approximation are considered. Comparisons and contrasts between work in applied math and statistics will be emphasized. Computational challenges for high dimensions and big data are the third theme.

▶ MS-Mo-E-37-1 16:00–16:30

Efficient History Matching and Calibration of Complex Simulators Using Bayesian Optimization

Wilkinson, Richard — Univ. of Nottingham

Abstract: Gaussian process emulation is one of the key tools used for parameter estimation (calibration) when the simulator is computationally expensive. Design of the simulator ensemble used to build the emulator is critical for obtaining accurate results while minimizing cost.
I will describe how Bayesian optimization can be used to build a design that minimizes the entropy in the results. This approach can be used for history matching or calibration, and for stochastic or deterministic simulators.

▶ MS-Mo-E-37-2 16:30–17:00

Advanced Emulation of A Tsunami Simulator

Beck, Joakim — Univ. College London
Guillas, Serge — UCL

Abstract: Earthquake generated tsunamis can occur in the Cascadia subduction zone (Pacific Northwest). Numerical simulation of tsunami wave propagation is used to forecast run-ups at the coast. The earthquake source represents the largest uncertainty. Gaussian process (GP) emulation is used to propagate these uncertainties. We introduce a joint sequential variable screening and design to reduce computational cost. A mixture of GPs is employed to capture non-stationarity.

▶ MS-Mo-E-37-3 17:00–17:30

Stochastic Polynomial Interpolation for Uncertainty Quantification with Computer Experiments

Tan, Matthias — City Univ. of Hong Kong

Abstract: Multivariate polynomial metamodels are widely used for uncertainty quantification due to the development of polynomial chaos methods and stochastic collocation. However, these metamodels only provide point predictions. There is no known method that can quantify interpolation error probabilistically and design interpolation points using available data to reduce the error. We shall introduce the stochastic interpolating polynomial model, which overcomes these problems. A Bayesian approach that quantifies interpolation uncertainty through the posterior distribution of the output.

▶ MS-Mo-E-37-4 17:30–18:00

Optimization of Computer Experiments with Tunable Accuracy

He, Xu — Chinese Acad. of Sci.

Abstract: This talk addresses the problem of kriging-based optimization for deterministic computer experiments with tunable accuracy. Our approach is to use multi-fidelity computer experiments with increasing accuracy levels and a nonstationary Gaussian process model. We propose an optimization scheme that sequentially add new computer runs by following two criteria. The first criterion scores candidate inputs with given level of accuracy, and the second criterion scores candidate combination of inputs and accuracy.

MS-Mo-E-38 16:00–18:00 302A

Minisymposium on Statistical Inference for Constrained Stochastic Dynamical Systems - Part II of II

For Part 1, see MS-Mo-D-38

Organizer: Rempala, Grzegorz — The Ohio State Univ.
Organizer: Kurtek, Sebastian — The Ohio State Univ.

Abstract: With the advent of new data capturing technologies in imaging, genomics, and environmental science, the math modeling community is increasingly facing the challenging issues of proper statistical inference for constrained stochastic dynamical systems. Some typical problems are: models identifiability conditions, methods for combining noisy dynamic observations from multiple scales or technologies, robustness and dimension reduction, quantification of model uncertainty. Since many of the underlying problems cannot be solved analytically, the issues of computational algorithms and practical simulation based inference is also very relevant and requires some theoretical framework. The minisymposium will consist of 2 blocks of 4 presentations each.

▶ MS-Mo-E-38-1 16:00–16:30

Piecewise Approaches to Estimating Dynamical Systems

Preston, Simon — Univ. of Nottingham

Abstract: I will discuss ways in which a piecewise approach for estimation of model parameters can be helpful. "Piecewise" means considering subsets of the data separately, doing estimation for each subset, then combining the results. I will focus on describing a piecewise version of "approximate Bayesian computation" (ABC), which benefits from advantages of ABC (not needing an explicit expression for the likelihood) but side-steps some difficulties (the need to choose an appropriate distance metrics and tolerances).

▶ MS-Mo-E-38-2 16:30–17:00

Asymptotic Inference for Tree-structured Data

Bharath, Karthik — Univ. of Nottingham

Abstract: Based on the continuum limit, the Continuum Random Tree (CRT), of a certain model for trees introduced by Aldous, we propose an inferential framework for large tree-structured data. The relationship between the CRT

and the standard Brownian excursion is utilised to construct goodness-of-fit tests. Asymptotic properties of the tests are examined and their performance is assessed on a task of comparing tumour images which allow for tree-like representations.

▶ MS-Mo-E-38-3 17:00–17:30

Inference and Experimental Design for Models of Biochemical Dynamics

Komorowski, Michal Polish Acad. of Sci.

Abstract: Dynamical models in quantitative biology are characterised by more complex structures and substantially larger sets of parameters than models used in physics and engineering. Viable methods of inference and experimental design should be therefore adapted to specificity of these models. In my talk I will present a framework capable of parameter inference and experimental design for, both noisy and complex, systems of biochemical dynamics.

▶ MS-Mo-E-38-4 17:30–18:00

Stochastic Dynamics on Large Contact Networks

Rempala, Grzegorz The Ohio State Univ.

Abstract: We develop a general framework for analyzing dynamics of certain classes of contact processes on random (configuration model) graphs with given degree distributions. The work is motivated by the need for a realistic but also mathematically tractable and statistically predictive dynamic model of the recent Ebola epidemic. We expand the traditional model of an SIR stochastic epidemic on a graph by including heterogenous contact and infectivity structure to account for the disease-specific features.

MS-Mo-E-39 16:00–18:00 302B

Recent advances on inverse scattering problems - Part II of III

For Part 1, see MS-Mo-D-39
For Part 3, see MS-Tu-D-39

Organizer: Liu, Xiaodong Inst. of Applied Mathematics, Chinese Acad. of Sci.
Organizer: Liu, Hongyu Hong Kong Baptist Unversity
Organizer: Zhang, Bo Acad. of Mathematics & Sys. Sci., CAS

Abstract: The minisymposium intends to bring together leading experts working on inverse scattering problems and their applications to discuss recent advances and new challenges in this fascinating field.

▶ MS-Mo-E-39-1 16:00–16:30

Inverse Scattering for Rough Surfaces with Tapered Wave Incidence

Lei, Zhang Heilongjiang Univ.; Zhejiang Univ.

Abstract: The study of Inverse scattering for rough surfaces has been the subject of intensive investigation for its application in a number of important research fields, such as remote sensing, target recgnition, surface optics, as well as semiconductor physics. Here we consider the Inverse scattering for rough surfaces with tapered wave Incidence, some theorical and numerical results are given.

▶ MS-Mo-E-39-2 16:30–17:00

C0IPG Error Analysis for Transmission Eigenvalue Problem

Ji, Xia chinese Acad. of Sci.

Abstract: We consider a non self-adjoint fourth eigenvlaue problem and use the Discontinuous Galerkin (DG) methods to compute it. For the fourth order problem, DG methods are competitive since they have less degrees of freedom and simper than the other classical finite element methods. We propose an interior penalty discontinuous Galerkin method using C0 Lagrange elements (C0IPG) and study its theoretical error estimate. Moreover, the optimal convergence is obtained.

▶ MS-Mo-E-39-3 17:00–17:30

Inverse Scattering from Extended Sources

Rundell, William Texas A&M Univ.

Abstract: We look at classical inverse acoustic scattering based on the non-homogeneous Helmholtz equation where one seeks to recover the location and shape of an extended source f from measurements of far (or near) field data. We will look at two very different algorithms, one using only a single frequency incident field, the other where we have multifrequency information.

▶ MS-Mo-E-39-4 17:30–18:00

A Recursive Algorithm for Multi-frequency Acoustic Inverse Source Problems

Lu, Shuai School of Mathematical Sci., Fudan Univ.
Bao, Gang Zhejiang Univ.
Rundell, William Texas A&M Univ.

Abstract: An iterative/recursive algorithm is studied for recovering unknown sources of acoustic field with multi-frequency measurement data. Under additional regularity assumptions on source functions, the first convergence result towards multi-frequency inverse source problems is obtained by assuming the background medium is homogeneous and the measurement data is noise-free. Error estimates are also provided when the observation data is contaminated by noise. Numerical examples verify the reliability and efficiency of our proposed algorithm.

MS-Mo-E-40 16:00–18:30 303A

Extreme Behavior in Flow Models: Analysis and Computations

Organizer: Protas, Bartosz McMaster Univ.
Organizer: Takashi, Sakajo Kyoto Univ.

Abstract: The minisymposium has for its objective to explore from the computational perspective extreme, and possibly singular, behavior in various PDE models of fluid flows. Such questions are motivated by the "blow-up" problem for the 3D Navier-Stokes system which is one of open problems in mathematics. In addition to the Navier-Stokes and Euler systems, the symposium will cover other simplified model problems in 1D and 2D, as well as vortex models, focusing on the interplay between mathematical analysis and careful numerical computations. Specific topics to be discussed include analytical and numerical criteria for blow-up, choice of initial data and simulation strategies.

▶ MS-Mo-E-40-1 16:00–16:30

Extreme Vortex States and the Hydrodynamic Blow-Up Problem

Protas, Bartosz McMaster Univ.

Abstract: We will discuss our research program concerning a systematic search for extreme events in viscous incompressible flows. It is motivated by questions related to singularity formation in the 3D Navier-Stokes system and other hydrodynamic models. We will demonstrate how new insights concerning extreme behavior in such models can be obtained by formulating these questions in terms of variational PDE optimization problems which can be solved computationally using discrete gradient flows. [Joint work with Diego Ayala]

▶ MS-Mo-E-40-2 16:30–17:00

On the Generalized Non-viscous/viscous DeGregorio Equation - Singular Solutions and Statistical Properties

Takashi, Sakajo Kyoto Univ.

Abstract: The generalized DeGregorio equation is a 1D model of the 3D Euler equations and Navier-Stokes equations. This equation is obtained by adding an advection term and the viscous dissipation term to the Constantin-Lax-Majda equation. In this talk, I am concerned with the relation between singular blow-up solutions to the for non-viscous equation as well as a "turbulent" statistical properties of solutions to the equation with small viscosity.

▶ MS-Mo-E-40-3 17:00–17:30

Assessing Late-time Singular Behaviour in Symmetry-plane Models of 3D Euler Flow

Bustamante, Miguel Univ. College Dublin

Abstract: We introduce a one-parameter family of models of the 3D-Euler fluid equations on a 2D symmetry plane, which provide a collection of blowup scenarios admitting analytical solutions. We exploit these features to validate a novel finite-time blowup assessment method in numerical simulations: the mapping to regular systems. We show a 3-order-of-magnitude accuracy increase on the measured singularity time when employing the mapping, with negligible computational expense. Relevant blowup quantities include vortex-stretching rate and analyticity-strip width.

▶ MS-Mo-E-40-4 17:30–18:00

Burgers Vortex System and Hermite Polynomials

Kimura, Yoshifumi Graduate School of Mathematics, Nagoya Univ.

Abstract: The Burgers vortex is well-known as a steady exact solution of the Navier-Stokes equation which is often used as a model for vortex motion in turbulence. In this talk, we extend this solution first to a time dependent problem, and then to the motion of a group of gaussian vortices. It will be shown that the solution for the latter problem is written with the superposition of Hermite polynomials.

▶ MS-Mo-E-40-5 18:00–18:30

Computer-assisted Proofs in Incompressible Fluids

Gomez-Serrano, Javier Princeton Univ.

Abstract: In this talk I will discuss how, guided by numerical simulations, one can accomplish to produce completely rigorous, computer-assisted theorems in problems related to fluid mechanics using interval arithmetics. Specifically, I will talk about the Muskat and the vortex patch (and its generalization known as the alpha-patch) problems. The talk is based in joint work with Angel Castro, Diego Cordoba, Rafael Granero-Belinchon and Alberto Martin Zamora.

IM-Mo-E-41 16:00–18:00 303B

Mathematical Techniques in the Analysis of Petroleum Industry Problems

Organizer: Carvalho, Luiz Mariano — Rio de Janeiro State Univ.
Organizer: Barichello, Liliane — UFRGS
Organizer: Benzi, Michele — Emory Univ.
Organizer: Rodrigues, Jose — Petrobras R&D Center

Abstract: The discovery of pre-salt oil reservoirs in 2006 under the Brazilian seabed gave rise to an important impulse in the collaboration between universities and Petrobras, the leading Brazilian oil company, and the main responsible for the pre-salt exploitation. This industrial minisymposium aims to present some results of this cooperation, a joint effort of researchers from academy and industry.

The drilling of wells in the pre-salt layer is radically different from the usual one through other rock layers of the post-salt regions. Therefore, the usual mathematical models describing the latter area are hardly applicable to the pre-salt layers.

The first panel debates a deterministic nuclear modeling of well logging. This work was partially supported by Petrobras (MSc. Daniella Schulz: she received a Petrobras fellowship). They discuss nuclear measurement techniques used to understand responses of the related logging tools. They present semi-analytical methods to deterministic approaches in the modeling of particle transport in well logging problems. In particular, the adjoint transport equation is explored to estimate source-detector measurements.

The second contribution addresses new mathematical models of salt migration in viscoelastic solid bodies. This is a joint work between a group in the Institute of Mathematics of the Federal University of Rio de Janeiro (UFRJ) and the Petrobras R&D Center (CENPES). They propose a Lagrangian formulation relative to a finitely deformed state, so that the problem of large deformation can be treated with a method of successive linear approximations. The existence and uniqueness of weak solutions are analyzed, and numerical simulations are presented.

To deal with the pre-salt exploitation complexity, new reservoir simulators have been developed. The new softwares treat reservoir, wells, networks, and production constraints as a whole. The solvers are still the main computational kernels; however, the linear systems are bigger and challenging, demanding parallel preconditioners and relying on hybrid parallel technologies.

The third talk presents a joint work of researchers from Brazilian universities (UFRJ and UERJ) and CENPES. The authors combine domain decomposition ideas with incomplete factorizations at subdomain level. They introduce an ILU(k)-based two-level domain decomposition preconditioner and compare its performance with a two-level ILU(k)-Block-Jacobi preconditioner.

The fourth talk presents a joint work of researchers from Brazilian universities (UFRJ, UFC, and UERJ), an American university (Emory), and CENPES. The authors address parallel preconditioners which compute an explicit sparse approximate inverse whose application only require sparse matrix vector multiplications. They present an extensive set of test problems from scientific and industrial applications associated to oil reservoir simulation.

The organizers of this minisymposium are members, amongst others, of the following societies: SIAM (Prof. Michele Benzi: he has an extensive history of SIAM service, including two terms on the Council), SBMAC (Prof. Liliane Barichello: she is vice-president of SBMAC, Brazil), and AMS. The authors are members of those societies, and others as SBM, ACM, and SBC, and they develop their researches in the academy and in the oil industry.

▶ IM-Mo-E-41-1 16:00–16:30

Two-level Parallel Preconditioners for Reservoir Simulation Problems

Carvalho, Luiz Mariano — Rio de Janeiro State Univ.
Rodrigues, Jose — Petrobras R&D Center
Goldfeld, Paulo — Universidade Federal do Rio de Janeiro
Nievinski Lima, Italo — Rio de Janeiro State Univ.
Augusto, Douglas — Federal Univ. of Rio de Janeiro
Maculan, Nelson — Federal Univ. of Rio de Janeiro

Abstract: With the ultimate goal of designing a scalable parallel preconditioner for reservoir simulation problems, we combine domain decomposition ideas (prove suitable for parallelization) with incomplete factorizations (which are standard in reservoir simulation) at subdomain level. We introduce an ILU(k)-based two-level domain decomposition preconditioner and compare its performance with a two-level ILU(k)-Block-Jacobi preconditioner.

▶ IM-Mo-E-41-2 16:30–17:00

Approximate Inverses Preconditioners for Petroleum Reservoir Simulation

SOUZA, MICHAEL — Federal Univ. of Ceara
Benzi, Michele — Emory Univ.
Zanardi, Joao Paulo — State Univ. of Rio de Janeiro
Portella, Felipe — Petrobras
Estrela, Daniel — Rio de Janeiro State Univ. (UERJ)
François, Jean Philippe — Petrobras
Figueirôa Goldstein, Brunno — Federal Univ. of Rio de Janeiro (UFRJ)

Abstract: A parallel implementation of the preconditioner AINV for the solution of general sparse linear systems of equations is presented. This preconditioner computes an explicit sparse approximate inverse whose application just requires matvec operations. This feature is appropriate for the parallel hybrid architectures. An extensive set of test problems from scientific and industrial applications associated to oil reservoir simulation provides evidence of the effectiveness of the proposed implementation. MATLAB and PETSc interfaces are also provided.

▶ IM-Mo-E-41-3 17:00–17:30

Deterministic Nuclear Modeling of Well Logging

Barichello, Liliane — UFRGS
Pazinatto, Cassio — Universidade Federal do Rio Grande do Sul
Schulz, Daniella Machado — Universidade Federal do Rio Grande do Sul
Da Cunha, Rudnei — Universidade Federal do Rio Grande do Sul
Barros, Ricardo — Universidade do Estado do Rio de Janeiro

Abstract: Nuclear measurement techniques have played a relevant role in dealing with problems as hydrocarbon exploration. The key to understanding the responses of the related logging tools are gamma rays and neutron transport. In this work we discuss semi-analytical methods to deterministic approaches in the modeling of particle transport in well logging problems. In particular, the adjoint transport equation is explored to estimate source-detector measurements.

▶ IM-Mo-E-41-4 17:30–18:00

Mathematical Model of Large Deformation in Viscoelastic Solid Bodies for Salt Migration

CIPOLATTI, ROLCI — Universidade Federal do Rio de Janeiro
LIU, I Shih — Universidade Federal do Rio de Janeiro
RINCON, MAURO — Universidade Federal do Rio de Janeiro
Palermo, Luiz A. C. — CENPES/Petrobras

Abstract: We consider a mathematical model for large deformation in viscoelastic solids for the problem of salt migration in geomechanics. We propose a Lagrangian formulation relative to a finitely deformed state, so that the problem of large deformation can be treated with a method of successive linear approximation. The existence and uniqueness of weak solutions are analyzed, and numerical simulations for salt migration have been successfully compared with the formation of salt dome in petroleum industry.

MS-Mo-E-42 16:00–18:30 301A

Characterizing complex networks through dynamics

Organizer: Miura, Keiji — Kwansei Gakuin Univ.
Organizer: Hasegawa, Takehisa — Ibaraki Univ.

Abstract: The goal of this session is to provide panoramic viewpoints on analyses of complex networks in the real world. Here we focus on the dynamics on the complex networks as latest advances. The topics include percolation, statistical mechanics, evolving neural networks, Hodge-Kodaira decomposition and temporal networks.

▶ MS-Mo-E-42-1 16:00–16:30

Recent Problems of Network Science

Hasegawa, Takehisa — Ibaraki Univ.

Abstract: Networks in real world have complex connectivities. The structure and dynamics in complex networks has been extensively studied, by extending/applying concepts of the statistical physics and mathematics, over the last dozen or so years. I briefly introduce recent topics of network science, which will be discussed in this session.

▶ MS-Mo-E-42-2 16:30–17:00

Scaling of Hodge-Kodaira Decomposition Distinguishes Learning Rules of Neural Networks

Miura, Keiji — Kwansei Gakuin Univ.
Aoki, Takaaki — Kagawa Univ.

Abstract: We applied the Hodge-Kodaira decomposition, a topological method to count global loops, to neural networks with different learning rules and edge densities. Interestingly, the networks which evolved under different learning rules showed different scalings with edge densities. The causal learning rule scaled similarly to its underlying graph (i.e. Erd ̋os-R ́enyi random graph, in this study), on which a network can grow, while the Hebbian-like rule did not.

▶ MS-Mo-E-42-3 17:00–17:30

Network Organization as A Dynamical System

Aoki, Takaaki — Kagawa Univ.

Abstract: Real-world networks continuously change to meet the evolving needs of society. To manage such dynamic networks, we studied an adaptive network model, combining the dynamics of a resource carried by random walkers and resource-regulated weighted connections. Under suitable conditions, the resource and the weights converged to power-law distributions, while they microscopically continued to change. We analyzed the equilibrium states from perspective of the dynamical system and found that the system has multi-stability including chaotic states.

▶MS-Mo-E-42-4 17:30–18:00

Phase Behavior of Bond Percolation on Hierarchical Small-world Networks

Nogawa, Tomoaki — Toho Univ.

Abstract: Cooperative systems on some small-world networks exhibit phase behavior that is essentially different from that of finite-dimensional systems. Remarkably, a number of systems show critical phases, i.e., the systems show the behavior that is observed at critical points of second-order transitions in a finite range of the control parameters. We discuss the nature of the phase and the phase transitions of percolation on a family of hierarchical small-world networks based on the renormalization-group analysis.

▶MS-Mo-E-42-5 18:00–18:30

Mining Temporal Patterns in Time-varying Social Networks

Takaguchi, Taro — National Inst. of Informatics

Abstract: Social networks are essentially temporal; the web of social interactions varies its form over time at all time scales from seconds to years. Such temporal patterns have considerable impact on dynamical processes such as disease spreading and information propagation. Digital logs of social interactions in online and offline settings unveil universal temporal patterns, such as heterogeneity in interevent times. In this talk, recent advances in social temporal network analysis will be reviewed and summarized.

MS-Mo-E-43 16:00–18:00 VIP4-1

Game-theoretic Models of Marketing Decisions in Supply Chains

Organizer: Aust, Gerhard — TU Dresden

Organizer: Xie, Jinxing — Tsinghua Univ

Abstract: The coordination of decisions in supply chains is a popular topic in operations research, whose complexity arises from the individual objectives of the different companies involved on the one hand, but also from interdependencies between their strategies on the other hand. These characteristics turn game theory into an appropriate solution approach, as it allows analyzing the strategic decision-making of individuals under different frameworks like, for instance, power imbalance within the supply chain. This symposium shall be dedicated especially to the game-theoretic analysis of marketing decisions, which are used to influence consumer demand including, but not limited to pricing and advertising.

▶MS-Mo-E-43-1 16:00–16:30

Game-theoretic Models of Marketing Decisions in Supply Chains

Aust, Gerhard — TU Dresden

Abstract: This talk shall give an overview on the application of game-theoretic models to analyze the behavior of supply chain members. As decisions in supply chains are highly interdependent and often impact the profit of the remaining echelons, game theory has proven to be an adequate instrument to determine the companies' best strategies. Special focus will be given to decision related to marketing like pricing, advertising, etc., as these activities are used to influence consumer demand.

▶MS-Mo-E-43-2 16:30–17:00

Benefits of Bilateral Participation in Cooperative Advertising

Xie, Jinxing — Tsinghua Univ

Abstract: We propose a bilateral participation co-op advertisement system for a one-manufacturer/ multi-retailer distribution channel, where the manufacturer's national advertising expense is shared by the retailers. We show that the bilateral participation system is capable of coordinating the distribution channel under a very general channel structure and sales response function and can lead to a Pareto improvement over any unilateral participation system.

▶MS-Mo-E-43-3 17:00–17:30

A Newsvendor Model with Strategic Voting Consumers

Qinglong, Gou — Univ. of Sci. & Tech. of China

Zhang, Juzhi — Univ. of Sci. & Tech. of China

Abstract: We propose the concept of strategic voting consumers as an extension of strategic consumers and apply it in a newsvendor model to investigate its impact on supply chain decisions. Results show that: (i) strategic voting consumer will reduce the newsvendor seller's retail price and its order quantity significantly; and (ii) the wholesale price and markdown money contracts cannot coordinate the supply chain under some certain conditions.

▶MS-Mo-E-43-4 17:30–18:00

Cooperation Advertising Strategy in A Dual Channel Supply Chain with A Risk-averse Retailer

Li, Bo — Tianjin Univ.

Hou, Peng-wen — Tianjin Univ.

Abstract: This paper considers a dual-channel supply chain with a manufacturer and a retailer. The retailer with risk aversion adopts advertising strategy and the manufacturer may either choose co-op advertising strategy or not. A Stackelberg game model is established and the equilibrium solutions are given.We find that co-op advertising strategy can increase the performance of the supply chain. But, both don't always benefit from the strategy and their decisons are related to the advertising cost coefficient.

MS-Mo-E-44 16:00–18:10 VIP2-1

Sparse Recovery of High-dimensional Data

Organizer: Wang, Chuan-Long — Taiyuan normal Univ.

Organizer: Chen, Di-Rong — Wuhan Textile Univ., Beijing Univ. of Aeronautics & Astronautics

Abstract: The minisymposium will provide a forum for the exchange of expertise, experience and insights among world leaders and young researchers who are active in the area of sparse recovery of high-dimensional data and related fields. It is envisaged that this minisymposium will stimulate further research, and act as a vehicle to promote this important field

▶MS-Mo-E-44-1 16:00–16:30

The Exact Recovery of Sparse Signals via Orthogonal Matching Pursuit

Liao, Anping — Hunan Univ.

Xie, Jiaxin — Hunan Univ.

Yang, Xiaobo — Hunan Univ.

Cheng, Liang — Hunan Univ.

Abstract: In this paper, some sufficient conditions for the exact recovery of sparse signals via orthogonal matching pursuit(OMP) are investigated. Some conditions under which all k-sparse signals or the support of the k-sparse signals can be exactly recovered via the OMP algorithm are presented. Because the computation of the condition is typically difficult, a new computable condition is presented, under the condition all k-sparse signals can be recovered exactly through the OMP algorithm.

▶MS-Mo-E-44-2 16:30–17:00

Directional Complex Wavelet Tight Framelets with Applications to Image Processing

Han, Bin — Univ. of Alberta

Abstract: Separable wavelets are known to have some shortcomings limiting full potential of wavelet-based applications. We discuss recent exciting developments on directional tensor product complex tight framelets (TP-CTFs). For image/video denoising/inpainting, we show that TP-CTFs have superior performance compared with current state-of-the-art methods. Such TP-CTFs inherit almost all the advantages of traditional wavelets but with directionality for capturing edges, enjoy desired features of DCT for capturing oscillating textures, and are computationally efficient.

▶MS-Mo-E-44-3 17:00–17:30

Sparse Recovery with Frame Representation

Song, Li — zhejiang Univ.

Abstract: In this talk, i shall introduce some new results on sparse recovery under frame representation from the point of views of approximation theory. In particular, we will focus on rewiewing our joint works with Dr.Lin ,Dr. Zhang and Dr.Xia.

▶CP-Mo-E-44-4 17:30–17:50

Numerical Algorithm and Its Revision for Solving A Class of Nonsingular Integro-Differential Equations of the First Kind

Chiang, Shihchung — Chung Hua Univ.

Abstract: This study presents a numerical algorithm for solving a class of integro-differential equations of the first kind. This class of equations consists of an integro-differential term containing an Abel-type nonsingular kernel. The first kind equations with a weakly singular kernel originated from an aeroelasticity problem. In the present study, the authors obtained satisfactory results after applying a previous version of the algorithm for singular equations, and obtained superior results by revising the numerical algorithm and the corresponding nonsingular equations. The authors propose numerical algorithms that do not involve transforming the original equation into the corresponding Volterra equation, but still facilitate determining the numerical solution of the original equation. In addition, the feasibility of the proposed numerical algorithm is also demonstrated by applying it to examples in which both the CPU times and maximum errors compared with exact solutions are shown.

▶CP-Mo-E-44-5 17:50–18:10

Numerical Simulation of the Weissenberg Effect: Some Numerical Experiments

Cuminato, Jose Alberto São Paulo Univ.
Oishi, Cassio UNESP - Sao Paulo State Univ.
Figueiredo, Rafael Univ. of São Paulo (USP)

Abstract: The Weissenberg effect is encountered in many industrial applications involving mixing processes. In this experiment a rotating rod is inserted into a container filled with a viscoelastic fluid. The behavior of the fluid is striking; it moves in the opposite direction of the centrifugal force and climbs up the rod. This effect has been experimentally reproduced by many researchers. However, there are few numerical works dealing with a rigorous study of this effect. One of the main challenges of this simulation is to provide numerical methods which achieve high elasticity rate and that represent the correct shape of the free surface. In this work a finite difference scheme is presented which is based on the projection method. The conformation tensor is employed to solve the viscoelastic model. The interface between the fluids is modelled by ELVIRA. We shall present simulations of the Weissenberg effect for the Oldroyd-B model.

MS-Mo-E-45 16:00–18:00 213A

Triangular decomposition of polynomial systems: solvers and applications - Part II of IV

For Part 1, see MS-Mo-D-45
For Part 3, see MS-Tu-D-45
For Part 4, see MS-Tu-E-45

Organizer: Moreno Maza, Marc The Univ. of Western Ontario
Organizer: Chen, Changbo Chinese Acad. of Sci.

Abstract: The Characteristic Set Method of Wen Tsun Wu has freed Ritt's decomposition from polynomial factorization, opening the door to a variety of discoveries in polynomial system solving. In the past three decades the work of Wu has been extended to more powerful decomposition algorithms and applied to different types of polynomial systems or decompositions: differential systems, difference systems, real parametric systems, primary decomposition, cylindrical algebraic decomposition. Today, triangular decomposition algorithms provide back-engines for computer algebra system front-end solvers, such as Maple's solve command and have been applied in various areas both in the academia and in the industry.
In this proposed workshop, we hope to gather researchers who have applied and extended the works Joseph Fels Ritt and Wen Tsun Wu. Our goals are, first, to disseminate the techniques and software tools which have been developed by this vibrant community and, second, to stimulate further developments and applications of polynomial system decomposition by means of characteristic sets.
At the International Congress on Mathematical Software (ICMS 2014), a satellite conference of the International Congress on Mathematics, in Seoul (South Korea), a session on the same topics as the proposed one had gathered 9 talks, see `http://www.csd.uwo.ca/~moreno/ICMS_Triangular_Decomposition_Session.html`
About another 30 researchers had expressed interest in participating to this session but were not able to do so at that time the year or in that location. Moreover, three other sessions of ICMS 2014 had talks on this subject of polynomial system decomposition by means of characteristic sets.
In a sum, the proposed workshop for ICIAM 2015 is expected to be well attended and to generate rich interactions. At the same time, the available software such as the RegularChains library (see http://www.regularchains.org) will support software demonstration of the applications of the Characteristic Set Method.

▶MS-Mo-E-45-1 16:00–16:30

Qualitative Analysis of Biological and Control Systems Using Algebraic Methods

Niu, Wei Beihang Univ.

Abstract: This talk is concerning on qualitative analysis of biological and control systems, modeled as systems of differential or difference equations, using algebraic methods. We will explain how to study the problems of detecting steady states, analyzing stability and different kinds of bifurcations, and constructing limit cycles for both continuous and discrete biological models. A systematic account of our investigations on these problems is provided.

▶MS-Mo-E-45-2 16:30–17:00

Computing the Decomposition Group of A Triangular Ideal by Using Elimination Methods

Yongbin, Li School of Mathematical Sci.,Univ. of Electronic Sci. & Tech. of China

Abstract: Given an ideal generated by a triangular set of multivariate polynomials, we present an alternitative method for computing the decomposition group of the triangular ideal using elimination methods.

▶MS-Mo-E-45-3 17:00–17:30

Solving Parametric Polynomial Optimization by Triangular Decomposition

Chen, Changbo Chinese Acad. of Sci.
Moreno Maza, Marc The Univ. of Western Ontario

Abstract: In this talk, we present two methods for solving parametric polynomial optimization: (1) a general method by means of cylindrical algebraic decomposition based on triangular decomposition; (2) a generic approach based on real comprehensive triangular decomposition. The motivation of this work is to solve optimization problems arising in model predictive control, where many on-line optimization problems can be reduced to a single parametric optimization problem to be solved in the off-line phase.

▶MS-Mo-E-45-4 17:30–18:00

DISCOVERING MULTIPLE LYAPUNOV FUNCTIONS FOR SWITCHED HYBRID SYSTEMS

She, Zhikun Beihang Univ.

Abstract: In this paper we analyze local asymptotic stability of switched hybrid systems, whose subsystems have polynomial vector fields, by discovering multiple Lyapunov functions in quadratic forms. We start with an algebraizable sufficient condition for the existence of quadratic multiple Lyapunov functions. Then, we apply real root classification together with a projection operator to obtain a multiple Lyapunov function. Finally, we test our approach on some examples using a prototypical implementation.

MS-Mo-E-46 16:00–18:00 306B

Attenuation and Dispersion in Photoacoustic Imaging - Part II of II

For Part 1, see MS-Mo-D-46

Organizer: Shi, Cong Univ. of Vienna
Organizer: Ammari, Habib Ecole Normale Superieure

Abstract: Photoacoustic Imaging is a promising imaging method that visualizes biological material parameters. In a typical PAT session, the object is exposed to a short pulse of an electromagnetic wave. The object absorbs a fraction of the induced energy, heats up, and reacts with thermoelastic expansion. This in turn produces acoustic waves, which can be recorded outside the specimen. The mathematical formulation of PAT is an inverse problem related to the wave equation - to reconstruct the source term of the wave equation from measurements of the acoustic wave. PAT combines the high resolution of ultrasound waves and high contrast of EM waves.
The classical mathematical models of PAT ignore the attenuation effects and dispersion within the object, which leads to inaccurate images. There are two main challenges in the topic: one is to model the attenuation effect mathematically, the other is to compensate for the effect in image reconstruction. To correctly model the attenuation effect in a given media, we need to investigate the relation between attenuation, dispersion, and causality. It is known that attenuation and dispersion are connected by the Kramers-Kronig relation. Several attenuation models are documented in the literature, and most of them are derived from power laws. On the other hand, the research on compensation for the attenuation effect has only begun recently, and much remains to be done on both of the problems. This minisymposium focuses on recent advances in this field.

▶MS-Mo-E-46-1 16:00–16:30

Analysis of the Attenuated Wave Equation in Photoacoustic Imaging

Shi, Cong Univ. of Vienna

Abstract: In this talk, we will investigate the degree of ill-posedness for the PAT inverse problem with attenuation. We define two cases of attenuation, called "strong" and "weak". Most classical attenuation models belong to the "strong attenuation" category, and we can prove that the inversion of such models is severely ill-posed. In contrast, in the "weak attenuation" case, we have proved that the inverse problem is mildly ill-posed. This helps with the selection of attenuation models.

▶MS-Mo-E-46-2 16:30–17:00

Combining Photoacoustic and Optical Coherence Tomography

Elbau, Peter Univ. of Vienna

Abstract: Since a quantitative reconstruction for photoacoustic imaging typically relies on some knowledge of the electromagnetic field around the object,

we want to propagate the idea to supplement the photoacoustic measurement with an optical coherence tomography measurement. As both methods give information about the light propagation in the medium, photoacoustics involving mainly the absorption, optical coherence tomography mainly the scattering properties, they perfectly complement each and thus make a quantitative reconstruction possible.

▶ CP-Mo-E-46-3 17:00–17:20

Synchrosqueezed Transform and Variational Method for Crystal Image Analysis

Yang, Haizhao — Stanford Univ.
Lu, Jianfeng — Duke Univ.
Wirth, Benedikt — Univ. of Munster
YING, LEXING — Stanford Univ.

Abstract: We propose an efficient two-step method for crystal image analysis. In the first step, a 2D synchrosqueezed transform (SST) is applied to extract mesoscopic and microscopic information from atomic crystal images. This method analyzes atomic crystal images as superpositions of non-linear wave-like components. In particular, crystal defects are interpreted as the irregularity of local energy of the SST; crystal rotations are described as the angle deviation of local wave vectors from their references; the gradient of a crystal elastic deformation can be obtained by a linear system generated by local wave vectors. In the second step, a variational model based on the physical understanding of the crystal elastic deformation is proposed to optimize the initial information in the first step. Several numerical examples of synthetic and real crystal images are provided to illustrate the efficiency, robustness, and reliability of our methods.

MS-Mo-E-47 16:00–18:00 108

Analytical and algorithmic advances in the immersed boundary method - Part II of II

For Part 1, see MS-Mo-D-47

Organizer: Stockie, John — Simon Fraser Univ.
Organizer: Lai, Ming-Chih — National Chiao Tung Univ.

Abstract: The immersed boundary method is a well-known approach for modelling fluid- structure interaction (FSI) problems involving highly deformable elastic structures. Applications include a wide range of biofluid mechanical systems and the method is increasingly being applied to engineering problems as well. Recently, major advances have been achieved in algorithms (fast and robust solvers), theoretical results (convergence and stability analyses) and model extensions intended to capture a wider spectrum of FSI phenomena (multiphase flows, membrane transport, stochastic effects). This minisymposium will highlight these recent advances and survey some of the complex fluid flows that can be simulated using the method.

▶ MS-Mo-E-47-1 16:00–16:30

A Strongly Consistent and Stable Approximation Strategy to Couple Compressible and Purely Elastic Materials with Incompressible Viscous Fluids in Immersed Boundary Methods and Immersed Finite Element Methods

Heltai, Luca — SISSA

Abstract: We present a variational formulation of the immersed finite element method, which allows incompressible Newtonian fluids to interact with a general hyperelastic solid: we allow (i) the mass density to be different in the solid and the fluid, (ii) the solid to be either viscoelastic of differential type or purely elastic, and (iii) the solid to be either compressible or incompressible. The proposed method is stable and strongly consistent. Various benchmarks are presented.

▶ MS-Mo-E-47-2 16:30–17:00

Simulations of Pulsating Soft Coral

Khatri, Shilpa — Univ. of California, Merced

Abstract: Soft coral of the family Xeniidae have a pulsating motion, a behavior not observed in many other sessile organisms. We are studying how this behavior may give these coral a competitive advantage. We will present direct numerical simulations of the pulsations of the coral and the resulting fluid flow by solving the Navier-Stokes equations coupled with the immersed boundary method. Also, results of transporting nutrients and waste coupled with these models will be discussed.

▶ MS-Mo-E-47-3 17:00–17:30

A New Penalty Immersed Boundary Method for A Rigid Body in Fluid

Kim, Yongsam — Chung-Ang Univ.

Abstract: We introduce a new penalty immersed boundary (pIB) method for the interaction between a rigid body and a surrounding fluid. The new pIB method is based on the idea of splitting an immersed boundary, which here is a rigid body, notionally into two Lagrangian components. The application problems include the interaction of two descending cylinders or balls and the dynamics of a freely falling maple seed with autorotation.

MS-Mo-E-48 16:00–18:00 212B

Computational learning and model optimization - Part II of II

For Part 1, see MS-Mo-D-48

Organizer: Schönlieb, Carola-Bibiane — Univ. of Cambridge
Organizer: Chung, Matthias — Virginia Tech
Organizer: De Los Reyes, Juan Carlos — ModeMat

Abstract: Many scientific fields such as engineering, life sciences, and geophysics encounter large scale problems where observations are contaminated with noise. To infer reliable information from experiments novel modeling techniques and inversion methods are needed. Computational learning and optimized modeling approaches are essential. To target challenges in these fields we will discuss statistical learning methods, optimization and design techniques under uncertainty, and inverse problems of big data.

▶ MS-Mo-E-48-1 16:00–16:30

Model Reduction in Optical Imaging Using A Statistical Approach

Tarvainen, Tanja — Univ. of Eastern Finland

Abstract: In optical tomography, optical parameters inside an object are estimated from light transport measurements made on the surface of the object. This is an ill-posed inverse problem. Thus, it tolerates measurement and modelling errors poorly. In this work, we consider using a Bayesian approximation error modelling for compensating for the modelling errors arising from using approximate forward models. Further, the relationship between a conventional reference measurement correction and the Bayesian approximation error modelling is considered.

▶ MS-Mo-E-48-2 16:30–17:00

Ensemble Filtering in Electrical Impedance Tomography

Somersalo, Erkki — Case Western Reserve Univ.
Calvetti, Daniela — Case Western Reserve

Abstract: Electrical impedance tomography aims at estimating conductivity distribution inside a body from current/voltage measurements from the boundary. The estimation can be done sequentially, either because of the measurement protocol, time evolution of the target, or because of the learning about the model discrepancies that are related to coarse modeling. In this talk, some of these aspects are addressed in the framework of ensemble filtering techniques.

▶ MS-Mo-E-48-3 17:00–17:30

Learning in Variational Image Regularisation

Schönlieb, Carola-Bibiane — Univ. of Cambridge

Abstract: We propose a bilevel optimization approach in function space for the determination of the optimal total variation (TV) regularisation technique. Starting with a generic TV-like approach - which may feature spatially dependent and higher-order TV regularisers - the optimal parameters in the model are determined. They are numerically computed by using a dynamically sampled quasi-Newton method, together with semismooth Newton algorithms for the the solution of the TV-problems. Exhaustive numerical discussion will be presented.

▶ MS-Mo-E-48-4 17:30–18:00

Learning and Experimental Design for Inverse Problems in Medical Imaging

Brune, Christoph — Univ. of Twente
Osting, Braxton — Univ. of Utah

Abstract: In several medical inverse problems compressive sensing and informative data collection is of great importance, particularly with regard to patient treatment, hardware limits and costs. We focus on the design and learning of subsampled, ill-posed imaging operators. Within the framework of experimental design and bi-level optimization we analyze specific criteria including Fisher information and mutual coherence. A specific application in MRI and photo-acoustic tomography shows improved reconstruction quality induced by reduced uncertainty via model.

MS-Mo-E-49 16:00–18:00 107

Rare Events in Complex Physical Systems - Part II of IV

For Part 1, see MS-Mo-D-49
For Part 3, see MS-Tu-D-49
For Part 4, see MS-Tu-E-49

Organizer: Cameron, Maria — Univ. of Maryland
Organizer: Li, Tiejun — Peking Univ.
Organizer: Lu, Jianfeng — Duke Univ.
Organizer: Weare, Jonathan — Univ. of Chicago
Organizer: Zhou, Xiang — City Univ. of Hong Kong

Abstract: Many problems arising from chemistry, physics and materials sci-

ence involve rare but significant exit events and/or transition events between stable states. The transitions happen on a time scale much longer than the intrinsic time scale of the dynamical system. Examples of such events are conformational changes of biomolecules, chemical reactions, etc. The purpose of this minisymposium is to bring together experts working in theory, numerical algorithms and application issues, such as analysis of models for metastable systems, free energy calculation, importance sampling, accelerated dynamics, and sampling of transition pathways.

▶ MS-Mo-E-49-1 16:00–16:30

Enhanced Sampling Simulations of Chemical Reactions in Solution

Gao, Yiqin — Peking Univ.

Abstract: Many chemical reactions occur in solutions and it is desirable to understand how solvation affects their mechanisms using molecular simulations. Such studies are normally hindered by the complex energy landscapes of molecular systems. Most of the molecular mechanism studies are performed with a pre-selected reaction coordinate. We will discuss how integrated tempering sampling (ITS) and trajectory sampling techniques can be combined with QM/MM simulations to study chemical reactions in solution.

▶ MS-Mo-E-49-2 16:30–17:00

Efficient Numerical Methods for Brownian, Langevin and Other Stochastic Differential Equations for Sampling A Probability Distribution, with Applications in Multiscale Modelling and Machine Learning

Leimkuhler, Benedict — Univ. of Edinburgh

Abstract: With the correct choice of numerical method, stochastic differential equations (SDEs) provide a rigorous, efficient and flexible approach to calculating averages with respect to a prescribed distribution. I will discuss efficient discretization methods and numerical analysis for systems of gradient type. I will also describe adaptive SDE methods that can automatically recover invariant distributions when the gradient is perturbed by error, for applications in multiscale modelling and machine learning.

▶ MS-Mo-E-49-3 17:00–17:30

Investigation Conformational Changes of Biological Macromolecules Using Kinetic Network Models

Huang, Xiuhui — The Hong Kong Univ. of Sci. & Tech.

Abstract: Markov State Models (MSMs), a kinetic network model, built from molecular dynamics (MD) simulations provide one means of overcoming this gap without sacrificing atomic resolution by extracting long time dynamics from short MD simulations through the coarse graining on the phase space and time. I will introduce a new efficient dynamic clustering algorithm for the automatic construction of MSMs for multi-body systems.

▶ MS-Mo-E-49-4 17:30–18:00

Shrinking Dimer Dynamics and Its Variants for Reliable Transition State Search

Zhang, Lei — Peking Univ.
Du, Qiang — Columbia Univ.

Abstract: Exploring complex energy landscape is a challenging issue in many applications. Besides locating equilibrium states, it is often also important to identify the transition states given by saddle points. In this talk, we discuss the mathematics and algorithms, in particular, the shrinking dimer dynamics and its variants, developed to compute transition states. Some applications will be considered.

MS-Mo-E-50 16:00–18:30 207

Modeling human cooperation

Organizer: Zhang, Boyu — Beijing Normal Univ.

Abstract: The evolution of cooperation is one the most important question in evolutionary biology and social science. Recent years, a number of theoretical approaches based on kin selection, direct and indirect reciprocity (e.g., reward and punishment), graph selection and group selection have been developed to explain the emergence and maintenance of cooperation in human society. These approaches involve mathematical tools from game theory, graph theory, dynamical systems, stochastic processes and others. The aim of this minisymposium is to provide a platform for comparing and orchestrating different research approaches in modeling human cooperation, and strengthen the connection between the theory and experiments.

▶ MS-Mo-E-50-1 16:00–16:30

Co-evolution of Conforming and Cooperation in Social Dilemmas

Zhang, Boyu — Beijing Normal Univ.

Abstract: We study the n-round PD game and the n-round m-person PGG by restricting individual strategies to the set of conforming behaviors. In the both games, TFT can prevent the invasion of non-cooperative strategies if the number of rounds is larger than a critical value. Adaptive dynamics analysis shows that conforming in general promotes the evolution of cooperation, and there is an evolutionary path from AllD to TFT-like strategies.

▶ MS-Mo-E-50-2 16:30–17:00

Solving the Collective-risk Social Dilemma with Risky Assets in Well-mixed and Structured Populations

Chen, Xiaojie — Univ. of Electronic Sci. & Tech. of China

Abstract: The collective-risk social dilemma game has recently received much attention from different scientific communities, as a well-known paradigm for studying the evolution of cooperation in the climate change game. In this talk, I will first introduce the collective-risk social dilemma game with risky assets, and then show how the introduction of risky assets influences the evolution of cooperation both in well-mixed and structured populations.

▶ MS-Mo-E-50-3 17:00–17:30

The Evolution of Cooperation: Theory and Experiment

Cressman, Ross — Wilfrid Laurier Univ.

Abstract: The evolution of cooperation remains a fundamental puzzle in evolutionary biology and social science. Theoretically, cooperation should not evolve for the Prisoner's Dilemma (PD) or Public Goods Game (PGG) without favorable extending circumstances whereas experiments consistently demonstrate cooperation. An overview of experiments and related theory is given before considering recent progress; the role of peer punishment in PD, of institutional reward/punishment in PGG, of player control over the number of rounds in repeated games.

▶ MS-Mo-E-50-4 17:30–18:00

Why We Punish: Preemptive Punishment and Retrospective Moral Assessment

Sasaki, Tatsuya — Univ. of Vienna

Abstract: Free riders can invade a society of cooperators, causing social dilemmas. Empirical and theoretical research on joint venture games indicates that social dilemmas can be overcome by punishment or reputation building. Since these public systems are costly, however, the so-called second-order free rider problem arises, leading to eroding cooperation. We by using game-theoretical investigations show how the problem can be solved with considering preemptive punishment and retrospective moral assessment.

▶ MS-Mo-E-50-5 18:00–18:30

The Role of Institutional Incentives and the Exemplar in Promoting Cooperation

Li, Cong — Department of mathematics & statistic, Univ. of Montreal

Abstract: We studied a repeated PGG experiment with an institutional reward and punishment. The result shows that institutions which both reward and punish (IRP) promote cooperation significantly better than either institutions which only punish (IP) or which only reward (IR). Our analysis shows that other intrinsic motivations that combine conforming behavior with reactions to being rewarded/punished provide a better explanation of observed outcomes.

MS-Mo-E-51 16:00–18:00 209A

Lyapunov Function Method in Mathematical Biology - Part I of II

For Part 2, see MS-Tu-D-51

Organizer: Shuai, Zhisheng — Univ. of Central Florida
Organizer: Wang, Chuncheng — Harbin Inst. of Tech.
Organizer: Wang, Jinliang — Heilongjiang Univ.

Abstract: The method of Lyapunov functions is a standard tool to analyze models arising in mathematical biology. These models often incorporate complex interactions among multiple species, age structure, behavior and spatial heterogeneity, and different time scales, and are in the form of ordinary differential equations, partial differential equations, functional differential equations, integro-differential equations, etc. A difficulty in applying the method is the ad hoc nature of the construction of a suitable Lyapunov function. This minisymposium will gather researchers employing a variety of mathematical techniques that guide the construction of Lyapunov functions for ecological and epidemiological models.

▶ MS-Mo-E-51-1 16:00–16:30

Impact of Intracellular Delay, Immune Activation Delay and Nonlinear Incidence on Viral Dynamics

Takeuchi, Yasuhiro — Aoyama Gakuin Univ.

Abstract: This presentation considers a class of viral infection models with two type discrete delays, one of which represents an intracellular latent period for the contacted target cells with viruses to begin producing virions, the other of which represents a time delay needed in cytotoxic T cells (CTLs) immune response before immune becomes effective after the invasion by a novel pathogen. By constructing Lyapunov functionals we investigate the global stability of the equilibria.

▶ MS-Mo-E-51-2 16:30–17:00
Global Analysis on Virus Dynamics
Shu, Hongying Tongji Univ.

Abstract: Determining sharp conditions for the global stability of equilibria remains one of the most challenging problems in the analysis of models for the management and control of biological systems. Yet such results are necessary for derivation of parameter thresholds for eradication of pests or clearing infections. This applies particularly to models involving nonlinearity and delays. In this talk, we provide some general results applicable to immune system dynamics.

▶ MS-Mo-E-51-3 17:00–17:30
Modeling Age-structured HIV Infection Dynamics with Both Virus-to-cell Infection and Cell-to-cell Transmission
Wang, Jinliang Heilongjiang Univ.

Abstract: Recent studies reveal that cell-to-cell transmission via formation of virological synapses might contribute significantly to virus spread. Age-structured models can be employed to study the variations in modeling the death rate and virus production rate of infected cells. Some basic mathematical arguments are achieved by using functional-analytic approaches. The global stability of equilibria, depending on basic reproduction number is obtained by constructing suitable Lyapunov functions.

▶ MS-Mo-E-51-4 17:30–18:00
Cyclic Structures on Epidemic Models and Its Stability in View of Renewal Equations and Delay Equations
Enatsu, Yoichi Tokyo Univ. of Sci.

Abstract: We focus on asymptotic stability of equilibria of epidemic models with cyclic structures such as SIRS, SIS models. In the situation that the models incorporate an age of infection, unsolved stability problems for an endemic equilibrium arising from the cyclic structure are presented by summarizing our recent results. By characterizing an age-distributed parameter of a transmission coefficient, a reformulation procedure into differential equations with distributed- or discrete- delays, is also discussed.

MS-Mo-E-52 16:00–18:30 212A
Mathematics in population genetics and evolution - Part II of II
For Part 1, see MS-Mo-D-52
Organizer: Yang, Ziheng Univ. College London
Organizer: Ma, Zhiming AMSS, CAS

Abstract: Population genetics provides mechanistic interpretations of Charles Darwin's theory of evolution by natural selection. It is a discipline in the life sciences that has a strong interplay with statistics, computer science and applied mathematics, founded by R.A. Fisher, S. Wright, and J. B. S. Haldane.It is essential both for understanding biological evolution and forinterpreting the ever-increasing genomic datasets, and has thus gained momentum in the last few decades because of the rapid accumulation of genetic data, driven by the various genome projects. This symposium will focus on probabilistic modeling and statistical analysis of modern genetic and genomic data, and the statistical and computational challenges that we face. The symposium will provide a forum for statisticians and computer scientists interested in this exciting field of biology to exchange ideas and experiences with evolutionary biologists, and to discuss various problems at the cutting edge of the field.

▶ MS-Mo-E-52-1 16:00–16:30
Thepopulation Trajectories of Many Species: A Synthesis
Zhai, Weiwei Genome Inst. of Singapore

Abstract: Population demographic history is a fundamental parameter in species evolutionary past. One very attractive method is the Pairwise Sequential Markovian Coalescent model where a single genome can be used to infer the past demographic change. In this work, we collected the population history across a wide range of species, we found that, there are many common determinants of past demographic change including recent divergence, global temperature fluctuation and a suite of many other factors.

▶ MS-Mo-E-52-2 16:30–17:00
A Maximum Likelihood Implementation of An Isolation-with-migration Model for Three Species
Zhu, Tianqi Beijing Inst. of genomics, CAS

Abstract: The isolation-with-migration models account for the phylogenetic structure of the populations while accommodating gene flow among them. We extend our previous maximum likelihood implementation of the symmetrical isolation-with-migration model for three species to accommodate arbitrary loci with two or three sequences per locus. The method is useful for analyzing genome-scale sequence data. We conduct a simulation study to examine the statistical properties of the likelihood ratio test for gene flow and analyzed a Drosophila dataset.

▶ MS-Mo-E-52-3 17:00–17:30
A New Measure of Population Differentiation
Ma, Liang Acad. of Mathematics & Sys. Sci. & Inst. of Zoology, CAS
Zhang, De-Xing Inst. of Zoology & Beijing Inst. of Genomics, CAS

Abstract: Population differentiation (subdivision) is a fundamental process of evolution, and many population genetic studies and applications demand the inference of population differentiation. Debates over the validity of the traditional population differentiation measure FST remain unsettled since 2008. Here, a new statistic, IST, the Inflation Index, are proposed, complementary to current measures. It is defined as the amount of inflation of gene identity within subpopulations to its idealized value and standardized by its theoretic maximum range.

▶ MS-Mo-E-52-4 17:30–18:00
Computational Approaches to Reconstructing Evolutionary Histories of Single Cells
Truszkowski, Jakub EMBL-European Bioinformatics Inst.
Goldman, Nick EMBL-European Bioinformatics Inst.

Abstract: Advanced single-cell sequencing technology can determine individual cells' genomes, enabling us to survey the heterogeneity of cells within an organism and reconstruct the history of cell divisions using phylogenetic methods. We present a method for reconstructing cell lineages, accounting for stochastic sequencing errors. The problem reduces to finding a series of cuts in a graph; our resulting algorithm outperforms standard methods for this task. We discuss possible implications for developmental biology, and sketch future directions.

▶ MS-Mo-E-52-5 18:00–18:30
Inference of Fine-scale Population Size Using the Allele Frequency Spectrum from Large Sample Genomic Sequences
Chen, Hua Beijing Inst. of Genomics, CAS
Chen, Kun Dana Farber Cancer Inst., Harvard Medical School

Abstract: Inferring historical population size is essential for population genetic study. Large sample genomic sequences provide unprecedented opportunities for learning population histories, however, the sample size is much beyond the limit of existing methods. We develop accurate approximation for the allele frequency spectrum for large samples. The approximation is in simple analytical form, and computationally very efficient comparing the simulation-based methods. More importantly, the result is accurate and flexible for various complex demographic scenarios.

MS-Mo-E-53 16:00–18:00 311B
New Developments in Stochastic Games: Mean Field Models and Beyond
Organizer: Ludkovski, Mike UC Santa Barbara
Organizer: Leung, Tim Columbia Univ.

Abstract: Mean-field games theory was introduced in 2006 by Lasry and Lions and by Huang, Caines and Malhaméas a way to describe consensus among a large population of individuals. Various applications appear in economy, finance and engineering. In the past 5 years rapid developments have taken place to address existence and uniqueness of the corresponding stochastic equilibria, connections to controlled McKean-Vlasov diffusion processes and numerical approximation methods. The minisymposium will feature 4 talks devoted to recent applications of these theories related to systemic risk, commodity market oligopolies and Stackelberg games.

▶ MS-Mo-E-53-1 16:00–16:30
Systemic Risk and Mean Field Games: Grouping Systems and A Central Bank
SUN, LI-HSIEN National Central Univ.

Abstract: We consider heterogeneous grouping cases where parameters are identical within their own groups but different between groups. Given this heterogeneity, a central bank has to keep deposits or provide extra cash flow instead of acting as a clearing house and systemic risk happens in the more complicated manner than the homogeneous case. In addition, in order to prevent systemic risk, a central bank must take control of the ensemble average.

▶ MS-Mo-E-53-2 16:30–17:00
Mean Field Stackelberg Games
Chau, Man Ho The Univ. of Hong Kong

YAM, Phillip — Chinese Univ. of Hong Kong

Abstract: In this talk, I shall introduce the mean field analogue of an N-player interacting strategic game in the presence of a (endogenous) dominating player, who gives direct influence on individual agents, through its impact on their control in the sense of Stackelberg game, and then on the whole community. At the same time, each individual agent is subject to a delay effect on collecting information, specifically at a delay time, from the dominating player.

▶ MS-Mo-E-53-3 17:00–17:30

Mean Field Games in Energy Market

Ludkovski, Mike — UC Santa Barbara
Xuwei, Yang — Univ. of California, Santa Barbara

Abstract: We employ mean field game approach to model an energy market with a continuum of producers. Nash equilibrium is obtained by solving a doubly coupled system of Hamilton-Jacobi-Bellman equation and probability transport equation. The novelty is that effects of exploration for new resource reserves are considered in the mean field game framework through a controlled point process.

▶ MS-Mo-E-53-4 17:30–18:00

Dynamic R&D Competition in Cournot Markets

Ludkovski, Mike — UC Santa Barbara

Abstract: We explore optimal investment in Research and Development activities among producers in a competitive market. R&D effort is costly and results in discrete technological advances that gradually lower production costs. Our model combines features of patent racing with dynamic market structure, capturing the interplay between the immediate competition in terms of production rates and long-term technological progress. Using a Cournot model of competition, we analyze the resulting Markov Nash equilibrium and the emerging comparative statics.

MS-Mo-E-54 16:00–18:00 VIP1-2

Minisymposium Computational Finance - Part II of III

For Part 1, see MS-Mo-D-54
For Part 3, see MS-Tu-D-54

Organizer: Teng, Long — Bergische Universität Wuppertal
Organizer: Guenther, Michael — Bergische Universität Wuppertal
Organizer: Ehrhardt, Matthias — Univ. of Wuppertal

Abstract: In recent years the variety and complexity of financial mathematics models has witnessed a tremendous growth. For the resulting computational complexity, advanced numerical techniques are imperative for the applications in financial industry. The aim is to deeper understand complex financial models and to develop effective and robust numerical schemes for solving linear and nonlinear problems arising from the mathematical theory of pricing financial derivatives and related financial products. The motivation for this minisymposium is to exchange and discuss current insights and ideas, and to lay groundwork for future collaborations. Finally, it should serve as a kick-off for the special interest group (SIG) Computational Finance within ECMI (European Consortium for Mathematics in Industry).

▶ MS-Mo-E-54-1 16:00–16:30

On the Heston Model with Stochastic Correlation

Teng, Long — Bergische Universität Wuppertal
Ehrhardt, Matthias — Univ. of Wuppertal
Guenther, Michael — Bergische Universität Wuppertal

Abstract: Financial correlation plays an essential role on pricing, hedging and is often assumed as a constant. However, market observation indicates that financial quantities are correlated in a strongly nonlinear way, correlation behaves even stochastically and unpredictably. This article extends the Heston model by imposing stochastic correlations given by Ornstein-Uhlenbeck or Jacobi processes. By approximating non-affine term we find the characteristic function in a closed-form which can be used for more reasonable pricing and hedging.

▶ MS-Mo-E-54-2 16:30–17:00

Valuation of Stock Loan with Stochastic Interest Rate

Zhu, Song-Ping — Univ. of Wollongong, Jilin Univ.
Xu, Liangbin — Univ. of Wollongong
Chen, Wenting — Univ. of Wollongong

Abstract: Stock loans are loans collateralized by stocks. They are modern financial products designed for investors with large equity positions. This study focuses on stock loan valuations under a stochastic interest rate framework. The pricing PDE is derived first with appropriate boundary conditions being proposed to properly close the system. A predictor-corrector finite difference method is adopted to solve the proposed PDE system. Numerical results suggest that the current method is numerically efficient and very reliable.

▶ MS-Mo-E-54-3 17:00–17:30

An Efficient Solver for Multi-dimensional Nonlinear Black-Scholes Equation with Newton-like Method

TAN, Shih-Hau — Univ. of Greenwich
Lai, Choi-Hong — Univ. of Greenwich
Skindilias, Konstantinos — Univ. of Greenwich

Abstract: Useful solvers for financial problems in an incomplete market are desired since analytic solutions to nonlinear PDEs are not always possible. Newton's method is usually considered to handle the nonlinearity but time-consuming problems occur in calculating the Jacobian matrix. In this talk, different schemes for the multi-dimensional nonlinear Black-Scholes equation will be compared, and efficient algorithms with Newton-like method will be addressed. Numerical experiments and possibilities in parallel computation will be demonstrated towards the end

▶ MS-Mo-E-54-4 17:30–18:00

Multivariate Shortfall Risk and Monetary Risk Allocation

Drapeau, Samuel — Shanghai Jiao Tong Univ.

Abstract: We present a risk measure designed for the global and intrinsic risk of multidimensional interconnected system (banks or CCP). It first provides the total amount of liquidity that has to be reserved for the system to overcome financial stress situations. Second, it addresses the respective amount that each member has to reserve in function of the systemic risk they put on the system. Computational methods for high dimension system are also presented.

MS-Mo-E-55 16:00–18:00 106

Theoretical Understanding of Charged Particles in Complex Environments - Part I of II

For Part 2, see MS-Tu-D-55

Organizer: Xu, Zhenli — Shanghai Jiao Tong Univ.
Organizer: Lu, Benzhuo — Acad. of Mathematics & Sys. Sci., CAS

Abstract: The theoretical understanding of ion interaction and transport has been attracting longstanding interest in different branches of mathematics, such as potential theory, numerical PDEs, computational physics and mathematical biology. Complex environments, including interfaces, dielectric inhomogeneities, many-body and dynamic interactions, have led to recent wide attention in math community. This mini-symposium will bring together of active researchers to discuss recent progress in this exciting field of disciplinary areas for computational and modeling issues of particle and interface motion in complex environments. There will be mathematical and numerical issues, such as variational approaches, finite element methods, high-performance computing, mesh generation, various coarse-grained techniques, and asymptotic analysis.

▶ MS-Mo-E-55-1 16:00–16:30

On the Numerical Accuracy of Ewald, Smooth Particle Mesh Ewald, and Staggered Mesh Ewald Methods for Inhomogeneous and Correlated Molecular Systems

Han, Wang — CAEP Software Center for High Performance Numerical Simulation

Abstract: In this work, we present the accurate error estimates for three state-of-art algorithms of long-range electrostatic interaction in inhomogeneous and correlated molecular systems . They are the Ewald summation, the smooth particle mesh Ewald (SPME) and the staggered mesh Ewald methods. Two branches of fast reciprocal force calculation, namely the ik- and analytical differentiation, are considered. The error is decomposed and estimated in three additive components : The homogeneity error, the inhomogeneity error and the correlation error. The effectiveness and the computational feasibility of the proposed estimates are demonstrated and discussed in example systems . We further show that the inhomogeneity and the correlation errors play a non-trivial and important role in inhomogeneous and correlated molecular systems . In addition, a long-range correction for the inhomogeneity error is presented.

▶ MS-Mo-E-55-2 16:30–17:00

Self-Consistent Approach to Global Charge Neutrality in Electrokinetics: A Surface Potential Trap Model

Xu, Shixin — Soochow Univ.
Liu, Chun — Penn State Univ.
Sheng, Ping — Hong Kong Univ. of Sci. & Tech.

Abstract: We propose a surface potential trap model that attributes an energy cost to the interfacial charge dissociation.By defining a chemical potential μ, a reformulated CCPB can be reduced to the form of the PB equation, whose prediction of the Debye screening layer profile is in excellent agreement with

that of the PB equation when the channel width is much larger than the Debye length.

▶ MS-Mo-E-55-3 17:00–17:30

Continuum Simulation of Macromolecular System in Ionic Solution: from Equilibrium to Non-equilibrium Processes

Lu, Benzhuo Acad. of Mathematics & Sys. Sci., CAS

Abstract: An overview will be given for our recent work on continuum modeling of macromolecular system: Poisson-Boltzmann electrostatic simulation, and its current developments toward model improvements at higher level of accuracy and generalization for treatment of non-equilibrium ionic flow. A current issue is that many technical difficulties in these modeling prevent their applications. Therefore, we are also making efforts to develop a convenient web server for continuum modeling, and demonstrations will be presented.

▶ MS-Mo-E-55-4 17:30–18:00

Self-consistent Field Model for Strong Electrostatic Correlations and Inhomogeneous Dielectric Media

Ma, Manman Shanghai Jiao Tong Univ.
Xu, Zhenli Shanghai Jiao Tong Univ.

Abstract: We propose a continuum electrostatic model for the treatment of electrostatic correlations and variable permittivity of electrolytes in the framework of the self-consistent field theory. The model incorporates a space- or field-dependent dielectric permittivity and an excluded ion-size effect for the correlation energy. Numerical results for symmetric and asymmetric electrolytes demonstrate that the model is able to predict the charge inversion at high correlation regime and strong effects due to the inhomogeneous permittivity.

MS-Mo-E-56 16:00–18:10 403

Computational Techinques in Geological Disasters and Environment Pollutions

Organizer: Yuan, Li ICMSEC, Acad. of Mathematics & Sys. Sci., CAS

Abstract: Landslides, avalanches, and debris flows are dangerous natural hazards to human beings. Environment pollutions like subsurface wastewater flow problems degenerate our life and cause disease. Although these phenomena have been studied extensively by numerous searchers in various disciplines, the inhomogeneous, multiphase, polydisperse, and phase variable materials and their interactions with disperse fluids are hard to describe both qualitatively and quantitatively. Mathematical simulation technologies for geological disasters and environment problems are still under development. The objective of this mini-symposia is to provide a forum for researchers from applied mathematics, numerical algorithms, and geomechanics to exchange the related research progress.

▶ MS-Mo-E-56-1 16:00–16:30

Wave Simulation in Three Dimensional Poroelastic Media by the Finite Volume Method

Zhang, Wensheng Acad. of Mathematics & Sys. Sci., Chinese Acad. of Sci., Beijing, 100190, P.R.China

Abstract: In this talk, we will present a finite volume scheme for solving the three dimensional Biot equation to simulate wave propagation in three dimensional poroelastic media. Based on the velocity-stress formulation of Biot equation, the computational scheme for cell-averaged quantities is presented. Numerical computations with the MPI parallel algorithm both for the theoretical model and the real landslide model with complex topographic changes are implemented.

▶ MS-Mo-E-56-2 16:30–17:00

Numerical Simulation of Hydraulic Fracturing

Liu, Chuanqi Department of hydraulic engineering
Sun, Qicheng Tsinghua Univ.

Abstract: To better understand the mechanism of hydraulic fracturing, we establish a new numerical model considering hydro-mechanical coupling. The model simulates mechanical behavior of rock formations using the combined finite-element method and uses a simplified fracture flow equation derived from the general Navier-Stokes (N-S) equations and Darcy's law to describe fluid flow. The interaction between these media is controlled by fluid leak-off. The process of hydraulic fracturing is effectively simulated using several numerical methods.

▶ MS-Mo-E-56-3 17:00–17:30

Discrete Element Method with Dilated Polyhedral Element and Its Applications in Cold Region Engineering

Ji, Shunying Dalian Univ. of Tech.
Liu, Lu Dalian Univ. of Tech.

Abstract: To describe the geometric shapes of irregular particles and calculate their collision contacts accurately with discrete element method, the dilated polyhedral element is developed based on Minkowski sums theory. To simulate the sea ice floes in cold regions, the elements are generated with the Voronoi tessellation algorithm. The influence of ice thickness and drifting velocity on ice loads on offshore structures and ship hull are simulated with the dilated polyhedral elements.

▶ CP-Mo-E-56-4 17:30–17:50

GENERAL EQUILIBRIUM ANALYSIS OF TRADE AND ENVIRONMENT UNDER ALTERNATIVE MARKET STRUCTURE: A COMPUTABLE GENERAL EQUILIBRIUM STUDY FOR INDIA

Das, Koushik Chandidas Mahavidyalaya

Abstract: The purpose of the present paper is to understand general equilibrium implications of international trade and globalization on social welfare and environmental emission caused on account of energy consumption by production sectors and domestic households. We applied Computable General Equilibrium (CGE) modelling as our relevant methodology following Shoven, J.B. and Whalley, J (1984). Constructing an Energy/Environmental Social Accounting Matrix (SAM), paper attempts to purport the effects of liberalized trade over different macroeconomic aspects, energy consumption and Green House Gas (GHG) emission through an Environmental CGE model logically based on SAM. Attempts have been made to simulate various trade related policies like import liberalization, foreign capital inflow and use of energy saving technologies for examining the impact over macroeconomic variables and domestic physical environment under both Perfect and Monopolistic Competition market structure assumption.

▶ CP-Mo-E-56-5 17:50–18:10

Urban Heat Islands: An Optimal Control Approach

Alvarez-Vazquez, Lino Univ. of Vigo
Fernandez, Francisco Escuela Naval Militar Marin
Garcia-Chan, Nestor Universidad de Guadalajara
Martinez, Aurea Univ. of Vigo
Vazquez-Mendez, Miguel Universidade de Santiago de Compostela

Abstract: In this work we use a combination of mathematical modelling, numerical simulation and optimal control of partial differential equations in order to mitigate the urban heat island effect (a metropolitan area that presents a significantly warmer temperature than its surrounding areas, mainly due to human activities). We introduce a well-posed mathematical formulation of the environmental problem, we propose a numerical algorithm for its resolution, and finally we present several numerical results.

MS-Mo-E-57 16:00–18:05 402A

Recent advances in modeling, analysis, and methodology for interface and free boundary problems and applications - Part II of V

For Part 1, see MS-Mo-D-57
For Part 3, see MS-We-D-26
For Part 4, see MS-We-E-26
For Part 5, see MS-Th-BC-26

Organizer: Li, Zhilin North Carolina State Univ.
Organizer: Lai, Ming-Chih National Chiao Tung Univ.

Abstract: In recent years, there is increasing interest in the development and application of advanced computational techniques for interface problems, problem with free boundary and moving interface, fluid-structure interactions driven by applications in physiology, fluid mechanics, material sciences, porous media flow, and biology. There are also many numerical approaches developed in recent years. The aim of this mini-symposium is to bring together scientists in the field to exchange their recent research discoveries and future directions, to stimulate novel ideas, and to nurture collaborations. The focus would be on Cartesian grid method such as the immersed boundary/interface methods, the level set methods, fluid-structure interactions, and applications.

▶ MS-Mo-E-57-1 16:00–16:25

The IIM for Axis-symmetric Problems and Application to the Hele-Shaw Flow

Ruiz, Juan Alcala Univ.
Li, Zhilin North Carolina State Univ.

Abstract: Many physical application problems are axis-symmetric. Using axis-symmetric properties, many three dimensional problems can be solved efficiently using two dimensional axis-symmetric coordinates. In this paper, the immersed interface method in axis-symmetric coordinates is developed for elliptic interface problems that have a discontinuous coefficient, solution or flux.The method is shown to be second order accurate in the infinity norm. The new IIM is applied to the Hele-Shaw flow and compared with results from the literature.

▶ MS-Mo-E-57-2 16:25–16:50

Low-Reynolds-number Swimming in Two-phase Viscoelastic Gels
Du, Jian — Florida Inst. of Tech.

Abstract: The fluid media surrounding many microorganisms are often mixtures of multiple materials with very different physical properties. We study the classical Taylor's swimming sheet problem within a two-fluid model, which describes a mixture of a viscous fluid solvent and a viscoelastic polymer network. Our results indicate that depending on the interactions between the swimming surface and the network, elasticity may have drastically different effects on the swimming speed.

▶ MS-Mo-E-57-3 — 16:50–17:15
Achieving High-Order for Interface Problems in An Immerse Setting
Nave, Jean-Christophe — McGill Univ.

Abstract: I'll present a numerical scheme able to handle discontinuous solutions arising from problems with interfaces. The method is based on a straight forward decomposition which turns the problem into two sub-problems: one for the jump, the other for the rest of the solution. This approach is applicable to a large number of problems, and is in principle of arbitrary order while not affecting (asymptotically) complexity. I'll present results for time-dependent and time-independent problems.

▶ MS-Mo-E-57-4 — 17:15–17:40
A Second-order Changing-connectivity ALE Scheme and Its Application to FSI
Liu, Jie — National Univ. of Singapore

Abstract: We propose a second-order characteristic-inclined changing-connectivity ALE scheme. It does not explicitly calculate the characteristics but allow characteristic-inclined discretization. The resulting semi-implicit scheme for Navier-Stokes equations can handle both large deformation of the domain and strong convection of the fluid. We prove its optimal convergence rate in space and time and show its application to FSI problems. Various convergence and benchmark tests are presented.

▶ MS-Mo-E-57-5 — 17:40–18:05
A Hybrid Immersed Boundary and Immersed Interface Method for Electrohydrodynamic Simulations
Lai, Ming-Chih — National Chiao Tung Univ.

Abstract: In this talk, we introduce a hybrid immersed boundary (IB) and immersed interface method (IIM) to simulate the dynamics of a drop under an electric field in Navier-Stokes flows. Within the leaky dielectric framework with piecewise constant electric properties in each fluid, the electric stress can be treated as an interfacial force on the drop interface. Thus, both the electric and capillary forces can be formulated in a unified immersed boundary framework.

MS-Mo-E-58 — 16:00–18:30 — 401
Surface diffusion and related problems and flows. - Part II of III
For Part 1, see MS-Mo-D-58
For Part 3, see MS-Tu-D-58
Organizer: Novick-Cohen, Amy — Technion IIT

Abstract: Motion by surface diffusion, in which the normal velocity of an evolving surface is proportional to minus the surface Laplacian of its mean curvature, constitutes a geometric motion which plays a critical role in many technological applications, from thin film drug delivery, optical coatings, printing, and spray technology. While surface diffusion has been discussed in the material science literature to 1950s, much concerning its mathematical theory remains to be developed. The aim of the proposed minisymposium is consider surface diffusion and related problems from a variety of aspects, including existence, uniqueness, self-similarity, numerical methods, and issues related to applications. SIAG-MS sponsored.
(Comment: the actual area might best reflect A04 as well as A24, and the organizer is a member of two siags: SIAG-APDE as well as SIAG-MS)

▶ MS-Mo-E-58-1 — 16:00–16:30
The Role of Surface and Interface Diffusion in Thermal Stability of Thin Films
Rabkin, Eugen — Technion

Abstract: Thin solid metal films on non-wetting ceramic substrate agglomerate in arrays of isolated particles at the temperatures allowing some diffusion mobility of atoms. We demonstrate that in addition to the surface diffusion which was thought as a primary mechanism of agglomeration, diffusion along the grain boundaries in the film, and diffusion along the film-substrate interface, coupled with the grain boundary sliding also play an important role in agglomeration process.

▶ MS-Mo-E-58-2 — 16:30–17:00
Contact Line Dynamics in Solid State Dewetting
Srolovitz, David J — Univ. of Pennsylvania

Abstract: Dewetting of thin solid films deposited on substrates is similar to the dewetting of liquid films, where transport occurs via surface diffusion rather than fluid dynamics. I will discuss an approach for handling the boundary condition at the contact line and its implications for the evolution of the thin film. Finally, I will discuss contact line dynamics with evaporation/condensation kinetics and a the motion of contact lines (triple junctions) in grain boundary migration.

▶ MS-Mo-E-58-3 — 17:00–17:30
A General Framework for High Accuracy Solutions to Energy Gradient Flows from Material Science Models
Wetton, Brian — Mathematics Department, UBC

Abstract: A computational framework is presented for materials science models that come from energy gradient flows such as the Cahn-Hilliard equation. Implicit time stepping is used, and the resulting implicit systems are solved iteratively with a preconditioned conjugate gradient method. The framework is easily extended to higher order derivative models, higher dimensional settings, and vector problems.

▶ MS-Mo-E-58-4 — 17:30–18:00
Island Dynamics Model for Mound Formation: Effect of A Step-Edge Barrier
Ratsch, Christian — UCLA

Abstract: We have developed an island dynamics model for epitaxial growth with the level-set technique, where islands are treated as continuous in the x-y-plane, while individual atomic layers are resolved in the z-direction. The effect of an additional step-edge barrier is incorporated via a mixed Robin-type boundary condition for the diffusion equation. We will present a numerical scheme to solve such a boundary condition and show how this leads to the formation of mounds.

▶ MS-Mo-E-58-5 — 18:00–18:30
Gradient Estimates for Solution of the Lame System with High-contrast Coefficients
Li, Haigang — Beijing Normal Univ.

Abstract: We consider the Lamé system with partial infinity coefficients in dimension two which describes a model of a linear isotropic elastic body containing two adjoint inclusions with infinity elastic parameters.
We establish upper bounds on the blow up rate of the gradients of solutions, as the distance, ϵ, between the surfaces of discontinuity of the coefficients of the system tends to zero. We show the upper bound is $\epsilon^{-1/2}$, which is expected to be optimal.

MS-Mo-E-59 — 16:00–18:00 — 402B
Analysis and modelling of dislocations and plasticity - Part II of II
For Part 1, see MS-Mo-D-59
Organizer: Garroni, Adriana — Sapienza, Univ. of Rome
Organizer: Ortiz, Michael — CALTECH

Abstract: Dislocations are line defects in crystals. Their motion and interaction is considered the fundamental mechanism for plastic deformation in metals. Effective models for plasticity have to take into account the collective behavior of many dislocations whose response is influenced by their microscopic arrangement. Considerable effort has been recently devoted to observing, modelling, analyzing and simulating large ensembles of dislocations. This effort involves multiple communities, including applied physics, materials science, solid mechanics and applied mathematics. We propose a minisymposium in three sessions, with the aim of bringing together experts from those diverse communities to share their understanding of the problem from their respective perspectives.

▶ MS-Mo-E-59-1 — 16:00–16:30
Variational Modeling of Dilute Dislocations in Crystals
Conti, Sergio — IAM, Univ. of Bonn
Garroni, Adriana — Sapienza, Univ. of Rome
Ortiz, Michael — CALTECH

Abstract: The energetics of dilute dislocations can be understood starting from elastic models with incompatible strains and suitable core regularizations. I shall discuss recent progress in the derivation of a small-lattice-spacing limit of this type of model, leading to a reduced energy of the line-tension type. The variational limiting procedure is necessarily coupled to relaxation and highlights the possible spontaneous formation of small-scale oscillations in the dislocation distribution.

▶ MS-Mo-E-59-2 — 16:30–17:00
Mathematical Methods for Dislocation Pile-Ups
Hall, Cameron — Univ. of Oxford

Van Meurs, Patrick Eindhoven Univ. of Tech.

Abstract: Since the 1950s, it has been understood that dislocations can arrange themselves into regular structures, and the analysis of these structures has been an important mathematical contribution to the theory of plasticity. This talk will summarise different mathematical methods that have been used to understand dislocation pile-ups, beginning with the results obtained in the 1950s and 1960s using orthogonal polynomials and integral equations, through to more recent work based on variational methods and asymptotic analysis.

▶ MS-Mo-E-59-3 17:00–17:30

Kinematics of Continuum Elastoplasticity in the Regime of Large Deformations

Reina, Celia Univ. of Pennsylvania
Conti, Sergio IAM, Univ. of Bonn

Abstract: The kinematic description of finite elastoplasticity based on the decomposition F=FeFp is standard in the continuum mechanics community. Besides its current acceptance, it has been largely debated in the literature and many issues still remain unresolved. In this talk we present some advances in this direction via mathematical multiscale analyses from discrete dislocations to the continuum scale.

▶ MS-Mo-E-59-4 17:30–18:00

Convergence of Interaction-driven Evolutions of Dislocations

Scardia, Lucia Univ. of Bath

Abstract: I will consider a system of N interacting parallel edge dislocations in single-slip, and discuss the convergence of the evolution of the corresponding empirical measures in the limit of many dislocations. The upscaling is performed by combining Gamma-convergence methods with the theory of rate-independent systems.
This is a result obtained in collaboration with M.G. Mora and M.A. Peletier.

IM-Mo-E-60 16:00–18:00 310

Industrial Mathematics Around the World - Part II of VIII

Problems from the Oil Industry

For Part 1, see IM-Mo-D-60
For Part 3, see IM-Tu-D-60
For Part 4, see IM-Tu-E-60
For Part 5, see IM-We-D-60
For Part 6, see IM-We-E-60
For Part 7, see IM-Th-BC-60
For Part 8, see IM-Th-D-60

Organizer: Cai, Zhijie Fudan Univ.
Organizer: Chen, Gui-Qiang G. Univ. of Oxford
Organizer: Huang, Huaxiong York Univ.
Organizer: LU, Liqiang Fudan Univ.
Organizer: Ockendon, Hilary Univ. of Oxford
Organizer: Ockendon, John Univ. of Oxford
Organizer: Peng, Shige Shandong Univ.
Organizer: Tan, Yongji Fudan Univ.
Organizer: Wake, Graeme Massey Univ.,
Organizer: Zhu, Yichao The Hong Kong Univ. of Sci. & Tech.
Organizer: CHENG, JIN Fudan Univ.

Abstract: The aim of this section is to boost the use of mathematics as an industrial resource in China and around the world. It will highlight (i) the global experience in industrial mathematics and (ii) the new mathematical ideas that these activities have created as well as the exploitation of existing technologies to new applications. Participants will come from both academia and industry and, for this purpose, the section is proposed to consist of eight minisymposia. Four of them will overview the identification and solution of industrially-driven mathematical problems and the mechanisms that have evolved to deal with them in different regions: China, other Asia-Pacific countries, Europe and North America. Three of the remaining minisymposia will focus on the problems coming from different industrial sectors: financial industry, petroleum industry and industrial areas in which wave propagation is important. The last minisymposium will involve an open discussion on how the global mathematics community can best respond to the increasing demand from industry for applied and computational mathematics; the agenda will include both the mechanisms for academic / industrial collaboration and the areas where it will be most fruitful.

▶ IM-Mo-E-60-1 16:00–16:30

Mathematical Problems in Petroleum Well Logging

Xiao, Lizhi China Univ. of Petroleum

Abstract: Well logging is very important for oil and gas exploration. The sensors may include electric, accoustic, radiation, and nuclear magnetic resonance. There are three levels of mathematical problems involved: 1, forward modeling; 2, inverse with data from single source; 3, inverse with data from multi-sources. The boundary conditions normally are very complicated due to the complexity of bore hole and oil reservoirs. We overview the mathematical problems invovled in well logging, outline the challenges.

▶ IM-Mo-E-60-2 16:30–17:00

Inverse Problem in Resistivity Well-Logging

Cai, Zhijie Fudan Univ.

Abstract: The resistivity well-logging is one of the most common and important techniques in petroleum exploitation. The main aim of this technique is to determine some physical and geometric parameters of the layer. In this paper, the resistivities of objective layer and invaded area and the invaded depth are inversed simultaneously by measuring the potentials on several electrodes. The mathematical theories and computational methods are presented. Some numerical simulations are given to illustrate our methods.

▶ IM-Mo-E-60-3 17:00–17:30

Application of Numerical Simulation in Well Logging

Yue, Aizhong Tech. Center, CNPC Logging company
Feng, Linwei Tech. Center, CNPC Logging company
He, Qiuli Tech. Center, CNPC Logging company
Lu, Tao Tech. Center, CNPC Logging company
Chen, Bao Tech. Center, CNPC Logging company

Abstract: This paper presents the principles of electrical logging, acoustic logging, radioactive logging and NMR (nuclear magnetic resonance) logging and establishes the mathematical and physical models. Numerical simulation shows forward results of different logging method in different geological conditions. Environmental influence on logging data is analyzed and some correction methods are proposed. The interpretation methods of logging data are also introduced and some application results are illustrated.

▶ IM-Mo-E-60-4 17:30–18:00

Mathematical Modeling and Numerical Method for the Spontaneous Potential Well-logging

Chen, Wei Shanghai Lixin Univ. of Commerce

Abstract: Spontaneous potential well-logging is one of the most common and useful well-logging techniques in petroleum exploitation. Based on a series of previous results and a recent research, we provide a complete theoretical and numerical framework of the mathematical modeling and numerical method together with examples and applications for the spontaneous potential well-logging. The contents consist of mathematical model and its well-posedness, limit behavior of solutions and a reduced mathematical model,efficient numerical methods, examples and applications.

CP-Mo-E-61 16:00–18:00 101

Ordinary and Partial Differential Equations

Chair: Ita, Benedicy Univ. of Calabar

Abstract:

▶ CP-Mo-E-61-1 16:00–16:20

SOLUTIONS OF THE SCHRӦDINGER EQUATION WITH INVERSELY QUADRATIC YUKAWA PLUS INVERSELY QUADRATIC POTENTIAL USING PEKERIS-LIKE APPROXIMATION OF THE COULOMB TERM AND PARAMETRIC NIKIFOROV-UVAROV METHOD

Ita, Benedicy Univ. of Calabar

Abstract: This work solves the Schrӧdinger equation with superposed potential (IQYIQP) made up of inversely quadratic Yukawa (IQY) potential and inversely quadratic (IQ) potential using the Pekeris-like approximation of the coulomb term in the potential and parametric Nikiforov-Uvarov (NU) method. The solution gives the energy eigenvalues and the corresponding un-normalized eigen functions obtained in terms of Jacobi polynomials. Also, special cases of the potential have been considered and their energy eigen values obtained. The result of the work could be applied to molecules moving under the influence of IQYIQP potential as negative energy eigenvalues obtained indicate a bound state system.

▶ CP-Mo-E-61-2 16:20–16:40

TV-Regularized EIT Problem Using A Multi-Phase Segmentation Approach

Mendoza, Renier Univ. of the Philippines Diliman
Keeling, Stephen Inst. for Mathematics & Scientific Computing

Abstract: In Electrical Impedance Tomography (EIT), image reconstruction of the typically piecewise values of the conductivity distribution σ of a body Ω can be calculated using measured voltages at the the boundary $\partial\Omega$. This is done by solving an inverse problem of a generalized Laplacian equaton.

We approach this problem by using a *multi-phase segmentation* method. We express σ as

$$\sigma(x) = \sum_{m=1}^{M} \sigma_m(x)\chi_m(x),$$

where χ_m is the characteristic function of a subdomain Ω_m such that $\Omega_m \cap \Omega_n = \emptyset$, $m \neq n$ and $\Omega = \cup_{m=1}^{M}\Omega_m$. The expected number of segments of Ω is M. Using a calculated optimality condition, the conductivity value σ_m is expressed as a function of χ_m. The total variation is then introduced to regularize the resulting cost functional. Using a descent method, an update for χ_m is proposed. Examples using topological derivative to obtain an initial estimate for χ_m are also presented.

▶ CP-Mo-E-61-3 16:40–17:00

Mathematical Model of Cancer Treatment via Chemotherapy in Cycles

Mancera, Paulo — Unesp, IBB
Guiraldello, Rafael Trevisanuto — Inst. of BioSci. - UNESP
Martins, Marcelo — Physics Department, Viçosa Federal Univ.

Abstract: We present a mathematical model with the goal of understanding tumor development and the effect of administration in cycles according two protocols of chemotherapy as well as two methods of drug delivery. A linear stability analysis is developed for the spatially homogeneous model with and without treatment, in order to understand the dynamics of the model. We conclude that the parameters of competition are the main bifurcation parameters of the system, which define the tumor progression and success of chemotherapy. With these results, we do the numerical simulations where we concluded that the metronomic protocol proves more effective in prolonging the patient's life than the Maximum Tolerated Dose (MTD) protocol. Moreover, the uniform delivery method along with the metronomic protocol is the most efficient in reducing the density of the tumor during treatment.

▶ CP-Mo-E-61-4 17:00–17:20

Modeling Drug Release from Polymer-free Drug-eluting Stents

Vo, Tuoi T.N. — Univ. of Limerick

Abstract: Polymer-free drug-eluting stents (DESs) are an innovative new treatment for coronary heart disease which is the leading cause of death globally. In these polymer-free stents, the drug is either sprayed directly onto a bare metal surface or infused in a metallic porous medium. They have the potential to overcome problems associated with the current best treatment: polymer-coated DESs. However with no polymer to control drug release, it is unclear how desired release rates can be achieved. In this talk, I will present the first model of drug elution from polymer-free stents which is capable of predicting the drug release from a number of polymer-free systems including those that exhibit nanoporous, nanotubular and smooth surfaces. The model is based principally on dissolution theory and the theory of diffusion in porous media. Analytical solutions are derived to determine the important parameters that control the drug release.

▶ CP-Mo-E-61-5 17:20–17:40

Proof of A Conjecture for the One-dimensional Perturbed Gelfand Problem from Combustion Theory

Wang, Shin-Hwa — National Tsing Hua Univ.
Huang, Shao Yuan — National Tsing Hua Univ.

Abstract: We study the global bifurcation curves and exact multiplicity of positive solutions for the one-dimensional perturbed Gelfand problem%

$$\left\{ \begin{array}{l} u''(x) + \lambda \exp\left(\frac{au}{a+u}\right) = 0, \ \% - 1 < x < 1, \\ u(-1) = u(1) = 0,\% \end{array} \right. \%$$

% where $\lambda, a > 0$. We prove that there exists a_0 $(\approx 4.069) > 4$ such that, on the $(\lambda, ||u||_\infty)$-plane, the bifurcation curve is S-shaped for $a > a_0$ and is monotone increasing for $0 < a \leq a_0$. It is joint work with Shao-Yuan Huang.

▶ CP-Mo-E-61-6 17:40–18:00

A Variational Property on the Bifurcation Curve for A Positone Problem with Cubic Nonlinearity

Huang, Shao Yuan — National Tsing Hua Univ.
Wang, Shin-Hwa — National Tsing Hua Univ.

Abstract: We study a variational property on the bifurcation curve for a positone problem%

$$\left\{ \begin{array}{l} u''(x) + \lambda f(u) = 0, \quad -1 < x < 1, \quad u(-1) = u(1) = 0, \\ f(u) = -\varepsilon u^3 + \sigma u^2 + \tau u + \rho, \% \end{array} \right. \%$$

% where $\lambda, \varepsilon, \sigma, \rho > 0$, $\tau \geq 0$. Precisely, we study the order relations of two degenerate positive solutions and numbers $\%\gamma$, p_1 and p_2, satisfying $f''(\gamma) = 0$ and

$$f(p_1) - p_1 f'(p_1) = f(p_2) - p_2 f'(p_2) = 0.$$

CP-Mo-E-62 16:00–18:20 102

Partial Differential Equations

Chair: Skalak, Zdenek — Inst. of Hydrodynamics AS CR

Abstract:

▶ CP-Mo-E-62-1 16:00–16:20

Regularity of the Solutions to the Navier-Stokes Equations Based on Conditional Regularity Imposed on the Velocity Gradient

Skalak, Zdenek — Inst. of Hydrodynamics AS CR

Abstract: We present recent results concerning the regularity of solutions to the Navier-Stokes equations in the whole three-dimensional space under the assumption that some additional conditions are imposed on one or more entries of the velocity gradient. We use the frame of the Lebesgue and Besov spaces and stress that most of the results proved so far are not, especially in the case of the Besov spaces, satisfactory from the scaling point of view.

▶ CP-Mo-E-62-2 16:20–16:40

Solutions to An Advanced Functional Partial Differential Equation of the Pantograph-type

Zaidi, Ali Ashher — Massey Univ., Auckland

Abstract: A model for cells structured by size undergoing growth and division leads to an initial boundary value problem that involves a first-order linear pde with a functional term. The separable solution to this problem has been studied extensively and plays an important role in the long term behaviour of solutions. The solution to the problem for arbitrary initial distributions, however, is elusive owing to the presence of the functional term and the paucity of solution techniques for such problems. We derive a solution to the problem for arbitrary initial cell distributions. The method employed exploits the hyperbolic character of the underlying differential operator, and the advanced nature of the functional argument to reduce the problem to a sequence of simple Cauchy problems. The existence of solutions for arbitrary initial distributions is established along with uniqueness. The asymptotic relationship with the separable solution is also established.

▶ CP-Mo-E-62-3 16:40–17:00

The Number of Boundary Conditions for Initial Boundary Value Problems

Nordstrom, Jan — Linkoping Univ.

Abstract: Both the energy method and the Laplace transform method can be used for determining the number of boundary conditions required for a well posed initial boundary value problem. The energy method builds on integration-by-parts combined with a suitable choice of norm. The Laplace transform method is completely different, and employs an expansion of the solution in modes. These two methods stemming from the beginning of the 70's, give the same result on all well known equation sets. However, so far it has not has not been clarified why. We reconsile the two methods, clearly explain why the results are the same and exemplify the theoretical development on two challenging problems: the compressible and incompressible Navier-Stokes equations.

▶ CP-Mo-E-62-4 17:00–17:20

Blow-up of Solutions of Reaction-Diffusion System Arising from Biology

ARUMUGAM, GURUSAMY — BHARATHIAR Univ.

Abstract: This work is devoted to the mathematical analysis of a reaction-diffusion system with cross-diffusion modeling the dispersal of an epidemic disease. We consider the propagation of an epidemic disease in a spatially distributed population and analyze the population densities at time t and the spatial location x of susceptible, infectious and recovered individuals. The existence of solutions is carried out by using the Galerkin technique and a compactness argument. Under suitable assumptions the blow-up of solutions is also established.

▶ CP-Mo-E-62-5 17:20–17:40

Explicit High-order Time Stepping Based on Componentwise Application of Asymptotic Block Lanczos Iteration

Lambers, James — Univ. of Southern Mississippi

Abstract: This talk describes explicit time stepping methods for linear and nonlinear PDEs that are specifically designed to cope with stiffness. As stiffness is caused by the contrasting behavior of coupled components of the solution, it is proposed to adopt a componentwise approach in which each Fourier coefficient of the solution is computed using an individualized approximation of the solution operator. This is accomplished by Krylov subspace spectral (KSS) methods, which treat these Fourier coefficients as bilinear forms involving matrix functions, that can be approximated using block Gaussian quadrature rules. The required quadrature nodes can be rapidly approximated using asymptotic analysis of the recursion coefficients produced by block Lanczos iteration. The effectiveness of this approach is illustrated through numerical

results obtained from the application of KSS methods to diffusion equations and wave equations, as well as nonlinear equations through combination with exponential propagation iterative (EPI) methods.

▶ CP-Mo-E-62-6 17:40–18:00

A Robust and Contact Resolving Riemann Solver in Two Dimensional Cylindrical Gemetry

Shen, Zhijun — Inst. of applied physics & computational mathematics

Abstract: This paper reviews some critical issues for the popular cell-centered numerical algorithms written in cylindrical geometry for compressible fluid. These issues include the spherical symmetry, conservation, singularity in the geometrical source and the compatibility between the numerical flux and nodal motion manner. Based on the understanding to above issues, some new cell-centered arbitrary Lagrangian Eulerian (ALE) methods on unstructured meshes are proposed. The main new feature of these algorithms is to establish a multi-dimensional Riemann solver based on HLLC method (denoted by ALE HLLC-2D). In the Riemann solver, a node-based discretization of the numerical fluxes is obtained through the computation of the time rate of change of the cell volume. It allows to derive finite volume numerical schemes that are compatible with the geometric conservation law (GCL). By employing the Riemann solver, the Eulerian ,ALE and Lagrangian formulations are written as a unified form and can be transformed freely.

▶ CP-Mo-E-62-7 18:00–18:20

The Growth of the Vorticity Gradient for the Two-dimensional Euler Flow on A Symmetric Domain with A Corner

Itoh, Tsubasa — Tokyo Inst. of Tech.
Yoneda, Tsuyoshi — Department of Mathematics, Tokyo Inst. of Tech.
Miura, Hideyuki — tokyo Inst. of Tech.

Abstract: We consider the two-dimensional Euler equation in a sector under a simple symmetry condition. It is shown that the growth of the vorticity gradient is depending on the angle of the sector. Moreover we generalize this result to the case of a symmetric domain with a corner.

CP-Mo-E-63 16:00–18:20 103
Numerical Analysis

Chair: Mehra, Mani — Indian Inst. of Tech. Delhi

Abstract:

▶ CP-Mo-E-63-1 16:00–16:20

High-order Compact Finite Difference Method for Black-Scholes PDE in Option Pricing

Mehra, Mani — Indian Inst. of Tech. Delhi
PATEL, KULDIP SINGH — INDIAN Inst. OF Tech. DELHI

Abstract: In 1973, F. Black and M. Scholes proposed a partial differential equation (PDE) for pricing European option. In this work, high order compact finite difference method on non-uniform grid using polynomial interpolation is used to solve the Black-Scholes PDE. Accuracy of order δx^3 is obtained for non-uniform grid. Results obtained are compared with the analytic solution.

▶ CP-Mo-E-63-2 16:20–16:40

The 2-Point Explicit Group Iterative Method with Complexity Reduction Approaches for Solving Second Order Composite Closed Newton-Cotes Quadrature System

Muthuvalu, Mohana — Universiti Teknologi PETRONAS

Abstract: In this paper, we introduce and analyse the performance of complexity reduction approaches with 2-Point Explicit Group (2-EG) iterative method for solving dense linear systems that arise from the second kind Fredholm integral equations. The derivation and implementation of the proposed methods are described. We present results of some test examples and computational complexity analysis to illustrate the efficiency of the proposed methods.

▶ CP-Mo-E-63-3 16:40–17:00

Finite Volume Approximation of Leaky Integrate-and-fire Model with Levy Noise

Singh, Paramjeet — Thapar Univ., Patiala

Abstract: We investigate the numerical analysis of leaky integrate-and-fire model with Levy noise. We consider a single neuronal model and write the probability density function in the form hyperbolic conservation laws. Levy noise is included due to jumps caused by excitatory and inhibitory impulses. Due to these jumps the resulting equation have two integrals in right side (jumps). We design, implement, and analyze numerical methods based on Gudunov finite volume approximation. Some numerical examples are also included.

▶ CP-Mo-E-63-4 17:00–17:20

Analysis of A Mixed Formulation of A Bilateral Obstacle Problem

MERMRI, El Bekkaye — Faculty of Sci., Univ. Mohammed Premier
Bouchlaghem, Mohammed — Univ. Mohammed Premier - Faculty of Sci. in Oujda

Abstract: We consider a variational inequality problem called bilateral obstacle problem. Based on the reformulation of the bilateral obstacle problem presented by Mermri et al. (2003), we transform the problem into a saddle point problem of a Langrangian function $\mathcal{L}(u, \mu)$, where u is the solution of the problem and the Lagrange multiplier μ is a function which characterizes the non-contact domain of the problem. Then we consider a discretization of the problem based on finite element method. In this paper we present the analysis of the continuous and the discrete problem. Then we show the convergence of the approximate solutions (u_h, μ_h) to the exact one (u, μ) and provide an error estimate. To solve the mixed formulation, we apply an iterative method and prove its convergence.

▶ CP-Mo-E-63-5 17:20–17:40

Fourth-order Off-Step Discretization for the System of 2D Non-linear Elliptic PDEs.

Setia, Nikita — Univ. of Delhi

Abstract: A new fourth-order difference method for solving the system of two-dimensional non-linear elliptic PDEs with variable coefficients is proposed. The difference scheme referred to as off-step discretization is applicable directly to the singular problems and problems in polar coordinates. Stability Analysis of the method applied to steady-state Convection-Diffusion equation is discussed. The methods are applied to many physical problems of interest including the steady-state Navier-Stokes equations of motion.

▶ CP-Mo-E-63-6 17:40–18:00

Phase-fitted and Optimized Zero-Dissipative Fourth Order Hybrid Method for Oscillatory Problems

Ismail, Fudziah — Universiti Putra Malaysia
Ahmad, Sufiazulfa — Universiti Putra Malaysia
Senu, Norazak — Universiti Putra Malaysia

Abstract: In this paper, we are concerned with the numerical method for solving special second-order ordinary differential equation which are oscillatory in nature. This type of differential equations cannot be solved efficiently using conventional methods. The problems need to be integrated over a cycle of the oscillation. To address the problem, a lot of research has been focused on developing methods with reduced phase-lag and dissipation. Phase-lag is the angle between the true and the approximated solution. In this work, we developed explicit hybrid method of three-stage fourth-order by imposing the phase lag, amplification error and the first derivative of the phase-lag relation. The new method is called optimized hybrid method and it is based on the existing non-zero-dissipative hybrid method in the literature. The comparisons of the new optimized method with other methods in the literature have shown that the new method is more efficient.

▶ CP-Mo-E-63-7 18:00–18:20

High-order Accurate Difference Potentials Methods for 2–D Parabolic Interface Problems

Albright, Jason — Univ. of Utah
Epshteyn, Yekaterina — Univ. of Utah
Xia, Qing — Univ. of Utah

Abstract: Designing high-order accurate numerical methods for interface problems or problems on arbitrary-shaped domains is a challenging area. The Difference Potentials Method(DPM) can be viewed as a discrete analog of the method of generalized Calderon potentials and Calderon boundary equations with projections. Recently, DPM was developed for parabolic interface problems. I will present our high-order accurate DPM approach and highlight its performance with several 2–D examples.
Co-authors: Yekaterina Epshteyn, University of Utah Qing Xia, University of Utah

CP-Mo-E-64 16:00–18:00 104
Probability and Statistics

Chair: Herdiani, Erna Tri — Hasanuddin Univ.

Abstract:

▶ CP-Mo-E-64-1 16:00–16:20

Application of Vector Variance without Duplication for Testing Hypothesis of Equality Covariance Matrix

Herdiani, Erna Tri — Hasanuddin Univ.
Sunusi, Nurtiti — Hasanuddin Univ.

Abstract: Testing hypothesis of equality covariance matrix has been studied by researchers, either data or engaged in health economics. The usual

method is the likelihood ratio and Wald statistics. The basic theory used includes determinants, and the inverse of the covariance matrix. In practice, when the number of variables involved is large enough, it turns out to cause problems. Problems encountered related to the value of the inverse covariance matrix are not positive definite or difficulty calculation of the inverse matrix is large. Some researchers were been to avoid the calculation of the inverse of a matrix by utilizing generalized inverse vector and variance. In this paper, we will propose variance vector without duplication. It will be used in testing the hypothesis matrix between the two populations.

▶ CP-Mo-E-64-2 16:20–16:40

Effective Path Tracking in Polyhedral Homotopy Continuation Method

Lee, Tsung-Lin — National Sun Yat-sen Univ.

Abstract: When solving polynomial systems by polyhedral homotopy continuation method, many curves may diverge in the end. Tracking divergent solution curves will not reach solution of target system and its computation is costly. The curve expression theory will be considered. The leading term of the series expansion can be used to identify the multiplicity of solutions and to determine whether a homotopy curve diverges, which leads to a more efficient method.

▶ CP-Mo-E-64-3 16:40–17:00

On A Linear Finite Volume Scheme to the Keller-Segel System Modeling Chemotaxis

Zhou, Guanyu — Unversity of Tokyo

Abstract: We are concerned with the finite volume approximation for the Keller-Segel system, which describes the aggregation of slime moulds resulting from their chemotactic features. We study a linear finite-volume scheme satisfies both positivity and mass conservation properties. Under some assumptions on mesh, we establish error estimates in L^p-norm with a suitable $p > d$, where d is the dimension of a spatial domain. We apply the analytical semi-group theory of the discrete Laplace operator to the error analysis. We derive the discrete version of Lyapunov functional for the finite volume solution, where the Lyapunov functional play important role in studying the global behavior of solution of Keller-Segel system. Some numerical experiments are performed to verity the theoretical results.

▶ CP-Mo-E-64-4 17:00–17:20

An Adaptive Clustering for Functional Data

Lue, Heng-Hui — Tunghai Univ.

Abstract: We propose a new adaptive approach for clustering functional data. The data-adaptive searching method based on dimension reduction theory is proposed for estimating the basis functions and the sufficient dimension reduction space of predictors. These estimates are obtained through local linear approximation techniques without requiring a prespecified parametric model. A K-means clustering method is then adopted for functional clustering analysis. Several simulations are reported for illustration.

CP-Mo-E-65 16:00–18:20 105

Materials Science and Solid Mechanics

Chair: Canning, Andrew — Lawrenece Berkeley National Laboratory, UC Davis

Abstract:

▶ CP-Mo-E-65-1 16:00–16:20

Hybrid OpenMP/MPI CG Eigensolver for Ab Initio Plane Wave Materials Science Codes

Canning, Andrew — Lawrenece Berkeley National Laboratory, UC Davis

Abstract: In recent years ab initio density functional theory (DFT) based materials science codes based using plane waves (PW) have become the largest user (by method) of computer cycles at scientific computer centers around the world. We present a hybrid OpenMP/MPI Conjugate Gradient based iterative eigensolver that allows this approach to scale to tens of thousands of cores on modern many core parallel computers. Performance results will be presented on Cray many core architectures.

▶ CP-Mo-E-65-2 16:20–16:40

On Analytical Solution of Equilibrium Equations for Transversely Isotropic Plates with Initial Stresses

Khoma, Ivan — S.P.Timoshenko Inst. of the NAS of Ukraine

Dashko, Olga — S. P. Timoshenko Inst. of Mechanics of the NAS of Ukraine

Abstract: A method of representation of the general analytical solution for equilibrium equations for transversally isotropic plates with initial stresses is presented. A method of expanding the unknown functions into Fourier series through the Legendre polynomials of a thickness coordinate is used. The differential equations system for the expansion coefficients as the functions of two independent variables and the corresponding boundary conditions are obtained. In the case of symmetrical deformation relative to a middle plane, the solution of the system is presented in terms of holomorphic and metaharmonic functions. The solution for a problem on three-dimensional stress distribution near a circular hole in the unbounded plate under applied tension and shear stresses at infinity is given.

▶ CP-Mo-E-65-3 16:40–17:00

On the Effect of Lumped Mass Matrices on the Dynamic Responses of Beams under Moving Loads.

Israel, Abiala — Univ. of Lagos, Akoka, Lagos

Bolaji, Bukola — Federal Univ. Oye-Ekiti, Ekiti State

Abstract: In this paper, the effect of the Lumped Mass Matrices (LMM) on the dynamic response of beams under uniformly distributed moving loads is investigated. The analysis was done by using finite element method. In this study, material properties, throughout the length of the beams under consideration are assumed to be homogeneous. The elements stiffness, mass and centripetal acceleration matrices as well as the load vectors were derived by applying the Galerkin's Weighted Residual Method (GWRM). Newmark's integration method is used to obtain the dynamic response of beams under uniformly distributed moving loads. Comparisons were made between the dynamic responses of beams under moving loads using Consistent Mass Matrices (CMM) and Lumped Mass Matrices (LMM) respectively. Numerical examples are presented to show the effects of lumped mass on the influences of :(i) velocity of the moving load; (ii) load's length on the dynamic response of beam under uniformly distributed moving loads.

▶ CP-Mo-E-65-4 17:00–17:20

A Dynamical Systems Approach to the Discrimination of Cryptographic Modes of Operation

Baetens, Jan — Ghent Univ.

Machicao, Jeaneth — Univ. of São Paulo

De Baets, Bernard — Ghent Univ.

Bruno, Odemir — Univ. of Sao Paulo

Abstract: Evidence of signatures associated with cryptographic modes of operation is established in this work by relying on Lyapunov exponents for estimating the divergence among ciphertexts as the encryption algorithm is applied iteratively. Using our approach it turns out to be possible to discriminate between six modes of operation, namely ECB, CBC, OFB, CFB, CTR and PCBC, for different block ciphers, such as DES, IDEA, TEA, and others.

▶ CP-Mo-E-65-5 17:20–17:40

Disc Having Variable Thickness and Density Profile Rotating with Constant Angular Speed Using Transition Theory

Sahni, Manoj — Pandit Deendayal Petroleum Univ., Gandhinagar

Sharma, Sanjeev — Jaypee Inst. of Information Tech., Noida

Abstract: In this paper, a disc is considered with variable thickness from the rim to the bore which is rotating with constant angular speed about an axis. A theoretical study is done keeping the load at the outer boundary of the annular disc using transition theory in which a transition phase is dealt with in between the two phases of elastic and plastic. A graph is drawn between the radii ratio and the variation in density and thickness considering both with edge load and without. An axis-symmetric case of a thin annular disc is considered. The angular speed required for initial yielding and fully plasticity is obtained using Transition theory. A rotating disc having variable thickness and density with edge loading requires higher percentage increase in angular speed to become fully plastic than to its initial yielding as compared to a rotating disc having variable thickness under density variation without edge

▶ CP-Mo-E-65-6 17:40–18:00

Stress Localisation in Equilibrium Shapes of Twisted and Folded Elastic Strips

Van Der Heijden, Gert — Univ. College London

Starostin, Eugene — Univ. College London

Abstract: We study isometric deformations of thin elastic strips of various (Moebius and other) topologies. A centreline-reduced variational formulation gives convenient equilibrium equations in (second-order) Euler-Poincare form. Numerical solutions reveal how closed strips fold into compact shapes with points of stress localisation as the length-to-width ratio of the strip is decreased. Our results may be relevant for determining curvature effects on physical properties of extremely thin two-dimensional structures as for instance produced in nanostructured origami.

▶ CP-Mo-E-65-7 18:00–18:20

On the N–dimensional Oseen–Brinkman Flow Around An (n-1)–dimensional Solid Obstacle

Wendland, Wolfgang — IANS Univ. Stuttgart

Kohr, Mirela Univ. Stuttgart
Medková, Dagmar Univ. Stuttgart

Abstract: We present a layer potential analysis in order to show the well–posedness of modeling a transmission problem for the Oseen and Brinkman systems in open sets in $\mathbb{R}^m$ $(m = 2$ or $3)$ with compact Lipschitz boundaries and around an $(m-1)$–dimensional solid obstacle when the data belong to some L^q spaces.

MS-Mo-E-66 16:00–18:00 VIP4-3
Current Trends in Wavelet Methods - Part II of II
For Part 1, see MS-Mo-D-66

Organizer: Manchanda, Pammy Guru Nanak Dev Univ., Amritsar
Organizer: Siddiqi,Prof., Abul Sharda Univ.,NCR

Abstract: A formal development of wavelet methods was initiated by a geophysicist Morlet and subsequently Meyer, Mallat, Daubechies, Donoho, Coifman et al played important role in providing a solid mathematical foundation of this theme. Several variants of wavelets such as wavelet packets, wave packets, complex wavelets, dyadic wavelets, curvelets, shearlets, framelets, vector valued wavelets have been studied along with their interesting applications. Relevance of wavelet methods to computerized tomography specially to the Radon transform and its variants have been studied in the recent years. It is well known by now that radon transform plays a significant role in medical imaging. In this mini symposium, updated results in the above mentioned fields will be presented including the results of the speakers in this area.

▶MS-Mo-E-66-1 16:00–16:30
A Review of Certain Variants of Wavelets
Manchanda, Pammy Guru Nanak Dev Univ., Amritsar

Abstract: Wavelet packets, Wave packets, Walsh type wavelets, Framelets, Complex Wavelets, Curvelets, Shearlets, Alpha-molecules, Haar-Vilenkin Wavelet, Wavelets associated with nonuniform multi resolution analysis and vector valued wavelets are some of the typical variants of wavelets which have been extensively studied in the recent past. In this talk a resume of some of the results particularly in the area of Nonuniform multi resolution analysis and associated wavelets, Haar Vilenkin wavelet, obtained by us will be discussed

▶MS-Mo-E-66-2 16:30–17:00
Estimation of Radar Targets Satisfying the Wide Sense Stationary with Uncorrelated Scattering Assumption
Pfander, Goetz Jacobs Univ.

Abstract: Many radar targets possess randomly varying parts which are described by a random process known as spreading function. Recent developments in operator sampling theory suggest novel channel sounding procedures that allow for the determination of the targets' scattering function given complete statistical knowledge of the operator response to a single weighted pulse train. The presented results apply whenever the scattering function is supported on a compact subset of the time-frequency plane of arbitrary large

▶MS-Mo-E-66-3 17:00–17:30
Sampling of Deterministic Operators
Walnut, David George Mason Univ.

Abstract: Operator Sampling is a generalization of classical sampling in which the objects being reconstructed from limited data are operators rather than functions. This theory is rooted in work of Kailath and Bello in the 1960s on the sounding of spread-spectrum communication channels. We will describe the tools from time-frequency analysis that are brought to bear on the problem, and describe connections to finite frame theory, capacity estimation of time-variant channels, and compressive sensing.

▶MS-Mo-E-66-4 17:30–18:00
Wavelet Transform for Tomography
Siddiqi,Prof., Abul Sharda Univ.,NCR

Abstract: Computer Tomography has been a major event in diagnostic medicine. An interesting account of this theme combined with Radon Transform and Fourier analysis can be found in a book by Prestini. In the recent past there are several research papers devoted to the role of wavelets and their variants in Tomography , Bottema et.al . An application of wavelets in Tomography. These developments along with some of our own results will be discussed.

SL-Mo-1 19:00–20:00 Ballroom C
Special Lecture
Chair: Keyfitz, Barbara
Abstract:

▶SL-Mo-1 19:00–20:00
Learning and Efficiency in Games with Dynamic Population
Tardos, Éva Cornell University

Abstract:

Tuesday, August 11, 2015

IL-Tu-1 8:30–9:30 Ballroom A
Invited Lecture
Chair: Kako, Takashi
Abstract:

▶ IL-Tu-1 8:30–9:30
Seismic full waveform inversion and the Monge-Ampère equation
Engquist, Björn University of Texas at Austin

Abstract:

IL-Tu-2 8:30–9:30 Ballroom B
Invited Lecture
Chair: Strang, Gilbert
Abstract:

▶ IL-Tu-2 8:30–9:30
From phenomena of synchronization to exact synchronization and approximate synchronization for hyperbolic systems
Li, Tatsien Fudan University

Abstract: In this talk the synchronization will be initially studied for infinite dimensional dynamical systems of partial differential equations instead of finite dimensional systems of ordinary differential equations, and will be connected with the control theory via boundary controls in a finite time interval. More precisely, various kinds of exact boundary synchronization and approximate boundary synchronization will be introduced and realized by means of fewer boundary controls for a coupled system of wave equations with Dirichlet boundary controls. Moreover, as necessary conditions for various kinds of approximate boundary synchronization, Criteria of Kalman's type are obtained. Finally some prospects will be given.

IL-Tu-3 8:30–9:30 Ballroom C
Invited Lecture
Chair: Otto, Felix
Abstract:

▶ IL-Tu-3 8:30–9:30
An Applied Math Perspective on Climate Science, Turbulence, and Other Complex Systems
Majda, Andrew J. Courant Institute at New York University

Abstract:

IL-Tu-4 10:00–11:00 Ballroom A
Invited Lecture
Chair: Ma, Zhiming
Abstract:

▶ IL-Tu-4 10:00–11:00
Covering the Uncertainty of Distributions by Nonlinear Expectation, Nonlinear PDE and BSDE
Peng, Shige Shandong University

Abstract: The uncertainty of probability distributions can be described and calculated by nonlinear expectation. Nonlinear parabolic PDE plays a crucially important role in the modeling and calculation of this model uncertainty problem. The theoretical foundation is our new law of large numbers and central limit theorem in the framework of nonlinear expectation. We also discuss the corresponding continuous time frameworks.

IL-Tu-5 10:00–11:00 Ballroom B
Invited Lecture
Chair: Huang, Yunqing
Abstract:

▶ IL-Tu-5 10:00–11:00
A PDE Approach to Numerical Fractional Diffusion
Nochetto, Ricardo University of Maryland

Abstract: Fractional diffusion has become a fundamental tool for the modeling of multiscale and heterogeneous phenomena. However, due to its nonlocal nature, its accurate numerical approximation is delicate. We survey our research program on the design and analysis of efficient solution techniques for problems involving fractional powers of elliptic operators. Starting from a localization PDE result for these operators, we develop local techniques for their solution: a priori and a posteriori error analyses, adaptivity and multilevel methods. We show the flexibility of our approach by proposing and analyzing local solution techniques for a space-time fractional parabolic equation.

IL-Tu-6 10:00–11:00 Ballroom C
Invited Lecture
Chair: Grandine, Thomas A.
Abstract:

▶ IL-Tu-6 10:00–11:00
Grid and Grid Control Optimization in Europe
Sax, Ludger Grid Optimization Europe - System Planning Gas & Water

Abstract: Until the end of the last millennium the gas industry was an integrated business. The integration of trading, network and gas storage facilities within a single enterprise guaranteed firstly the security of supply and lastly comfortable profits for the companies operating in this business. These high profits were a thorn in the eyes of the EU which tried to bring down energy prices by liberalizing and regulating the energy market.
Regulation meant that companies had to unbundle the trading arm from the network. This disintegration almost allowed the issue of security of supply to fall by the wayside because this role was now split between two different market players with divergent interests.
Newly established Transport System Operators (TSOs) had to simplify the system of tarification, introducing an entry and exit system that allows customers to be supplied from any grid entry point without this being linked to a specific route. For these TSOs, network planning has become much more complex. They rely on engineers and mathematicians to apply contemporary mathematics and state-of-the-art technology to establish modern mathematical methods in the planning and control of gas transport networks. This is so as to maximize grid capacity at minimum cost, thereby safeguarding security of supply. In other words, more "Mathematics to Gas Industry", M2GI, the only way of maximizing the provision of capacity that can be freely allocated, of optimizing the grid and grid control to handle this and of reinstating security of supply.

IL-Tu-7 11:10–12:10 Ballroom A
Invited Lecture
Chair: E, Weinan
Abstract:

▶ IL-Tu-7 11:10–12:10
Modeling Rare Transition Events
Vanden-Eijnden, Eric New York University

Abstract: Dynamics in nature often proceed in the form of rare transition events: The system under study spends very long periods of time at various metastable states; only very rarely it hops from one metastable state to another. Understanding the dynamics of such systems requires us to study the ensemble of transition paths between the different metastable states. Transition path theory is a general mathematical framework developed for this purpose. It is also the foundation for developing modern numerical algorithms such as the string method for finding the transition pathways. We review the basic ingredients of the transition path theory and discuss connections with the more classical transition state theory. We also discuss how the string method arises in order to find approximate solutions in the framework of the transition path theory.

IL-Tu-8 11:10–12:10 Ballroom B
Invited Lecture
Chair: Chayes, Jennifer
Abstract:

▶ IL-Tu-8 11:10–12:10
Explorations in the biofluid dynamics of locomotion
Fauci, Lisa Tulane University

Abstract: In the past decade the study of the fluid dynamics of swimming organisms has flourished. With the possibility of using fabricated robotic micro swimmers for drug delivery, the need for a full description of flow properties is evident. At a larger scale, the swimming of a simple vertebrate, the lamprey, can shed light on the coupling of neural signals to muscle mechanics and passive body dynamics in animal locomotion. We will present recent progress in the development of a computational model of a lamprey with proprioceptive feedback and examine the emergent swimming behavior of the coupled fluid-muscle-body system . At the micro scale, we will examine the swimming of a flagellum in a viscoelastic network. We hope to demonstrate that even when body kinematics at zero Reynolds number are specified, there are still interesting fluid dynamic questions that have yet to be answered.

IL-Tu-9 11:10–12:10 Ballroom C
Invited Lecture
Chair: Jiang, Song
Abstract:

▶ IL-Tu-9 11:10–12:10
Randomized Algorithms in Linear Algebra
Kannan, Ravi — Microsoft Research

Abstract: A small random sample of rows/columns of any matrix is a decent proxy for the matrix, provided sampling probabilities are proportional to squared lengths. Since the early theorems on this from the 90's, there has been a substantial body of work using sampling (random projections and probabilties based on leverage scores are two examples) to reduce matrix sizes for Linear Algebra computations. The talk will describe theorems, applications and challenges in the area.

EM-Tu-D-01 13:30–15:30 311A
Third Workshop on Hybrid Methodologies for Symbolic-Numeric Computation - Part III of VIII
For Part 1, see EM-Mo-D-01
For Part 2, see EM-Mo-E-01
For Part 4, see EM-Tu-E-01
For Part 5, see EM-We-D-01
For Part 6, see EM-We-E-01
For Part 7, see EM-Th-BC-01
For Part 8, see EM-Th-D-01
Organizer: Giesbrecht, Mark — Univ. of Waterloo
Organizer: Kaltofen, Erich — North Carolina State Univ.
Organizer: Safey El Din, Mohab — Univ. Pierre & Marie Curie
Organizer: Zhi, Lihong — Acad. of Mathematics & Sys. Sci.
Abstract: Hybrid symbolic-numeric computation methods, which first appeared some twenty years ago, have gained considerable prominence. Algorithms have been developed that improve numeric robustness (e.g., in quadrature or solving ODE systems) using symbolic techniques prior to, or during, a numerical solution. Likewise, traditionally symbolic algorithms have seen speed improvements from adaptation of numeric methods (e.g., lattice reduction methods). There is also an emerging approach of characterizing, locating, and solving "interesting nearby problems", wherein one seeks an important event (for example a nontrivial factorization or other useful singularities), that in some measure is close to a given problem (one that might have only imprecisely specified data). Many novel techniques have been developed in these complementary areas, but there is a general belief that a deeper understanding and wider approach will foster future progress. The problems we are interested are driven by applications in computational physics (quadrature of singular integrals), dynamics (symplectic integrators), robotics (global solutions of direct and inverse problems near singular manifolds), control theory (stability of models), and the engineering of large-scale continuous and hybrid discrete-continuous dynamical systems. Emphasis will be given to validated and certified outputs via algebraic and exact techniques, error estimation, interval techniques and optimization strategies.
Our workshop will follow up on the seminal SIAM-MSRI Workshop on Hybrid Methodologies for Symbolic-Numeric Computation held in November 2010 and the Fields Institute Workshop on Hybrid Methodologies for Symbolic-Numeric Computation, November 16-19, 2011 at the University of Waterloo, Canada. We will provide a forum for researchers on all sides of hybrid symbolic-numeric computation.

▶ EM-Tu-D-01-1 13:30–14:30
Spherical t_ϵ Designs and Numerical Approximations on the Sphere
Chen, Xiaojun — Department of Applied Mathematics, The Hong Kong Polytechnic Univ.

Abstract: Spherical t_ϵ-designs with $\epsilon \in [0, 1)$ provide positive weight quadrature rules for the sphere which are exact for polynomials up to degree t. Spherical t_ϵ-designs with $\epsilon = 0$ are spherical t-designs which provide equal weight quadrature rules. In this talk, we introduce a computational algorithm based on interval arithmetic which, for given t, upon successful completion will have proved the existence of a t-design with $(t + 1)^2$ nodes on the unit sphere $S^2 \subseteq R^3$ and will have computed narrow interval enclosures which are known to contain these nodes with mathematical certainty. Since there is no theoretical result which proves the existence of a t-design with $(t + 1)^2$ nodes for arbitrary t, our method contributes to the theory because it was tested successfully for $t = 1, 2, \ldots, 100$. The t-design is usually not unique; our method aims at finding a well-conditioned one. The method relies on computing an interval enclosure for the zero of a highly nonlinear system of dimension $(t+1)^2$. Moreover, we show that any point set in the interval enclosures is a spherical t_ϵ design. Numerical results illustrate good performance of spherical t_ϵ-designs for numerical integration and function approximation on the sphere.

▶ EM-Tu-D-01-2 14:30–15:00
High-precision Verified Eigenvalue Bounds for Self-adjoint Differential Operators
Liu, Xuefeng — Niigata Univ., Japan

Abstract: A general framework to give high-precision verified eigenvalue bounds for self-adjoint differential operators will be proposed. The framework is based on the non-conforming finite element method theories and Lehmann-Goerisch's theorem. We will demonstrate the efficiency of the proposed method by its applications to eigenvalue problems of Lapalace and Biharmonic differential operators.

▶ EM-Tu-D-01-3 15:00–15:30
Recent Results in Rounding Error Analysis
Jeannerod, Claude-Pierre — Inria - ENS Lyon

Abstract: This talk will survey very recent improvements of the classical, Wilkinson-style error bounds for summation, inner products, and complex arithmetic. In particular, we will see how to exploit low-level features of standard floating-point arithmetic, and how symbolic computation can help to verify the optimality of some of these new bounds.

EM-Tu-D-02 13:30–15:30 309A
Differential Algebra and Related Topics - Part III of VIII
For Part 1, see EM-Mo-D-02
For Part 2, see EM-Mo-E-02
For Part 4, see EM-Tu-E-02
For Part 5, see EM-We-D-02
For Part 6, see EM-We-E-02
For Part 7, see EM-Fr-D-02
For Part 8, see EM-Fr-E-02
Organizer: Feng, Ruyong — Acad. of Mathematics & Sys. Sci.,CAS
Organizer: Guo, Li — Rutgers Univ. at Newark, USA
Organizer: Gao, Xiao-Shan — Acad. of Mathematics & Sys. Sci., Chinese Acad. of Sci.
Abstract: This meeting is to offer an opportunity for participants to present original research , to learn of reserch progress and new developments on differential algebra and related topics, particularly, the applications of differential algebra to control theory, physics, chemistry, biology and so on.

▶ EM-Tu-D-02-1 13:30–14:30
An Application of the Model Theory of Differential Fields to Poisson Algebras
Moosa, Rahim — Univ. of Waterloo

Abstract: Using families of Manin Kernels in differentially closed fields we answer a question of Brown and Gordon, showing that the Dixmier-Moeglin equivalence fails for affine complex Poisson algebras. On the positive side, using a version of Hrushovski's finiteness theorem on codegree one differential subvarieties, we prove that a natural weakening of the equivalence does hold. I will report on this joint work with Jason Bell, Stephane Launois, and Omar Leon Sanchez.

▶ EM-Tu-D-02-2 14:30–15:00
Generalized Shuffle Algebra
Zhang, Bin — Sichuan Univ.

Abstract: The shuffle algebra of multiple zeta values comprises values at positive arguments. In joint work with L. Guo, we generalized it to the case nonnegative arguments by means of Rota-Baxter techniques. Using a geometric criterion for the linear independence of fractions (with L. Guo and S. Paycha), we further generalize the shuffle product structure to all integer arguments.

▶ EM-Tu-D-02-3 15:00–15:30
Differential Algebra and CR Geometry
Sabzevari, Masoud — Univ. of Shahrekord

Abstract: Computing the symmetry Lie algebra of a CR-manifold, what is called in this terminology by the associated Lie algebra of infinitesimal CR-automorphisms, relies mainly on constructing and solving some certain linear and complex PDE system. We describe the applications of differential algebra techniques and also designed packages like DifferentialAlgebra to manage such computations. For this aim, one needs first to adapt some famous results like Ritt's Reduction Theorem and Rosenfeld-Grobner algorithm for the complex field.

MS-Tu-D-03 13:30–15:30 306A
Applied Integrable Systems - Part III of V
For Part 1, see MS-Mo-D-03
For Part 2, see MS-Mo-E-03
For Part 4, see MS-Tu-E-03
For Part 5, see MS-We-D-03
Organizer: Hu, Xing-Biao Inst. of Computational Mathematics, Chinese Acad. of Sci. (CAS), China
Organizer: Kajiwara, Kenji Kyushu Univ.
Organizer: Kakei, Saburo RIkkyo Univ.
Organizer: Maruno, Kenichi Waseda Univ.
Abstract: In recent years, there have been major developments in applications of integrable systems. Originally, integrability has been recognized through solitons, which are particle-like nonlinear waves in various physical systems. Thanks to rich mathematical structure of integrable systems, recent applications of integrable systems extend to a wide range of pure/applied mathematics and physical sciences, such as algebraic geometry, combinatorics, probability theory, numerical algorithms, cellular automata, (discrete) differential geometry, computer visualizations, statistical physics, nonlinear physics and so on. The purpose of this minisymposium is to bring together researchers to discuss recent advances on various aspects of applied integrable systems.

▶ MS-Tu-D-03-1 13:30–14:00
Ultradiscrete Inverse Scattering and Combinatorics
Willox, Ralph the Univ. of Tokyo
Kakei, Saburo RIkkyo Univ.
Abstract: A novel, inverse scattering-type, technique for solving Cauchy problems for integrable cellular automata will be presented for the case of the ultradiscrete KdV equation, defined over the real numbers. The action-angle variables that arise naturally in this approach turn out to be related in a rather simple way to those that can be obtained from a slightly modifed version of an algorithm proposed by Takagi for calculating the Kerov – Kirillov – Reshetikhin map in the context of rigged-configurations.

▶ MS-Tu-D-03-2 14:00–14:30
Jeu De Taquin Slide and Ultra-discrete KP Equation
Kakei, Saburo RIkkyo Univ.
Abstract: Jeu de taquin is a combinatorial operation on skew Young tableaux. We consider difference equations that describe a Jeu de taquin slide and their relation to the discrete KP equation.

▶ MS-Tu-D-03-3 14:30–15:00
Determinantal Structures in the O'Connell-Yor Polymer
Imamura, Takashi Chiba Univ.
Abstract: O'Connell-Yor polymer is a typical directed polymer model in 2 dimensioanl random media which belongs to the KPZ universality class and has nice integrable structures related to the quantum Toda lattice and the Macdonald processes . In this talk I will report novel determinantal structures in this model. This is a joint work with Tomohiro Sasamoto.

▶ MS-Tu-D-03-4 15:00–15:30
Biorthogonal Polynomials, the Discrete Two-dimensional Toda Molecule and Plane Partitions
Kamioka, Shuhei Kyoto Univ.
Abstract: A connection between biorthogonal polynomials and plane partitions is discussed. For a combinatorial problem of counting plane partitions in a rectangular box, or for an equivalent problem of counting rhombus tilings of a hexagonal region, a product formula of MacMahon type is derived by means of biorthogonal polynomials including the little q-Jacobi polynomials. Another proof by using a special solution to the discrete two-dimensional Toda molecule is also shown.

IM-Tu-D-04 13:30–15:30 308
Mathematics and Algorithms in Computer-Aided Manufacturing, Manufacturing Systems and Numerical Control - Part III of VI
For Part 1, see IM-Mo-D-04
For Part 2, see IM-Mo-E-04
For Part 4, see IM-Tu-E-04
For Part 5, see IM-We-D-04
For Part 6, see IM-We-E-04
Organizer: Li, Hongbo Acad. of Mathematics & Sys. Sci., Chinese Acad. of Sci.
Organizer: Shpitalni, Moshe Technion, Israel
Abstract: The fast development of advanced manufacturing technology has witnessed the growing importance of mathematical methods and algorithms, ranging from algebraic geometry, discrete geometry and differential geometry to differential equations, computational mathematics and computer mathematics. Conversely, problems arising from the field of advanced manufacturing have also stimulated the development of such branches in pure and applied mathematics as computational geometry and mathematics mechanization.
Mathematics and Algorithms for Computer-Aided Manufacturing, Engineering and Numerical Control is intended to be an interdisciplinary forum focusing on the interaction between the side of mathematical methods and algorithms, and the other side of computer-aided manufacturing (CAM), computer-aided engineering (CAE) and computer numerical control (CNC). It concentrates on (but is not restricted to) the following topics: tool path planning, multiscale simulation, feature-based process chain with CAM/CNC coupling, interpolation for CNC controllers.
The proposed industrial mini-symposium of 20 talks will provide an excellent platform for the participants to get acquainted with new research results, to exchange new ideas, and to create new collaboration.
To ensure full success of the proposed mini-symposium, we have invited 8 speakers from abroad. All are knowledgeable world experts in their fields, with impressive records of research, publications and awards, as well as solid background of mathematics. The invited speakers are from various countries and represent different aspects in Manufacturing, Manufacturing Systems and Computer Numerical Control.

▶ IM-Tu-D-04-1 13:30–14:15
Modeling Multi-Stage Assembly Systems for Quality and Productivity
Hu, S. Jack Univ. of Michigan
Abstract: Assembly systems for consumer products are usually consisted of many machines arranged into various configurations. Variability and reliability at the machines can impact the system performance in terms of product quality and system throughput. In this talk, we present models on the propagation of quality variation in multi-stage assembly systems. In particular, the role of part compliance is considered in modeling non-rigid part assembly. We also present analytical models for system throughput prediction.

▶ IM-Tu-D-04-2 14:15–15:00
Simulation Based Machine and Process Development
Uhlmann, Eckart Fraunhofer Inst. for Production Sys. & Design Tech. IPK
Abstract: In competitive markets, it is essential to improve the productivity, which can be achieved by raising the material removal rate. Yet, the dynamic behavior of the machine tool structures, process parameters and the complexity of the process itself can give rise to instabilities which restrict the performance of machines. Simulation models for machining processes and simulation-based machine development can help to optimize process planning and control. These models need to be parameterized and validated.

▶ IM-Tu-D-04-3 15:00–15:30
On the Approximate Expression of Scallop Height under High-Order Contact
Li, Hongbo Acad. of Mathematics & Sys. Sci., Chinese Acad. of Sci.
Abstract: In milling path designing, the scallop height is a key concept. Traditionally, the approximate expression of the scallop height for flat-end cutter is obtained by projecting everything onto a plane perpendicular to the tool path in the space. This is correct for first-order contact, but not for high-order contact. In this talk, we present our recent work on finding the approximate expression of the scallop height for flat-end cutter under high-order contact.

MS-Tu-D-05 13:30–15:30 215
Compressed Sensing, Extensions and Applications - Part III of III
For Part 1, see MS-Mo-D-05
For Part 2, see MS-Mo-E-05
Organizer: Kutyniok, Gitta Technische Universität Berlin
Organizer: Holger, Rauhut RWTH Aachen Univ.
Abstract: Compressed sensing has seen an enormous research activity in recent years. The key principle is that (approximately) sparse signals can be recovered efficiently from what was previously believed to be vastly incomplete information. For this reason, compressed sensing and its algorithms (often convex optimization approaches) have a large range of applications such as magnetic resonance imaging, radar, wireless communications, and more. Remarkably, all provably optimal measurement schemes are based on randomness and therefore, compressed sensing connects various mathematical fields such as random matrix theory, optimization, approximation theory, and harmonic analysis. Recent developments have extended the theory and its algorithms to the recovery of low rank matrices from incomplete informa-

tion, to the phaseless estimation problem, and to low tensor recovery. The minisymposium aims at bringing together experts in the field and to provide an overview of its most recent results.

▶ MS-Tu-D-05-1 13:30–14:00

The State of Quantum Applications of Compressed Sensing and Low-rank Methods

Gross, David — Univ. of Freiburg

Abstract: Early developments in the theory of low-rank matrix recovery sparked significant interest from the physics community. Certain quantum-mechanical estimation problems are well-described in terms of low-rank models. Despite a successful exchange between physics and applied math on the conceptual level of low-rank recovery, experimental implementations were slow to appear. However, this has been changing over the past year. I will report on these developments, explain the initial obstacles and mention remaining open problems (mostly statistical).

▶ MS-Tu-D-05-2 14:00–14:30

Co-Sparse Tomographic Image Recovery: Performance Estimates and Large-Scale Programming

Petra, Stefania — Univ. of Heidelberg

Abstract: We investigate the reconstruction problem of discrete tomography and present a relation between image co-/sparsity and sufficient number of tomographic measurements for exact recovery similar to the settings in Compressed Sensing. Further, known quantisation levels are used as prior knowledge to improve recovery using techniques from the field of discrete graphical models. Finally, regarding recovery algorithms, we focus on decomposition schemes that exploit the problem structure and scale up to large problem sizes.

▶ MS-Tu-D-05-3 14:30–15:00

Quantitative MRI Using Model-based Compressed Sensing

Davies, Mike — Univ. of Edinburgh

Abstract: We develop a model based compressed sensing framework for fully quantitative MRI. That is the simultaneous acquisition of multiple MR physical parameters. The key components are: a random excitation sequence, a random EPI subsampling strategy, and an iterative projection algorithm imposing consistency with the Bloch equations. As long as the excitation sequence possesses persistent excitation, we are able to achieve accurate recovery of the density, T1, T2 and off-resonance maps simultaneously from limited samples.

▶ MS-Tu-D-05-4 15:00–15:30

Cross Validation for Function Approximation: Quantitative Guarantees and Error Estimates

Ward, Rachel — Univ. of Texas at Austin

Abstract: Using tools from compressive sensing and matrix concentration, we provide quantitative guarantees for the accuracy of leave-p-out cross validation towards model selection and error estimation in function interpolation and approximation problems. The guarantees are 'with high probability' with respect to the stochastic sampling points. This is joint work with Holger Rauhut.

MS-Tu-D-06 13:30–15:30 201

Divergence-free elements, grad-div stabilization, and related methods for incompressible flow problems - Part I of II

For Part 2, see MS-Tu-E-06

Organizer: Linke, Alexander — Weierstrass Inst.
Organizer: John, Volker — Weierstrass Inst.
Organizer: Rebholz, Leo — Clemson Univ.

Abstract: Description In recent years, great progress has been achieved in the construction and understanding of divergence-free methods for incompressible flow problems, and in understanding the role of related stabilization methods for mixed finite elements like the grad-div stabilization. Especially, a lack of robustness of classical mixed methods with respect to large irrotational forces makes divergence-free methods appear attractive. The idea of the minisymposium is to gather researchers from around the world, who are active in this field, in order to discuss new ideas and to reflect on possible application fields, where divergence-free methods could outperform classical discretization approaches.

▶ MS-Tu-D-06-1 13:30–14:00

The Divergence Constraint in Mixed Methods for Incompressible Flows: to Relax or Not to Relax?

Linke, Alexander — Weierstrass Inst.

Abstract: The divergence constraint of the incompressible Navier-Stokes equations is revisited in mixed finite elements. Classical stable and convergent mixed elements relax the divergence constraint and only enforce the condition discretely. As a result, these popular methods introduce a pressure-dependent consistency error which can potentially pollute the computed solution. This numerical error is harmful, wherever large and complicated pressures arise, like in large-scale ocean modeling (Coriolis force), coupled flow problems or flows around obstacles. Novel robust mixed methods are discussed, which allow for pressure-independent velocity errors.

▶ MS-Tu-D-06-2 14:00–14:30

Optimal L2 Error for A Modified Crouzeix-Raviart Stokes Element

Wollner, Winnifried — Univ. of Hamburg
Linke, Alexander — Weierstrass Inst.
Merdon, Christian — Weierstrass Inst. for Applied Analysis & Stochastics

Abstract: The talk is concerned with optimal L2 error estimates for the velocity approximation in a nonconforming finite element approximation for the incompressible Stokes equation as proposed in [1]. The contribution of this presentation is to show that also optimal velocity estimates in L2, independent of the pressure, can be derived.

[1] A. Linke, On the Role of the Helmholtz-Decomposition in Mixed Methods for Incompressible Flows and a New Variational Crime. CMAME, Vol. 268, pp. 782-800

▶ MS-Tu-D-06-3 14:30–15:00

Cochain-complex Based Multigrid for Stokes and Darcy-Stokes Problems

Kanschat, Guido — Universität Heidelberg

Abstract: Divergence-conforming discontinuous Galerkin methods for incompressible flow have been applied to different kinds of coupled flow problems during the last years. Here, we demonstrate how cochain-complex based multigrid methods can be used to obtain robust and efficient preconditioners for such methods. We present convergence estimates for the Stokes problem and present numerical results for coupled flow problems.

▶ MS-Tu-D-06-4 15:00–15:30

Flux-preserving Boundary Conditions for Navier-Stokes and Grad-Div Stabilization

Heister, Timo — Clemson Univ.

Abstract: We discuss how incorrect interpolation of boundary conditions in numerical computations especially with Grad-Div stabilization can lead to accuracy issues and present a flux preserving interpolation operator that fixes the problem.

MS-Tu-D-07 13:30–15:30 202A

Mathematics of Climate: From the Tropics to Antarctica - Part III of III

For Part 1, see MS-Mo-D-07
For Part 2, see MS-Mo-E-07

Organizer: Stechmann, Samuel — Univ. of Wisconsin-Madison
Organizer: Golden, Kenneth — Univ. of Utah

Abstract: The Earth offers a multitude of modeling challenges, from the dynamics of the atmosphere and oceans, to the melting of the polar ice caps. To understand and model these climate processes, a wide range of mathematics is needed, such as differential equations, multiscale modeling, and stochastic processes. In this minisymposium, the presentations span a broad range of climate processes and mathematical areas, and will be accessible to a more general audience. They include a blend of modeling, experiments, and data analysis, and demonstrate how mathematics is being employed to address fundamental problems of climate science.

▶ MS-Tu-D-07-1 13:30–14:00

Modeling the Melt: What Math Tells Us about the Shrinking Polar Ice Caps

Golden, Kenneth — Univ. of Utah

Abstract: The precipitous loss of Arctic sea ice has far outpaced expert predictions. We will discuss how mathematical models of composite materials and statistical physics are being used to study key sea ice processes and advance how sea ice is represented in climate models. This work is helping to improve projections of the fate of Earth's ice packs, and the response of polar ecosystems.

▶ MS-Tu-D-07-2 14:00–14:30

A Minimal Model for Precipitating Convection

Smith, Leslie — Univ. of Wisconsin, Madison

Abstract: We consider a minimal model of precipitating, turbulent convection. Cloud microphysics is included assuming fast condensation, auto-conversion and evaporation. The conservation laws for momentum, energy, moist entropy, and total water are retained in simple nontrivial form. We demonstrate that the model is able to capture general features of tropical squall lines. Lin-

ear stability analysis in a saturated environment predicts that the unstable scales depend on rainfall speed, a feature not captured by parcel theory.

▶ CP-Tu-D-07-3 14:30–14:50

Modelling and Simulating Drought Risk in Arid Climates

Pollanen, Marco — Trent Univ.
Paek, Jayeong — Trent Univ.
Abdella, Kenzu — Trent Univ.
Huda, Samsul — Univ. of Western Sydney
Kaitibie, Simeon — Qatar Univ.
Goktepe, Ipek — Qatar Univ.
Moustafa, Ahmed — Al Sulaiteen Agricultural & Industrial Complex (SAIC)

Abstract: We develop stochastic models for temperature, precipitation and humidity for arid climates in order to simulate drought index values and model drought risk so as to improve food security. We validate the models by using historical weather data from Qatar and simulate the price of hypothetical drought derivative contracts designed to protect Qatari agricultural producers from the negative financial impacts associated with drought.

▶ CP-Tu-D-07-4 14:50–15:10

Acceleration of A High Order CFD Solver with Optimized OpenACC Directives

Gong, Jing — KTH Royal Inst. of Tech.

Abstract: Nek5000 is an open-source code for the simulation of incompressible flows. Nek5000 is widely used in a broad range of applications, including the study of thermal hydraulics in nuclear reactor cores, the modeling of ocean currents and the simulation of combustion in mechanical engines.
We have previously introduced a case study of partially porting to parallel GPU-accelerated systems using OpenACC. In this presentation, we follow on from our previously developed work and take advantage of the optimized results to port the full version of Nek5000 to GPU-accelerated systems. The presentation focuses on porting and optimizing the most time-consuming parts of Nek5000 to the GPU systems, namely the matrix-matrix multiplication and the preconditioned CG linear solvers. The gather-scatter method with MPI operations is redesigned to decrease the amount of data transferred between the host and accelerator.

MS-Tu-D-08 13:30–15:30 202B

Inverse Problems for Medical Imaging - Part I of II

For Part 2, see MS-Tu-E-08

Organizer: Lee, Eunjung — Yonsei Univ.
Organizer: Song, Yizhuang — Shandong Normal Univ.

Abstract: This minisymposium focuses on imaging methodologies, mathematical models, and computational algorithms on inverse problems for biomedical applications. The imaging problems in this topic can be formulated as inverse problems that are intrinsically nonlinear. Experiences over the last three decades showed that symbiotic interplay among theoretical mathematics, computational mathematics, and experiments is crucial for understanding and solving these nonlinear problems in practice. With this minisymposium we hope to introduce inverse problems related to biomedical applications, to show how a various methods can solve them, and to present new schemes to solve these inverse problems.

▶ MS-Tu-D-08-1 13:30–14:00

Monitoring of Regional Lung Monotonic Conductivity Changes Using EIT

ZHOU, LIANGDONG — Yonsei Univ.

Abstract: This paper presents a monotonicity-based spatiotemporal conductivity imaging method for continuous regional lung monitoring using electrical impedance tomography(EIT). EIT boundary data can be decomposed into pulmonary, cardiac and other parts using their different periodic nature. Then, the time-differential current-voltage operator corresponding to lung ventilation can be viewed as either semi-positive or semi-negative definite because of monotonic conductivity changes within lung region. The monotonicity constraints enable us to improve the image quality of lung EIT.

▶ MS-Tu-D-08-2 14:00–14:30

Functional Magnetic Resonance Electrical Impedance Tomography Based on Skipped K-space Data

Song, Yizhuang — Shandong Normal Univ.

Abstract: Neural activity associated with opening of ion channels in cell membranes causes an increase in conductivity, which may be probed by developing a fast MREIT technique. We present a method of functional MREIT (fMREIT), which aims to visualize local conductivity changes related to neuronal activity using the technique called Magnetic Resonance Electrical Impedance Tomography (MREIT). The key idea we used is skipping the time consuming phase encoding lines. Numerical experiments validate our proposed method.

▶ MS-Tu-D-08-3 14:30–15:00

Tissue Characterization at Variable Depth Using Localized Planar EIT

Kwon, Hyeuknam — Yonsei

Abstract: This paper presents a multi-scale method of measuring admittivity spectra using the bioimpedance spectroscopy (BIS) having a probe of 64x64 miniaturized electrodes. The proposed method evaluates the average admittivity values of voxels with varying their sizes with suitable combination of BIS data. This method allow to evaluates depth dependent admittivity distribution.

▶ MS-Tu-D-08-4 15:00–15:30

Reconstruction of EIT Images via Patch Based Sparse Representation over Learned Dictionaries

Qi, Wang — Tianjin Polytechnic Univ.

Abstract: This paper presents the study of a new sparse reconstruction method for electrical impedance tomography (EIT). The EIT images are reconstructed based on adaptive patch-based sparse representation. Furthermore, the sparse dictionary is optimized during iteration. Simulation results are provided and compared with that of traditional reconstruction methods.

MS-Tu-D-09 13:30–15:30 203A

Inverse Problems of Model Validation: Challenges, Computational Methods and Applications

Organizer: Kostina, Ekaterina — Univ. of Heidelberg
Organizer: Bock, Hans Georg — IWR, Univ. of Heidelberg

Abstract: Mathematical methods of model-based simulation and optimization are increasingly used in science, engineering and industrial applications. Their successful application requires the development and quantitative validation of mathematical models. This difficult mission is supported by numerical methods for inverse problems of model validation and calibration. Here, fundamental tasks are the estimation of unknown model coefficients by means of experimental data and design of optimal experiments to choose e.g. measurement times and experimental conditions, which deliver sufficiently accurate estimates for the model parameters.
The application of these methods in industrial practice shows, however, that in order to use their full potential we have to deal with a number of new mathematical challenges. The topic of this mini-symposium is on the new developments in efficient numerical methods for inverse problems of model calibration and validation and on the transfer of these methods into challenging application areas.

▶ MS-Tu-D-09-1 13:30–14:00

Algorithms That Satisfy A Stopping Criterion, Probably

Ascher, Uri — Univ. of BC

Abstract: In practical applications, precise value for stopping tolerance is rarely known: only vague idea of desired quality of numerical approximation is available. We discuss case studies from different areas of numerical computation, where uncertainty in error tolerance values and stopping criterion is revealed. We then concentrate on probabilistic relaxation of given tolerance. This allows derivation of proven bounds on the sample size of certain Monte Carlo methods for inverse problems.

▶ MS-Tu-D-09-2 14:00–14:30

Efficient Numerical Methods for Satellite Orbit Determination

Schloeder, Johannes — IWR, Univ. of Heidelberg

Abstract: The paper presents a newly developed multiple shooting method for constrained nonlinear dynamic least squares problems designed for efficient and robust satellite orbit determination. For the generation of appropriate initial guesses, techniques are developed that exploit the type of available ground station measurements. Numerical results for challenging test scenarios using original tracking data of Artemis, Cluster-II and other satellites show that the new method offers substantial advantages compared to the traditionally applied single shooting approaches.

▶ MS-Tu-D-09-3 14:30–15:00

Numerical Methods of Optimum Experimental Design Based on A Second-Order Analysis of Parameter Estimates

Kostina, Ekaterina — Univ. of Heidelberg

Abstract: Methods for optimum experimental design are becoming more popular in industry by at least two reasons. First, increasing use of model-based simulation and optimization implies models validated by experiments. Secondly, OED offers the possibility to significantly reduce parameter errors and costs. Realization of methods in practice shows however, that we have to deal with several new mathematical challenges. On of them is addressed in this talk, namely methods for new robust formulation of OED problem.

▶ MS-Tu-D-09-4 15:00–15:30

Efficient Numerical Methods for Solving Inverse Optimal Control Problems and Recent Computational Results for Modeling Human Locomotion
Bock, Hans Georg — IWR, Univ. of Heidelberg

Abstract: We present an efficient direct all-at-once - or simultaneous - optimization approach for solving inverse optimal control problems. These are complex bi-level optimization problems arising, e.g., in the identification of models for autonomous dynamical behavior. The performance of the method is demonstrated by identifying the parameters of a bio-mechanical optimal control model for the gait of cerebral palsy patients from real-world motion capture data provided by the Motion Lab of the Orthopedic University Hospital Heidelberg.

MS-Tu-D-10 13:30–15:30 206B
Propagation, destruction and recovery dynamics for localized patterns in dissipative systems Part I

Organizer: Nishiura, Yasumasa — Tohoku Univ., WPI-AIMR
Organizer: Iima, Makoto — Hiroshima Univ.

Abstract: Spatially localized patterns arise ubiquitously in many fields including nerve systems, chemical reaction, binary fluids and bio-convection. This minisymposium especially highlights issues concerning wave-particle duality of the traveling spots, destruction of photo sensitive BZ waves, self-recovery property of multi-state network dynamics, and collective motion of self-propelled particles as well as emerging patterns in bioconvection of Euglena gracilis. All these problems are related to the interactive dynamics among the localized species and/or with external environments so that our goal is to extract the underlying common mechanism behind those variety of dynamics. In part I we will focus on the destruction and recovery properties of traveling spots and pulses in reaction diffusion systems. In part II more physical and biological aspect of localized pattern dynamics will be discussed.

▶MS-Tu-D-10-1 13:30–14:00
Wave-particle Duality in Dissipative Systems
Nishiura, Yasumasa — Tohoku Univ., WPI-AIMR

Abstract: Localized traveling spots with oscillatory tails have two different types of dynamic characteristics: one is a localized particle-like behaviors and the other is wave-like dynamics coming from the oscillatory tails. We will discuss about the wave-particle duality in reaction diffusion setting and try to understand a quantum-like behaviors in macroscopic level similar to Couder's experiments of bouncing droplets.This is a joint work with Gao Zhijun.

▶MS-Tu-D-10-2 14:00–14:30
An Autonomous Distributed System for the Pathfinding Problem with Self-recovery Property
Ueda, Keiichi — Univ. of Toyama

Abstract: Self-recovery of function is one of the remarkable properties of biological systems, and its implementation in autonomous distributed systems is highly desirable. In this study, we propose an autonomous distributed system which is capable of finding a path connecting two specified vertices which are connected by unidirectional edges. The system has a self-recovery property, i.e., the system can find a path when one of the connections in the existing

▶MS-Tu-D-10-3 14:30–15:00
Where is the Achilles Heel of the BZ Traveling Pulse?
Nishi, Kei — Department of Mathematics, Hokkaido Univ.
Nishiura, Yasumasa — Tohoku Univ., WPI-AIMR

Abstract: It is known that the traveling pulse moving in photo-sensitive BZ media disappears when the photo-intensity is increased uniformly in space. Our questions are, " Can we make the pulse die out by a localized beam of light in space and time?" and " Where is the Achilles heel of it, the most vulnerable part of the pulse to the photo beam?" We numerically give an answer to these questions, and demonstrate it by experiments.

MS-Tu-D-11 13:30–15:30 203B
Recent developments on Electrochemical Interface Modeling

Organizer: Landstorfer, Manuel — WIAS

Abstract: A model based understanding of electrochemical interfaces is a key issue for a variety of new technological developments, such as new generations of batteries and fuel cells or applications like desalination or galvanisation. Such an understanding relies on a consistent coupling of thermodynamics and electrodynamics in solid and liquid phases, as well as on their interface. Within this mini-symposium we address recent developments in this area which significantly enhance the modelling precision. Mathematical tools such as asymptotic analysis or homogenisation methods give direction to industry scale application.

▶MS-Tu-D-11-1 13:30–14:00
Revision of the Butler-Volmer Equations in the Context of Thermodynamics of Irreversible Processes
Guhlke, Clemens — Weierstrass Inst.

Abstract: In the lecture we show that a thermodynamically consistent choice of reaction rates in addition to some asymptotic analysis of the double layer leads to a generalized Butler-Volmer equation. One important result is that the formulation of the BV equation is coupled to the transport equations of the electrode and electrolyte. The generalized BV equation forms the basis for modeling of electron transfer reactions in electrochemical systems such as modern batteries, fuel cells.

▶MS-Tu-D-11-2 14:00–14:30
Ionic Specific Effects Beyond the Poisson-Boltzmann Theory: Electrolytes, Surfaces & Membranes
Andelman, David — Tel Aviv Univ.

Abstract: In aqueous solutions, dissolved ions interact strongly with the surrounding water and surfaces, thereby modifying solution properties in an ion-specific manner. The Poisson-Boltzmann description of ionic solutions has been successfully used in predicting charge distributions and interactions between charged macromolecules. However, when dealing with various aspects of real physical, chemical and biological systems, the Poisson-Boltzmann has several noticeable shortcomings. In the talk I will describe several such effects that we have considered recently. I will review how this strategy has been used to predict some of the ways ion-specific effects can modify the forces acting within and between charged interfaces immersed in salt solutions. Among others, they include steric effects due to finite ion size close to interfaces, decrement of the solution dielectric constant due to the presence of ions, mixed solvent effects, and a new ion-specific model for surface tension of electrolytes that takes into account direct surface-ion interactions.

▶MS-Tu-D-11-3 14:30–15:00
Theory, Structure and Experimental Justification of the Metal/electrolyte Interface
Landstorfer, Manuel — WIAS

Abstract: In this talk we will provide insight to our new electrolytic mixture theory which explicitly accounts for solvation and adsorption. We will show that this model is the very basis for a qualitative and quantitative understanding of the capacitive behaviour of a variety of electrodes and electrolytes. We will further show that our approach is also the very basis for a model based understanding of cyclic voltammetry and thus a key tool for analytical electrochemistry.

▶MS-Tu-D-11-4 15:00–15:30
Combined Electrical Double Layer and Ion Transport Modeling in Water Desalination
Dykstra, Jouke — Wetsus / Wageningen Univ.
Keesman, Karel — Wageningen Univ. / Wetsus
Van Der Wal, Albert — Wageningen Univ.
Biesheuvel, Maarten — Mr

Abstract: Capacitive deionization is a novel electrochemical desalination technology. Salt water flows between two oppositely polarized porous carbon electrodes and is desalinated. Ions are adsorbed into porous carbon electrodes, where two processes occur: the adsorption of ions in Electrical Double Layers and the transport of ions subject to diffusional and migrational forces. We theoretically describe and animate the time-dependent salt concentration profiles across the electrodes and show the development of very steep "shocks" in salt concentration.

MS-Tu-D-12 13:30–15:30 208B
Extremal Combinatorics, Probabilistic Combinatorics, and their applications - Part III of III

For Part 1, see MS-Mo-D-12
For Part 2, see MS-Mo-E-12

Organizer: Ma, Jie — Univ. of Sci. & Tech. of China
Organizer: Huang, Hao — Inst. for Mathematics & its Applications, Univ. of Minnesota
Organizer: Chen, Guantao — Georgia State Univ.

Abstract: Combinatorics is a fundamental discipline of modern mathematics which studies discrete objects and their properties. This minisymposium we propose will focus on the subfield of extremal and probabilistic combinatorics, which has witnessed an exciting development over the past decades, and also has many striking practical applications in mathematical optimization, computer science, statistical physics and voting society. We aim to bring the top researchers to the minisymposium, where they will present the recent progress, discuss open challenges, exchange research ideas, and initiate new collaborations. We expect a minisymposium of this nature to have a lasting impact on the future of the subject.

▶ MS-Tu-D-12-1 13:30–14:00

A Simple Removal Lemma for Large Nearly-intersecting Families

Das, Shagnik — Freie Universität Berlin

Abstract: We give a simple proof of a removal lemma for large intersecting families, showing that a k-uniform set family on [n] with close to $\binom{n-1}{k-1}$ sets and few disjoint pairs can be made intersecting by removing few sets. We then apply the lemma to resolve a question of Bollobas, Narayanan and Raigorodskii regarding transference of the Erdos-Ko-Rado theorem to sparse random Kneser subgraphs.
Joint work with Tuan Tran.

▶ MS-Tu-D-12-2 14:00–14:30

Circular Flow of Highly Edge Connected Signed Graphs

Zhu, Xuding — Zhejiang Normal Univ.

Abstract: This paper proves that if a signed graph is (12k-1)-edge connected and is essentialy(k=1-unbalanaced, then its circlar flow number is atmost 2+1/k.

▶ MS-Tu-D-12-3 14:30–15:00

Fractional Chromatic Number of Subgraphs

Wu, Hehui — Univ. of Mississippi

Abstract: In 1970's, Erdős and Hajnal conjectured that for any numbers k and g, there exists a number $f(k,g)$, such that every graph with chromatic number at least $f(k,g)$ contains a subgraph with chromatic number at least k and girth at least g. We prove that fractional chromatic number version of the conjecture for $k = 4$.
Bukh conjectured that a random subgraph $G_{1/2}$ has chromatic number $\omega\frac{\chi(G)}{\log\chi(G)}$, we proved the fractional version of this conjecture.

▶ MS-Tu-D-12-4 15:00–15:30

Computing with Voting Trees

Iglesias, Jennifer — Carnegie Mellon Univ.
Ince, Nathaniel — Carnegie Mellon Univ.
Loh, Po-Shen — Carnegie Mellon Univ.

Abstract: One well-studied election procedure specifies a complete binary tree with leaves labeled by the candidates, and evaluates it by running pairwise elections between the pairs of leaves, sending winners to successive rounds of pairwise elections which ultimately terminate with a single winner. We exhibit a new construction which always produces a winner who could defeat at least sqrt(N) other candidates, significantly improving the previous log(N) bound.
Joint work with Jennifer Iglesias and Nate Ince.

MS-Tu-D-13 13:30–15:50 VIP3-2

Analysis and algorithm for coupling of kinetic and fluid equations - Part III of III

For Part 1, see MS-Mo-D-13
For Part 2, see MS-Mo-E-13

Organizer: Lu, Jianfeng — Duke Univ.
Organizer: Sun, Weiran — Simon Fraser Univ.

Abstract: Kinetic equations are widely used to model complex systems occurring in gas dynamics and transport phenomenon, as examples. In these applications, it is common that dense and dilute parts coexist in the system. This leads to multiple spatio-temporal scales which introduce difficulties in both analysis and numerics. Kinetic-fluid coupling hence has received intensive studies in recent years. This minisymposium aims to bring together experts in analysis and algorithm in kinetic equations to discuss the current status and future developments of the field. It also provides a platform for further interaction and collaboration for researchers in this and related areas.

▶ MS-Tu-D-13-1 13:30–14:00

Hydrodynamic Limits from Kinetic Equations in Bounded Domain

Jiang, Ning — Tsinghua Univ., Beijing

Abstract: In this talk I will review the hydrodynamic limits from kinetic equations in domain with boundary. Incompressible Navier-Stokes equations can be derived from Boltzmann equation with Maxwell reflection boundary condition. The boundary conditions for the NS equation depends on the relative sizes of the Knudsen number and accommodation number. We also will discuss the incompressible Euler limit, in particular the relation with Prandtl boundary layer.

▶ MS-Tu-D-13-2 14:00–14:30

Uncertainty Quantification for Kinetic Equations

Jin, Shi — Univ. of Wisconsin-Madison & Shanghai Jiao Tong Univ.

Abstract: In this talk we will study the generalized polynomial chaos (gPC) approach to hyperbolic and kinetic equations with uncertain coefficients/inputs, and multiple time or space scales, and show that they can be made asymptotic-preserving or well-balanced, in the sense that the gPC scheme preserves various asymptotic limits in the discrete space. This allows the implemention of the gPC methods for these problems without numerically resolving (by space, time, and gPC modes) the small scales.

▶ CP-Tu-D-13-3 14:30–14:50

A Multilevel Monte Carlo Method for the Kinetic Equations of Plasma Dynamics

Ricketson, Lee — New York Univ.

Abstract: The multilevel Monte Carlo (MLMC) method - introduced by Giles for rapid valuation of financial assets modeled by SDEs - has found numerous applications in other fields, where it frequently accelerates computations by multiple orders of magnitude. An outstanding challenge, however, is the application of the method to McKean-Vlasov equations - SDEs featuring interaction with a mean field determined by an average over the underlying stochastic dynamics. Such equations are ubiquitous in statistical models of physical phenomena. Of particular interest are kinetic equations, whose high dimensionality makes Monte Carlo particularly attractive. We present a generalization of MLMC to a class of McKean-Vlasov equations, with particular emphasis on applications to the acceleration of the particle-in-cell (PIC) codes that are ubiquitous in the kinetic plasma simulation community. Both theoretical results establishing the efficiency of the method and results from numerical tests will be discussed.

▶ CP-Tu-D-13-4 14:50–15:10

A Robust Numerical Method for A Multi-scale Dynamical System

Patidar, Kailash C. — Univ. of the Western Cape

Abstract: In this talk, we will consider a multi-scale dynamical system arising in mathematical biology. The various parameters involved in the models that very at different time scales make such governing problems very difficult to be solved analytically. One can gather semi-qualitative information about the solutions using standard analytical techniques. However, a full description about the behavior of solutions is hardly obtainable. To this end, we will discuss a class of numerical methods that can better suit such models. Proposed method will be explored on a number of test examples.

▶ CP-Tu-D-13-5 15:10–15:30

A Kinetic Model of Wealth Distribution and Migration Phenomena

Knopoff, Damian — Universidad Nacional de Cordoba
Torres, German Ariel — Facultad de Matematica, Astronomia y Fisica - Universidad Nacional de Cordoba - CIEM - CONICET

Abstract: A kinetic model for wealth distribution within a population based on the kinetic theory for active particles is presented, where individuals are characterized by a microscopic variable (the activity) describing their state and are subdivided into classes, including the eventual migration of individuals between populations. In contrast to previous models, it is assumed that interactions among individuals (viewed as trades) are non-conservative and that an external agent (e.g. the State) implements certain distribution policies, since it is clear that wealth can be created and destroyed within a society and consequently the total wealth and the mean wealth per capita evolves in time. The model is stated in terms of a system of differential equations modelling the time evolution of a distribution function that represents the proportion of individuals in each class. Existence and uniqueness of solutions are shown and some selected simulations representing different scenarios and a parameter

▶ CP-Tu-D-13-6 15:30–15:50

Escaping An Infestation of Parasites by Outrunning Them: Insights from A Simple Stochastic Model

Dong, JiaJia — Bucknell Univ.

Abstract: Co-existence of multiple species abounds in ecological systems as a consequence of various interactions. We study a parasite-host model, in which the parasites wander randomly and die, giving birth only when they land on the host. For a stationary host with certain boundary conditions, the stochastic process can be solved and the results match well to Monte Carlo simulations. In non-trivial stationary states, the characteristics of the "parasite-cloud" around the host are well understood. If the host moves with uniform velocity, solving the problem becomes much more challenging. Instead, we consider a stationary host with parasites performing biased diffusion, for which our theoretical predictions also agree with simulation. In the appropriate continuum limit, the two processes are identical but interesting differences emerge in our lattice model. The most notable phenomenon is that the stationary parasite population generally increases with the bias, reaching a maximum before vanishing at some critical value.

MS-Tu-D-14 13:30–15:30 111
Mathematical Theories and Computational Aspects of Complex Fluids - Part III of III

For Part 1, see MS-Mo-D-14
For Part 2, see MS-Mo-E-14

Organizer: Wang, Changyou Purdue Univ.
Organizer: Liu, Chun Penn State Univ.
Organizer: LIn, Fanghua Courant Inst./NYU

Abstract: Complex fluids, fluids with microstructure, are ubiquitous in our daily life and modern day engineering and biology applications. We are facing new challenges in mathematical theories and techniques in order to resolve issues such as ensemble of micro-elements, intermolecular interactions, coupling to hydrodynamics and applied electric or magnetic fields. The multiphysics-multiscale nature of these complicated materials also provide the best testing ground for new techniques and ideas.
In these mini-symposium sessions, we will bring some of the most active researchers in this field, together with postdocs and students. The purpose is to present the most current results, provoking new ideas, as well as motivate the young researchers to work in the field.

▶ MS-Tu-D-14-1 13:30–14:00
Decoupled, Linear and Energy Stable Schemes for Phase-field Models of Multiphase Complex Fluids
Shen, Jie Purdue Univ.

Abstract: I shall present some recent work on designing efficient decoupled energy stable schemes for phase-field models of multiphase complex fluids. I shall provide ample numerical results which not only demonstrate the effectiveness of the numerical schemes, but also validate the flexibility and robustness of the phase-field model.

▶ MS-Tu-D-14-2 14:00–14:30
Global Existence and Uniqueness Theorem to 2-D Incompressible Non-resistive MHD System Subject to Linearly Growing Velocity
Zhang, Ting Zhejiang Univ.

Abstract: In this talk, we consider the 2D incompressible viscous and non-resistive magnetohydrodynamics (MHD) system. Here, we consider the global existence and uniqueness of the solution which close to the particular solution that the velocity is linearly growing at infinity.

▶ MS-Tu-D-14-3 14:30–15:00
Steady Viscous Compressible Channel Flows
Jiang, Song Inst. of Applied Physics & Computational Mathematics

Abstract: We prove the existence and uniqueness of strong solutions to the steady isentropic compressible Navier-Stokes equations with inflow boundary condition in a 2-D finite channel near a uniform flow. The proof is based on the delicate a priori estimates and exploitation of the elliptic theory. For our result, we do not require the velocity, density, the Reynolds number and the Mach number to be small. (joint work with Y. Guo and H. Zhou)

▶ MS-Tu-D-14-4 15:00–15:30
Isotropic-Nematic Phase Transition for the Liquid Crystal
Zhang, Zhifei Peking Univ.

Abstract: I will talk about the derivation of the sharp interface model of the Isotropic-Nematic phase transition from the Landau-de Gennes theory.

MS-Tu-D-15 13:30–15:30 213B
Inverse problems in PDE and probability - Part I of II

For Part 2, see MS-Tu-E-15

Organizer: Helin, Tapio Univ. of Helsinki
Organizer: Hyvonen, Nuutti Aalto Univ.

Abstract: The aim of the minisymposium is to highlight new research results in inverse problems that involve stochastic modelling and partial differential equations. All aspects of such inversion are discussed, including mathematical analysis, computational techniques, and experimental results.

▶ MS-Tu-D-15-1 13:30–14:00
A Bayesian Level Set Method for Geometric Inverse Problems
Lu, Yulong Univ. of Warwick

Abstract: We develop a novel Bayesian level set approach for geometric inverse problems that arise in PDE-constrained applications. Our work consists of a rigorous application of the infinite-dimensional Bayesian framework whereby proving the measurability of the observational map that arises from our level-set representation enables us to show existence and well-posedness of the posterior measure. The method is applied to solve two model problems: inverse source problem and groundwater flow problem.

▶ MS-Tu-D-15-2 14:00–14:30
Spectral Approximations for Iterative Inversion Methods: A Parabolic Case
Mustonen, Lauri Aalto Univ.

Abstract: In the context of nonlinear inverse problems, we present an efficient way to construct the linear subproblems of a Gauss-Newtonian iteration. The method is based on solving the forward problem in a high-dimensional parameter domain by using spectral methods, resulting in a numerical solution that depends explicitly on the parameters. As an example we study the inverse boundary value problem of a parabolic partial differential equation.

▶ MS-Tu-D-15-3 14:30–15:00
Detecting Stochastic Inclusions in Electrical Impedance Tomography
Harrach, Bastian Univ. of Stuttgart,

Abstract: (This is a joint work with A. Barth, N. Hyvönen and L. Mustonen.) We consider the inclusion detection problem of electrical impedance tomography with stochastic conductivities. We show that a conductivity anomaly with a random conductivity can be identified by applying the Factorization Method or the Monotonicity Method to the mean value of the corresponding Neumann-to-Dirichlet map provided that the anomaly has high enough contrast.

▶ MS-Tu-D-15-4 15:00–15:30
Edge-promoting Reconstruction of Absorption and Diffusivity in Optical Tomography
Majander, Helle Aalto Univ.

Abstract: Diffuse optical tomography is an imaging modality for determining the diffusion and absorption distributions inside a highly scattering object. This is done by guiding near-infrared light to the surface of the object and observing the light propagation by the detectors on the surface. In this talk we assume that both properties contain distinct inclusions in a constant background. We introduce an iterative algorithm for simultaneously reconstructing the diffusion and absorption using edge-preferring priors.

MS-Tu-D-16 13:30–15:30 205A
Multi-scale complex flows - Part I of II

For Part 2, see MS-Tu-E-16

Organizer: Swierczewska-Gwiazda, Agnieszka Univ. of Warsaw

Abstract: The mini-symposium aims to present challenging problems of multiscale description of various phenomena including polymeric fluids, collective behaviour, to name a few. There are different approaches to such problems - either through kinetic equations, modelling of the microstructure by the stochastic partial differential equations or by capturing microscopic quantities in terms of averaged macroscopic ones. Our aim is to present some of these approaches and the recent studies, both from the point of view of mathematical analysis and numerical results.

▶ MS-Tu-D-16-1 13:30–14:00
Yield Stress Fluids as Singular Limits of Viscoelastic Fluids
Renardy, Michael Virginia Tech

Abstract: Traditional models of yield stress fluids postulate a critical stress where a change from solid to fluid behavior occurs. Many yield stress fluids, however, exhibit much more complicated behavior such as delayed yielding, yield stress hysteresis, and thixotropy, i.e. the long time persistence of a yielded state long after flow has stopped. The lecture will review recent efforts to model such behaviors by a viscoelastic fluid with a long relaxation time.

▶ MS-Tu-D-16-2 14:00–14:30
Hydrodynamic Models for Collective Behavior
Carrillo, Jose A. Imperial College London

Abstract: We study the critical thresholds for the compressible pressureless Euler equations with pairwise attractive or repulsive interaction forces and non-local alignment forces in velocity in one dimension. We provide a complete description for the critical threshold to the system without interaction forces leading to a sharp dichotomy condition between global in time existence or finite-time blow-up of strong solutions.

▶ MS-Tu-D-16-3 14:30–15:00
Deterministic Modeling of Protein Polymerization
Gabriel, Pierre Univ. of Versailles

Abstract: The polymerization of proteins is involved in numerous neurodegenerative diseases as prion or Alzheimer diseases. The growth-fragmentation PDE provides a relevant first modeling of the elongation and breakage of the

polymers. After an overview of recent results on the long time behaviour of the linear growth-fragmentation equation, we will derive more realistic nonlinear models. These new models will be analysed by taking advantage of a self-similar change of variables.

▶MS-Tu-D-16-4 15:00–15:30

Stochastic and Deterministic Models for Protein Polymerization

Doumic, Marie — Inria

Abstract: Amyloid diseases (which include Alzheimer's, Huntington's, Parkinson's etc) involve the aggregation of misfolded proteins. Elucidating the intrinsic mechanisms of the chain reactions involved is a major challenge of molecular biology due to the extremely high complexity of the considered processes. I will review existing results and explain our approach, based on combined ODE-PDE and stochastic models.

MS-Tu-D-17 13:30–15:30 205B

Reaction-diffusion-advecton systems arising from mathematical biology modeling chemotaxis - Part I of III

For Part 2, see MS-Tu-E-17

For Part 3, see MS-We-D-17

Organizer: Xiang, Tian — Renmin Univ. of China

Abstract: As with all living organisms, single cells and bacteria sense and respond to the environment where they live. The primary way these organisms achieve this is through the phenomenon of chemotaxis. Chemotaxis is the oriented movement of cells and organisms along chemical gradients, as a response to gradients of the concentration of chemical substances. It plays a significant role in many biological fields, and chemotaxis models have been successfully applied to the aggregation patterns in bacteria, slime molds, skin pigmentation patterns, angiogenesis in tumor progression and wound healing and many other examples. Therefore, a huge number of works, both theoretical and experimental, have been devoted to exploring and hence understanding the mechanistic basis of chemotaxis.

In 1953, Patlak contributed the first mathematical idea to model chemotaxis. In 1970s, Keller and Segel introduced a classical and important chemotaxis model (a advection-diffusion type parabolic-parabolic quasi-linear PDE systems) to describe the aggregation process of cellular slime mold by chemical attractions. These pioneering works have initiated an intensive mathematical investigation of the (Patlak-)Keller-Segel model and chemotaxis models have become one of the best study models in mathematical biology over the last 40 years.

Despite its simple looking, the Keller-Segel model exhibits the phenomenon of cell aggregation, which is usually modeled by time-dependent solutions blowing up in finite or infinite time. Thus, the issue whether or not the solutions of the proposed chemotaxis models are globally bounded or blow-up becomes the main concern in studying K-S type models. It is a very active research subject; up to now, there are at least 5 beautiful survey papers, Horstsmann [1,2], Hillen and Painter [3], Wang [4] and Blanchet [5], where one is provided with a broad survey on the progress of various chemotaxis models as well as with a rich selection of references. The key phenomena are: no blow-up in 1-D, except in some extreme nonlinear diffusion models, critical mass blow-up in 2-D, and generic blow-up in ≥ 3-D, a breakthrough made in Winkler [6].

Chemotaxis phenomenon has been also successfully applied to other equations, for instance, Navier-Stokes equations, see [7] for a glimpse.

Thus, in our mini-symposium, our group topics center mainly on reaction-diffusion-advecton systems modeling chemotaxis arising from mathematical biology. We bring together active researchers to share and discuss their very recent results on boundedness versus blow-up, critical mass blow-up, global existences, stability and large time behavior so as to understand more insights on the mechanism of chemotaxis. This mini-symposium will definitely stimulate more inspirations. [1] D. Horstman, From 1970 until now: the Keller-Segal model in chaemotaxis and its consequence I, Jahresber DMV, 105 (2003), 103–165. [2] D. Horstman, From 1970 until now: the Keller-Segal model in chaemotaxis and its consequence II, Jahresber DMV, 106 (2003), 51–69. [3]T. Hillen and K. J. Painter, A user's guide to PDE models for chemotaxis, J. Math. Biol., 58 (2009), 183–217. [4] Z. A. Wang, Mathematics of traveling waves in chemotaxis, Discrete Contin. Dyn. Syst. Ser. B 18 (2013), 601–641. [5] A. Blanchet, On the Parabolic-Elliptic Patlak-Keller-Segel System in Dimension 2 and Higher, preprint, arXiv:1109.1543 [6] M. Winkler, Finite-time blow-up in the higher-dimensional parabolic-parabolic Keller-Segel system, J. Math. Pures Appl. 100 (2013), 748–767. [7] R. J. Duan and Z.Y. Xiang, A note on global existence for the chemotaxis-Stokes model with nonlinear diffusion. Int. Math. Res. Not. IMRN 2014, no. 7, 1833-1852.

▶MS-Tu-D-17-1 13:30–14:00

Boundedness and Global Existence for the Keller-Segel Chemotaxis Systems With/without Growth

Xiang, Tian — Renmin Univ. of China

Abstract: We study a general class of parabolic-parabolic Keller-Segel chemotaxis systems with/without growth source in a smooth bounded domain in higher dimensional Euclid space. It is recently known that blowup is possible even in the presence of super-linear growth restrictions. Here, we first derive new and interesting characterizations on the growth versus the boundedness, which shows that the hard task of proving the L^∞-boundedness of the cell density can be reduced to proving its L^r-boundedness for some finite r. These results reveal deep understandings of blowup mechanism for chemotaxis models. Then we employ these criteria to establish uniform boundedness and hence global existence of the underlying models. As a result, in a chemotaxis-growth model, blow-up is impossible if the growth effect is suitably "strong". It is worth to emphasize that our results remove the commonly assumed convexity on the domain.

▶MS-Tu-D-17-2 14:00–14:30

The Existence and Stability of Nontrivial Steady States for S-K-T Competition Model with Cross-Diffusion

Qian, Xu — Beijing union Univ.

Abstract: We concerns with the existence and stability properties of nonconstant positive steady states in one dimensional space for the S-K-T model. By Lyapunov-Schmidt method, we obtain the existence and the detailed structure of a type of small nontrivial positive steady states to the shadow system, based on the detailed structure of the steady states, we further establish the stability of the small nontrivial positive steady state for the shadow system by spectral analysis.

▶MS-Tu-D-17-3 14:30–15:00

Spiky Steady States of A Chemotaxis Model with Singular Sensitivity

Li, Huicong — East China Normal Univ.

Abstract: We study positive steady states of a chemotaxis system with singular sensitivity in 1-D. Using the chemotactic coefficient as a bifurcation parameter, with an application of the local and global bifurcation theory, we establish pattern formation in the system provided the parameter is large. Asymptotic behavior of the solutions is also investigated, as the chemotactic coefficient goes to infinity. The existence of spiky steady states is shown by using Helly's compactness theorem.

▶MS-Tu-D-17-4 15:00–15:30

ASYMPTOTIC DYNAMICS ON A SINGULAR CHEMOTAXIS SYSTEM MODELING ONSET OF TUMOR ANGIOGENESIS

Xiang, Zhaoyin — Univ. of Electronic Sci. & Tech. of China

Abstract: In this talk, we investigate the asymptotic behavior of solutions to a singular chemotaxis system modeling the onset of tumor angiogenesis in two and three dimensional whole spaces. We establish the global existence, asymptotic decay rates and diffusion convergence rate of solutions with the method of energy estimates by studying a non-singular hyperbolic system which is transformed from the original singular chemotaxis system by a Cole-Hopf type transformation.

MS-Tu-D-18 13:30–15:30 209B

Nonlinear aggregation-diffusion equations - Part I of III

For Part 2, see MS-Tu-E-18

For Part 3, see MS-We-D-18

Organizer: Huang, Yanghong — Univ. of Manchester

Organizer: Carrillo, Jose A. — Imperial College London

Organizer: Yao, Yao — Univ. of Wisconsin Madison

Abstract: A large variety of stationary and dynamic patterns are the results of the competition between nonlinear diffusion and aggregation effects, including the well-known Patlak-Keller-Segel system. These systems are typically modelled from the collective behaviour of individuals, as the kinetic and/or continuum description based on mean-field type PDEs. The aim of the mini-symposium is to highlight recent advances on the interplay between the aggregation and the nonlinear diffusion, by developing tools to understand the long time asymptotics, stability of the patterns, related functional inequalities and numerical schemes.

▶MS-Tu-D-18-1 13:30–14:00

Nonlocal Fisher KPP Problems

Bian, Shen — Beijing Univ. of Chemical Tech.

Chen, Li — Univ. of Mannheim

Latos, Evangelos — Univ. of Mannheim

Abstract: In this work, a nonlocal Fisher KPP reaction-diffusion problem with the reaction powers α. When $\alpha \geq 1$ and the initial mass is greater than or equal to one, or if the initial mass is less than one and $1 < \alpha < 1 + 2/n$, the

problem has a unique nonnegative classical solution. Moreover, the asymptotic convergence to the solution of the heat equation is proved. Finally, numerical results in the super critical case show that solution exists globally.

▶ MS-Tu-D-18-2 14:00–14:30

Gamma-convergence of the Discrete Internal Energy and Application to Gradient Flows

Patacchini, Francesco Saverio — Imperial College London

Abstract: We approximate diffusion equations with finite numbers of particles. As the 2-Wasserstein energy is not defined for point-masses, we spread uniformly the mass of each particle in some ball around it. This "tessellation" gives a discrete energy defined on point-masses, which Gamma-converges in the Wasserstein topology to its continuum version as the particles' number increases. For the linear diffusion case, we show the convergence of the resulting discrete gradient flow to the standard heat equation.

▶ MS-Tu-D-18-3 14:30–15:00

Aggregation Equation with Density Constraint

Yao, Yao — Univ. of Wisconsin Madison

Abstract: In this talk, we discuss an aggregation equation with a constraint on the maximum density. We will discuss the relationship between this equation and the Keller-Segel equation with degenerate diffusion. We will also show that in 2D, if the initial data is a characteristic function, it will converge to the characteristic function of a disk as the time goes to infinity. This is a joint work with Katy Craig and Inwon Kim.

MS-Tu-D-19 13:30–15:30 307B

Multiscale methods with applications in fluid mechanics and materials modeling. - Part III of III

For Part 1, see MS-Mo-D-19
For Part 2, see MS-Mo-E-19

Organizer: Brown, Donald — Univ. of Bonn
Organizer: Henning, Patrick — Univ. of Muenster

Abstract: With this Minisymposium we aim to gather leading researchers in the field of numerical multiscale methods, i.e. methods that are constructed to efficiently tackle differential equations with a large spectrum of length and time scales. The speakers present a wide range of different applications and approaches resulting in an extensive exchange of ideas. Among others, parabolic and hyperbolic multiscale problems are discussed, as well as Maxwell's equations or the two-phase flow equations in porous media. The minisymposium focuses on the practical aspects of the methods, as well as on questions regarding a corresponding numerical analysis.

▶ MS-Tu-D-19-1 13:30–14:00

Cloud Based Interactive Simulations of Maxwell's Equations Using the Localized Reduced Basis Method

Buhr, Andreas — Univ. of Muenster
Ohlberger, Mario — Univ. of Muenster
Rave, Stephan — Univ. of Muenster

Abstract: Engineers manually optimizing a structure using simulation software often employ an iterative approach where in each iteration they change the structure and resimulate. ArbiLoMod, a method designed for this manual, iterative workflow will be shown. It allows fast recomputation after arbitrary local modifications. It employs a domain decomposition and a localized, certified form of the Reduced Basis Method for model order reduction. The reduced model is adapted when necessary, steered by a localized error indicator.

▶ MS-Tu-D-19-2 14:00–14:30

An Efficient Hierachical Multiscale Finite Element Method for Stokes Equations in Slowly Varying Media

Hoang, Viet Ha — Nanyang Technological Univ.

Abstract: We develop an efficient numerical method to compute effective properties for media with varying microstructures. We achieve essentially equal accuracy to that for the full resolution of every local cell problem but require essentially equal complexity to that for solving only one problem. Solutions of cell problems at different macroscopic points are solved with different levels of accuracy and used to correct each other (joint work with Donald Brown (Bonn) and Yalchin Efendiev (Texas A&M)),

▶ MS-Tu-D-19-3 14:30–15:00

Reduced Order Models for the Optimization of A Material Microstructure

Legoll, Frederic — ENPC

Abstract: We present an approach for the optimization of the microstructure of a material, in order to minimize its compliance. The current microstructure is modelled as a macroscopic deformation, to be optimized upon, of a reference periodic microstructure. In this talk, we describe the approach and show how to use reduced order models to keep the computational load limited.
Joint work with V. Ehrlacher, C. Le Bris, G. Leugering and M. Stingl.

▶ MS-Tu-D-19-4 15:00–15:30

Variational Multiscale Method Using Divergence-conforming Spaces with Applications to Incompressible Flows

Sarmiento, Adel — King Abdullah Univ. of Sci. & Tech.
Calo, Victor — King Abdullah Univ. of Sci. & Tech.
Cortes, Adriano — King Abdullah Univ. of Sci. & Tech.
Efendiev, Yalchin — Texas A&M Univ.

Abstract: Multiscale stabilization methods like the SUPG and the VMS were developed for advection-diffusion equations, and then applied to general problems including multiscale and porous media problems. Raviart-Thomas elements were developed to satisfy the discrete inf-sup stability condition, recently the discrete differential theory has established the requirements to fulfill this condition. We develop a variational multiscale method in the context of divergence-conforming spaces, stabilizing advection and satisfying inf-sup stability condition exactly.

MS-Tu-D-20 13:30–15:30 210B

Recent advances in Iterative Nonlinear Solvers

Organizer: Woodward, Carol — Lawrence Livermore National Laboratory
Organizer: Kelley, Carl — North Carolina State Univ.

Abstract: Continued growth in the complexity of computational models has resulted in an increased demand for solution methods for nonlinear problems with characteristics that challenge the commonly used Newton-Krylov method. Coupled multiphysics problems and material science applications often lead to problems for which Jacobians and Jacobian-vector products are not available. In addition, nonlinear equations which mix stochastic and deterministic approaches are becoming more common. These problems lead to random errors in the evaluation of the nonlinear residual which do not work well with Newton's method. The speakers in this mini-symposium will discuss recent work in development and application of nonlinear, iterative solvers to problems challenging traditional Newton-Krylov methods.

▶ MS-Tu-D-20-1 13:30–14:00

Recent Advances in Anderson Acceleration for Large-Scale Problems

Woodward, Carol — Lawrence Livermore National Laboratory

Abstract: Anderson acceleration has demonstrated significant benefits in accelerating fixed point solutions in a number of applications. The method, however, adds new synchronization points that can slow down its use in parallel. In this presentation, we will examine the parallel communication requirements of Anderson acceleration and discuss its performance for parallel applications. In addition, we will discuss use of communication-avoiding ideas within the Anderson acceleration algorithm and show results on model problems.

▶ MS-Tu-D-20-2 14:00–14:30

Convergence Theorems for Anderson Acceleration

Kelley, Carl — North Carolina State Univ.

Abstract: We will discuss recent results on the local convergence of Anderson Acceleration. This is an algorithm for accelerating the convergence of fixed point or Picard iteration. In this talk we will discuss the first convergence results for the method, illustrate the results with an application to radiative transport, discuss issues with multi-physics coupling, and list a few open questions.

▶ MS-Tu-D-20-3 14:30–15:00

Nonlinearly Preconditioned Inexact Newton Methods and Applications

Cai, Xiao-Chuan — Univ. of Colorado Boulder

Abstract: The classical inexact Newton algorithm is a popular technique for solving large sparse nonlinear system of equations. In this talk, we discuss some recently developed versions of preconditioned inexact Newton methods which are more robust than the classical version when the nonlinearities in the system are not balanced. The preconditioners are constructed using a combination of some domain decomposition methods and nonlinear elimination methods. We show numerically that the preconditioned inexact Newton methods perform well for solving some fluid flow problems with high Reynolds numbers and on machines with large number of processors.

▶ MS-Tu-D-20-4 15:00–15:30

A Smoothing Trust Region Filter Algorithm for Nonsmooth Least Squares Problem

Chen, Xiaojun — Department of Applied Mathematics, The Hong Kong Polytechnic Univ.

Abstract: We propose a smoothing trust region filter algorithm for nonsmooth nonconvex least squares problems. We present convergence theorems of the proposed algorithm to a Clarke stationary point or a global minimizer of the objective function under certain conditions. Preliminary numerical exper-

iments show the efficiency of the proposed algorithm for finding zeros of a system of polynomial equations with high degrees on the sphere and solving differential variational inequalities.

MS-Tu-D-21 13:30–15:30 309B
Minisymposium on discontinuous Galerkin method: recent development and applications - Part I of VIII

For Part 2, see MS-Tu-E-21
For Part 3, see MS-We-D-21
For Part 4, see MS-We-E-21
For Part 5, see MS-Th-BC-21
For Part 6, see MS-Th-D-21
For Part 7, see MS-Th-E-21
For Part 8, see MS-Fr-D-21

Organizer: Xu, Yan Univ. of Sci. & Tech. of China
Organizer: Shu, Chi-Wang Brown Univ.

Abstract: Over the last few years, discontinuous Galerkin (DG) methods have found their way into the main stream of computational sciences and are now being successfully applied in almost all areas of natural sciences and engineering. The aim of this minisymposium is to present the most recent developments in the design and theoretical analysis of DG methods, and to discuss relevant issues related to the practical implementation and applications of these methods. Topics include: theoretical aspects and numerical analysis of discontinuous Galerkin methods, non-linear problems, and applications. Particular emphasis will be given to applications coming from fluid dynamics, solid mechanics and kinetic theory.

▶ MS-Tu-D-21-1 13:30–14:00
DG Methods for Convection-dominated Problems: Survey and Recent Developments
Shu, Chi-Wang Brown Univ.

Abstract: We give a short survey of high order accurate discontinuous Galerkin (DG) methods for solving convection-dominated problems. We will then review some of their recent developments, including DG methods for Hamilton-Jacobi equations with obstacles, efficient IMEX time discretization for DG methods solving convection-diffusion equations, and other topics.

▶ MS-Tu-D-21-2 14:00–14:30
Nonstandard Discontinuous Galerkin Methods for Fully Nonlinear Second Order PDEs
Feng, Xiaobing The Univ. of Tennessee

Abstract: In this talk I shall present some recent developments in discontinuous Galerkin (DG) methods for fully nonlinear second order PDEs, such as the Monge-Ampere equation and Hamilton-Jacobi-Bellman equations, in high dimensions. The focus of the talk will be on introducing two families of nonstandard DG methods, namely, mixed IP-DG (interior penalty DG) methods and LDG (local discontinuous Galerkin) methods, for those fully nonlinear PDEs. The main ideas and formulations of the proposed DG methods will be explained in details, numerical experiments will also be presented to show the performance of the proposed DG methods. The challenges and open questions will be discussed as well at the end. This is a joint work with Tom Lewis of the University of North Carolina at Greensboro, U.S.A.

▶ MS-Tu-D-21-3 14:30–15:00
Simulating Steady State Solutions of Some 1D Kinetic Models
Li, Fengyan Rensselaer Polytechnic Inst.

Abstract: In this work, we investigate how well the discontinuous Galerkin discretizations can capture the steady state solutions of some one-dimensional linear kinetic models, with examples including electron-phonon scattering models arising from the design of low-dimensional semiconductor devices. Mathematical properties will be examined for the discrete operators, and this is complemented by the numerical experiments. This work is jointly with Y. Chen, Z. Chen, Y. Cheng and A. Gillman.

▶ MS-Tu-D-21-4 15:00–15:30
Stormer-Numerov HDG Methods for Acoustic Waves
Ji, Liangyue Univ. of Minnesota

Abstract: In this work, we first propose a semi-discretization conserving HDG method for the acoustic wave equation and prove that the displacement and gradient converge with the optimal order of k+1 in the L2-norm uniformly in time whenever polynomials of degree k great than or equal to 0 are used. Then, we use a local postprocessing technique to obtain a new approximation of the displacement converging with order k+2 for k¿0.

MS-Tu-D-22 13:30–15:30 206A
Iterative Methods and Preconditioning - Part I of II

For Part 2, see MS-Tu-E-22

Organizer: Pestana, Jennifer The Univ. of Manchester
Organizer: Szyld, Daniel Temple Univ.

Abstract: The solution of large sparse linear systems are at the core of most problems in science and engineering. Iterative methods, in conjunction with the use of preconditioning, are among the leading techniques for their solution. Development and analysis of known and new methods and preconditioners continues to be at the forefront of research, with new applications and new outlooks for larger problems and new computer architectures.
In this minisymposium current developments are showcased, illustrating recent advances and the wide range of applications including tensor equations, matrix equations, shifted systems, PDE-constrained optimization, and nonlinear eigenvalue problems.

▶ MS-Tu-D-22-1 13:30–14:00
Iterative Methods for Tensor Linear Equations
Chu, King-wah Eric Monash Univ.

Abstract: We consider the numerical solution of linear equations in the tensor product space, arising from the discretization of elliptic partial differential operators in high dimension. We apply the classical GMRES and BiCGSTAB methods, and a new iterative method, without any tensor toolboxes. It is critical to control the growth of ranks of the iterates and the associated insatiable demand on computing resources. Good data structures and preconditioning will be vital for any algorithm.

▶ MS-Tu-D-22-2 14:00–14:30
On Operator and Matrix Descriptions of Iterative Methods
Strakos, Zdenek Charles Univ. in Prague

Abstract: This contribution deals with coupling the infinite dimensional operator, discretization and algebraic computation levels in iterative solution of problems modeled by PDEs. We will focus on distribution of the error over the domain, convergence behavior and the interplay between discretization and acceleration of convergence .
Reference: J. Malek and Z. Strakos, Preconditioning of the Conjugate Gradient Method in the Context of Solving PDEs, SIAM, Philadelphia, 2015.

▶ MS-Tu-D-22-3 14:30–15:00
Parallel Preconditioning for Time-dependent PDE-constrained Optimisation
McDonald, Eleanor Univ. of Oxford

Abstract: All-at-once schemes aim to solve all time-steps of parabolic PDE-constrained optimization problems in one coupled computation, leading to exceedingly large linear systems requiring efficient iterative methods. We present a new block diagonal preconditioner which is both optimal with respect to the mesh parameter and parallelizable over time, thus can provide significant speed-up. We will present numerical results to demonstrate the effectiveness of this preconditioner.

▶ MS-Tu-D-22-4 15:00–15:30
Classical Iterative Methods for the Solution of Generalized Lyapunov Equations
Szyld, Daniel Temple Univ.

Abstract: We propose low-rank stationary iterations for the solution of generalized Lyapunov equations. At each step we solve a Lyapunov equation using Galerkin projection with extended Krylov subspaces. One of the advantages of this classical approach is that only the data and the low-rank factors of the old and new iterates need to be kept in storage. Numerical experiments show the competitiveness of the proposed approach. Joint work with S.Shank and V.Simoncini.

MS-Tu-D-23 13:30–15:30 208A
Locally Refinable Splines and its Application in Isogeometric Analysis - Part I of II

For Part 2, see MS-Tu-E-23

Organizer: Deng, Jiansong Univ. of Sci. & Tech. of China
Organizer: Chen, Falai Univ. of Sci. & Tech. of China

Abstract: In geometric modeling and numerical analysis, splines are popular representations of geometric shapes. With the introduction and development of isogeometric analysis, locally refinable splines have attracted much attention both in geometric modeling and analysis. The minisymposium consists of eight talks given by the leading experts in the corresponding research topics. The talks include T-splines, LR-splines, and splines over T-meshes and related topics. Also the applications in isogeometric analysis is included.

▶ MS-Tu-D-23-1 13:30–14:00
Compact Representation of Big Geospatial Data by Locally Refinable Splines

Dokken, Tor SINTEF

Abstract: The EC fp7 Integrating Project www.iqmulus.eu addresses the representation and processing of big geospatial data in the Cloud. One of the objectives is to address smooth ocean floor and provide LR-spline algorithms for accurate and compact approximation of hundreds of millions of data points acquired by LIDAR. The results provide a platform on which to build IGA solutions for geospatial problems, and a bridge from reverse engineering of human made shapes to IGA.

▶MS-Tu-D-23-2 14:00–14:30

Efficient Isogeometric Analysis-reuse Method for Complex Objects with Topology-consistent Volumetric Parameterization

Xu, Gang Hangzhou Dianzi Univ.

Abstract: Volumetric spline parameterization and computational efficiency are two main challenges in isogeometric analysis. In this talk, we propose the concept of analysis-reuse for three-dimensional models with similar semantic features, by which the computational efficiency can be improved significantly. Given a template domain, a CSRBF-based elastic function method is proposed to construct topology-consistent volumetric B-spline parameterization for models with similar semantic features. Several examples are presented to show the effectiveness of the proposed method.

▶MS-Tu-D-23-3 14:30–15:00

Discussions on the Dimensions of the Spline Spaces Defined on T-meshes

Li, Chong-Jun Dalian Univ. of Tech.

Abstract: The T-meshes are local modification of rectangular meshes which allow T-junctions. The dimension of a spline space is a basic problem for the theories and applications of splines. However, the problem of determining the dimension of a spline space is difficult since it heavily depends on the geometric properties of the partition. In many cases, the dimension is unstable. In this talk, we study the dimensions of the spline spaces defined on T-meshes.

▶MS-Tu-D-23-4 15:00–15:30

Analysis-suitable T-splines

Li, Xin ustc

Abstract: This talk provides the basic mathematical properties for a sub-class of T-splines, analysis-suitable T-splines, and their applications in isogeometric analysis.

MS-Tu-D-24 13:30–16:00 211

Time integration of partial differential equations

Organizer: Ostermann, Alexander Univ. of Innsbruck

Organizer: Einkemmer, Lukas Univ. of Innsbruck

Abstract: In recent years there has been much progress in the construction and analysis of new time discretization schemes for partial differential equations. As important developments, we mention exponential integrators and operator splitting methods. The former rely on the variation-of-constants formula and solve linear problems exactly. They are thus particularly suited for stiff and highly oscillatory semi-linear problems with small nonlinearity. The latter, although in use since many decades, are nowadays much better understood in terms of stability and convergence properties (e.g., order reduction due to boundary conditions). In addition, the conservation of geometric properties of solutions (i.e. the preservation of invariants and the long term behaviour of numerical approximations) is becoming increasingly important. In this regard, splitting methods have a great potential. The aim of this minisymposium is to present a stage for these ideas and new developments.

▶MS-Tu-D-24-1 13:30–14:00

Toolkit for Building An Efficient Exponential Integrator.

Tokman, Mayya Univ. of California, Merced

Abstract: We will provide an overview of analytical, numerical and implementation-related issues that have to be addressed to develop efficient exponential integrators of EPIRK-type. Existing classes of such integrators for different types of problems will be discussed. We will present numerical experiments demonstrating comparative performance of several exponential and implicit schemes and describe a software package EPIC that implements these exponential methods for serial and parallel architectures.

▶MS-Tu-D-24-2 14:00–14:30

A Semi-Lagrangian Discontinuous Galerkin Approach for the Vlasov Equation

Einkemmer, Lukas Univ. of Innsbruck

Abstract: The numerical solution of the Vlasov equation poses a number of challenges. Among them are the high dimensional nature of the problem, the development of small scale structures in phase space, and the importance of charge conservation.
The so-called semi-Lagrangian discontinuous Galerkin methods are considered an attractive alternative to more traditional approaches (such as spline interpolation). In this talk we will describe this method, discuss its properties, and consider high performance computing aspects.

▶MS-Tu-D-24-3 14:30–15:00

High-order Splitting Methods for Non-autonomous Parabolic Equations

Blanes, Sergio Polytechnical Univ. of Valencia

Abstract: We consider the numerical integration of non-autonomous separable parabolic equations using high order splitting methods with complex coefficients. Splitting methods with complex coefficients with positive real part have been successfully proposed in the literature. A straightforward application to non-autonomous problems requires the evaluation of the time-dependent operators at complex times. We propose new time-averaging high order methods with half the coefficients being real and positive (for the time-averaging) and tailored for several classes of problems.

▶CP-Tu-D-24-4 15:00–15:20

New Preconditioned Exponential Time Integrators for Stiff Differential Equations

Luan, Vu Thai Univ. of California, Merced
Tokman, Mayya Univ. of California, Merced
Rainwater, Greg Univ. of California, Merced

Abstract: We propose two new classes of time integrators for stiff DEs: the implicit-explicit exponential (IMEXP) and the hybrid exponential methods. In contrast to the existing exponential schemes, the new methods offer significant computational advantages when used with preconditioners. Any preconditioner can be used with any of these new schemes. This leads to a broader applicability of exponential methods. The proof of stability and convergence of these integrators and numerical demonstration of their efficiency are presented.

▶CP-Tu-D-24-5 15:20–15:40

Stiffly Accurate Efficient Exponential Integrators of EPIRK-type

Rainwater, Greg Univ. of California, Merced
Tokman, Mayya Univ. of California, Merced

Abstract: The theory of stiff order conditions originally proposed for Exponential Rosenbrock methods (EXPRB) in [1,2] is extended to the class of exponential propagation iterative methods of Runge-Kutta type (EPIRK). We show how the structural flexibility inherent in the coefficients of the EPIRK methods can be exploited to derive more efficient integrators then previously proposed EPIRK and EXRB schemes. We illustrate this approach for the stiffly accurate EPIRK methods coupled with the adaptive Krylov methods.
[1] M. Hochbruck and A. Ostermann, Exponential integrators of Rosenbrock-type, Oberwolfach Reports 3 (2006), 1107-1110. [2] L. Vu and A. Ostermann, Exponential Rosenbrock methods of order five - construction, analysis, and numerical comparisons, J. of Computational and Applied Mathematics (2012)

▶CP-Tu-D-24-6 15:40–16:00

A Backward Error Analysis for the Leja Method

Kandolf, Peter Univ. of Innsbruck
Ostermann, Alexander Univ. of Innsbruck

Abstract: The Leja method is a well established scheme for computing the action of the matrix exponential. We present a new backward error analysis allowing a more efficient method. From a scalar computation in high precision we predict the necessary number of scaling steps based only on a rough estimate of the field of values or norm of the matrix and the desired backward error. The efficiency of the approach is shown in numerical experiments.

MS-Tu-D-25 13:30–15:30 210A

Isogeometric methods and design-through-analysis tools in CAD/CAE - Part III of III

For Part 1, see MS-Mo-D-25
For Part 2, see MS-Mo-E-25

Organizer: BUFFA, Annalisa IMATI "E. Magenes", CNR

Organizer: Giannelli, Carlotta INdAM c/o Univ. of Florence

Abstract: The development process of industrial digital products relies on geometrical and numerical technologies provided by computer aided applications. The computational models are usually designed through commercial Computer Aided Design (CAD) systems and subsequently processed and approximated with Computer Aided Engineering (CAE) software tools.
In order to drastically improve the efficiency and robustness of this process, a deep interaction among scientists from geometric modeling and numerical analysis is needed. An active area of research in this context is related to isogeometric analysis, an emerging paradigm for the solution of partial differential equations which combines and extends finite element techniques with CAD methods related to spline technologies. The isogeometric perspective

outlines new paths of research for the identification of geometric representations suitable for numerical simulation.
Indeed, isogeometric analysis is based on the idea that the exact geometry of the model should be preserved throughout the overall design-through-analysis process and numerical methods should be able to simulate physical phenomena directly on the CAD model. This is possible only if new, spline based, numerical techniques are designed and innovative schemes for geometric design are developed.
The minisymposium will address theoretical and computational issues that arise in the identification, characterization and use of advanced geometric and analytical methods that share the goal of promoting new paradigms for a better CAD/CAE integration.

▶ MS-Tu-D-25-1 13:30–14:00
Geometric Design in An Industrial Environment
Grossmann, David — MTU Aero Engines AG

Abstract: The overall design of aircraft engines is one of the most challenging tasks in todays engineering world comprising newest technologies in design and simulation where the capability of fast and robust geometric algorithms for automatic shape optimization is a key. After an overview about the currently used geometric design framework at MTU, the integration of adaptive spline technologies and isogeometric approaches will show paths to improve the overall design-trough-analysis processes within an industrial environment.

▶ MS-Tu-D-25-2 14:00–14:30
A Natural Framework for Isogeometric Fluid-structure-interaction: Coupling BEM and Shell Models
Heltai, Luca — SISSA

Abstract: We propose an iso-geometric FSI method for the coupling of thin structures and viscous flows, entirely based on surface CAD representations. This is made possible by a shell formulation for the structure and a boundary integral representation for the fluid. We couple a nonlinear isogeometric Kirchhoff-Love formulation with an isogeometric BEM formulation of three dimensional Stokes flows. This allows the treatment of infinite computational domains, and it is entirely based on surface NURBS descriptions.

▶ MS-Tu-D-25-3 14:30–15:00
TriGA: Generalization of Isogeometric Analysis to Unstructured Triangular and Tetrahedral Discretizations
Evans, John — Univ. of Colorado Boulder
Luke, Engvall — Univ. of Colorado Boulder

Abstract: In this talk, we present the TriGA software framework which generalizes the isogeometric design-through-analysis methodology to unstructured triangular and tetrahedral discretizations. TriGA is capable of automatically creating high-quality triangular meshes that exactly match arbitrary 2D geometries defined by NURBS curves, and it enables semi-automatic 3D mesh generation for most classes of geometries. We demonstrate the utility of the TriGA framework in the context of continuous and discontinuous Galerkin methods with a suite of numerical examples.

▶ MS-Tu-D-25-4 15:00–15:30
Design and Convergence of Adaptive Isogeometric Methods
Giannelli, Carlotta — INdAM c/o Univ. of Florence
BUFFA, Annalisa — IMATI "E. Magenes", CNR

Abstract: The rise of isogeometric analysis is increasingly demanding the study of reliable adaptive schemes that combine suitable spline technologies which provide local refinement possibilities with the design of a posteriori error estimators. The talk will present an adaptive isogeometric method that exploits the potential of hierarchical B-spline constructions, in connection with admissible mesh configurations. The derivation of error bounds for residual-type estimators will be presented and used for the convergence analysis of the scheme.

MS-Tu-D-26	13:30–15:30	110
A recent progress in computational methods for solving differential equations		

Organizer: Kumar, Manoj — Motilal Nehru National Inst. of Tech. Allahabad
Abstract: Problems in science and engineering often involve differential equations (des) sufficiently complicated to require numerical techniques for approximating their solutions. Traditionally, the finite difference, finite element, and boundary element methods have been employed to numerically solve DEs. Although powerful and widespread, these tools do have drawbacks including problematic discretization of the problem domain and complications in solving nonlinear DEs. Computational Mathematics is the area of Mathematics and Computer Science that creates, analyzes, and implements algorithms for solving numerically the complicated non-linear problems of real life. Such type of problems originate generally from real-world applications of algebra, geometry, and calculus, and they involve variables, which vary continuously; these problems occur throughout the natural sciences, social sciences, engineering, medicine, business, and many others. During the past half-century, the growth in power and availability of digital computers has led to an increasing use of realistic mathematical models in science and engineering, and numerical analysis of increasing sophistication has been needed to solve these more detailed mathematical models. A wide variety of the great important problems in physics and engineering are formulated in terms of nonlinear equations. One of the most important and striking phenomena of the applications of differential equations(DEs) in the physical sciences and engineering has been the impact of high speed digital computation. This minisymposium looks at recent progress in numerical methods and covers both theoretical and computational aspects with applications.

▶ MS-Tu-D-26-1 13:30–14:00
Convergence Analysis of Higher Order Iterative Methods with Memory
Jaiswal, Jai Prakash — Maulana Azad National Inst. of Tech., Bhopal

Abstract: The object of the present paper is to accelerate the R- order convergence of with memory derivative free family given by Lot et al. (2014) without any adding evaluations. To achieve this goal one more iterative parameter is introduced, which is calculated with the help of Newton's interpolatory polynomial. Smooth as well as non-smooth examples are presented to confirm theoretical result and significance of the new scheme.

▶ MS-Tu-D-26-2 14:00–14:30
Numerical simulation of Plateu's problem of minimal surfaces using nonvarational finite element method
Mishra, Garima — Motilal Nehru National Inst. of Tech. Allahabad

Abstract: The present paper is dedicated to numerical solution of Plateau's problem of minimal surface using non-variational finite element method. An efficient algorithm is proposed for the computation of minimal surfaces and numerical results are presented. The solutions obtained here are examined for several examples and are considered to be sufficiently accurate.

▶ MS-Tu-D-26-3 14:30–15:00
Off-step Discretization for Higher Order Boundary Value Problems
Khan, Arshad — Jamia Millia Islamia, New Delhi

Abstract: In this paper, we propose numerical methods based on off-step points to solve fourth order boundary value problems of the type $u^{(iv)} = f(x, u, u', u'', u''')$ subject to boundary conditions $u(0) = \alpha, u''(0) = \beta, u(1) = \gamma, u''(1) = \delta$, where $f \in C^4[a, b]$ and $\alpha, \beta, \gamma, \delta \in$ **R** .The methods are applicable to singular as well as nonlinear boundary value problems. Convergence analysis has been briefly discussed.Numerical results are provided to illustrate the accuracy of the proposed methods.

▶ MS-Tu-D-26-4 15:00–15:30
Family of Variable Mesh Cubic Spline Methods for Higher Order Boundary Value Problems
NAYAK, SUCHETA — LADY SHRI RAM COLLEGE FOR WOMEN, Univ. OF DELHI

Abstract: In this paper, we propose two variable mesh cubic spline numerical methods to solve higher boundary value problems of the type $u^{(4)} = f(x, u, u^{(1)}, u^{(2)}, u^{(3)})$,$x \in [a, b]$ with boundary conditions $u(a) = A_1, u^{(2)}(a) = A_2, u(b) = B_1, u^{(2)}(b) = B_2$, where $f \in C^4[a, b]$ and A_i, B_i are real constants. Convergence of both the methods have been briefly discussed.Numerical results are provided to confirm the accuracy and efficiency of the proposed methods.

MS-Tu-D-27	13:30–15:30	407
Numerical Simulations in Poromechanics - Part III of III		

For Part 1, see MS-Mo-D-27
For Part 2, see MS-Mo-E-27

Organizer: Gaspar, Francisco — Univ. of Zaragoza
Organizer: Hu, Xiaozhe — Tufts Univ.
Organizer: Rodrigo, Carmen — Univ. of Zaragoza
Organizer: Zikatanov, Ludmil — The Pennsylvania State Univ.
Abstract: Poromechanics studies the interactions between fluid motion and deformation in porous media. It has important applications including consolidation, subsidence due to fluid withdrawal, and hydraulic fracturing. Many discretizations and solver schemes have been developed for poromechanics but the design of effective simulation techniques for handling the coupling between fluid motion and solid deformation is still a challenging task. The main theme of the minisymposium is on the advanced numerical algorithms for sim-

ulating poromechanics. The focus is on robust discretizations, adaptivity and efficient nonlinear and linear solvers for various poroelastic models and their applications.

▶ MS-Tu-D-27-1 13:30–14:00

On Dimension Reduction Approach for Simulations of Poroelastic Deformations in Pleated Filters

Iliev, Dimitar — Fraunhofer Inst. for Industrial Mathematics ITWM
Iliev, Oleg — Fraunhofer ITWM
Kirsch, Ralf — Fraunhofer ITWM

Abstract: Approach for solving poroelasticity equations for thin porous media is considered. The particular application is filtration, flat and pleated porous media are considered. Reduction of the 3D poroelasticity equations to poroelastic plate and poroelastic shell models, done by Mikelic is the starting point. Weak coupling approach between Navier-Stokes-Brinkman and the poroelasticity is exploited. Validation results, results demonstrating the computational efficiency of the approach, and simulations in realistic geometries will be presented.

▶ MS-Tu-D-27-2 14:00–14:30

Convergence Analysis of Finite Element Discretizations for Biot' s Equations

Rodrigo, Carmen — Univ. of Zaragoza
Gaspar, Francisco — Univ. of Zaragoza
Hu, Xiaozhe — Tufts Univ.
Zikatanov, Ludmil — The Pennsylvania State Univ.

Abstract: Poroelasticity models the processes of coupled deformable porous media flow which is essential in many applications. In this talk, we consider the discretizations for the Biot' s model using lowest order finite elements and address the issue related to the non-physical oscillations in the pressure approximation for low permeabilities and/or small time steps. We introduce a stabilization term which removes the oscillations and show the convergence. Numerical experiments are presented to support our theoretical results.

▶ MS-Tu-D-27-3 14:30–15:00

Efficient Preconditioners for Finite Element Discretizations of Biot Consolidation Model

Bin, Zheng — Pacific Northwest National Laboratory

Abstract: In this work we construct efficient block preconditioners for solving the linear systems resulting from finite element discretizations of Biot model. We show that the preconditioned Krylov iterative methods converge uniformly with respect to both the discretization parameters and the model parameters. Numerical examples are given to verify the theoretical results. This is a joint work with (in alphabetical order) Luoping Chen, Xiaozhe Hu, Lu Wang, and Jinchao Xu.

▶ MS-Tu-D-27-4 15:00–15:30

Phase-field Modeling for Hydraulic Fracturing in Porous Media

Wheeler, Mary F — UT-Austin

Abstract: We discuss phase-field modeling of a fluid-driven fracture in a poroelastic medium. The mathematical model consists of a linear elasticity system with fading elastic moduli as the crack grows, coupled with an elliptic variational inequality for the phase field variable and with a pressure equation. Two approaches of coupled are considered, both fully coupled and one based on stress splitting. Computational results are presented. This work is in collaboration with Andro Mikelic,Thomas Wick,and Sanghyun Lee

MS-Tu-D-28 13:30–15:30 109

Weak Galerkin Method and Its Applications - Part III of III

For Part 1, see MS-Mo-D-28
For Part 2, see MS-Mo-E-28

Organizer: Chen, Long — Univ. of California at Irvine
Organizer: Ye, Xiu — Univ. of Arkansas at Little Rock
Organizer: Zhang, Ran — Jilin Univ.

Abstract: The Weak Galerkin method is an extension of the standard Galerkin finite element method where classical derivatives were substituted by weakly defined derivatives on functions with discontinuity. As such, the WG methods have the flexibility in handling complex geometry and low regularity solutions, the simplicity in analyzing real-world physical problems, and the symmetry in reformulating the original PDEs. The aim of this mini-symposium is to bring together specialists in order to ex- change ideas regarding the development of WG-FEMs and its industry and research applications. Since women is an underrepresented group in mathematics and engi- neering, we pay a particular attention to attract female participants.

▶ MS-Tu-D-28-1 13:30–14:00

Equivalence of Weak Galerkin Methods and Virtual Element Methods for Elliptic Equations

Chen, Long — Univ. of California at Irvine

Abstract: We propose a modification of the weak Galerkin methods and show its equivalence to a new version of virtual element methods. We also show the original weak Galerkin method is equivalent to the non-conforming virtual element method. As a consequence, ideas and techniques used for one method can be transferred to another. The key of the connection is the degree of freedoms.

▶ MS-Tu-D-28-2 14:00–14:30

A Divergence-free Weak Galerkin Finite Element

Zhang, Shangyou — Univ. of Delaware

Abstract: A weak Galerkin finite element is designed so that the computed velocity is divergence-free. The significance of such a method is shown by solving a low-viscosity Stokes problem. The traditional finite elements, weak Galerkin finite elements and discontinous Galerkin finite flements fail to produce a meaningful solution in solving such a test problem.

▶ CP-Tu-D-28-3 14:30–14:50

Minisymposium's Code "ycGz6P": Modified Weak Galerkin Methods for Convection-diffusion Problem

Gao, Fuzheng — Shandong Univ.

Abstract: Minisymposium's code "ycGz6P": In modern numerical simulation of problems in energy resources and environmental science, it is very important to develop efficient numerical methods for convection – diffusion problems. Based on modified weak gradient operator and weak divergence operator, we present a modified weak Galerkin finite element method (MWG-FEM) on arbitrary grids. Some techniques, such as calculus of variations, commutating operator and the theory of prior error estimates and techniques, are adopted. Optimal order error estimates for the corresponding MWG-FEM approximations in both a discrete H^1 norm and the standard L^2 norm are derived to determine the errors in the approximate solution. Numerical results are presented to demonstrate the robustness, reliability, and accuracy of the MWG-FEM

▶ CP-Tu-D-28-4 14:50–15:10

An Adaptively Weighted Galerkin Finite Element Method for Boundary Value Problems

Sun, Yifei — Courant Inst. of Mathematical Sci., New York Univ.
Westphal, Chad — Wabash College

Abstract: We introduce an adaptively weighted Galerkin approach for elliptic problems where diffusion is dominated by strong convection or reaction terms. In such problems, standard Galerkin approximations can have unacceptable oscillatory behavior near boundaries unless the computational mesh is sufficiently fine. Here we show how adaptively weighting the equations within the variational problem can increase accuracy and stability of solutions on under-resolved meshes. Rather than relying on specialized finite elements or meshes, the idea here sets a flexible and robust framework where the metric of the variational formulation is adapted by an approximate solution. We give a general overview of the formulation and an algorithmic structure for choosing weight functions. Numerical examples are presented to illustrate the method.

▶ CP-Tu-D-28-5 15:10–15:30

Hp-Version Discontinuous Galerkin Methods for Partial Differential Equation with Nonnegative Characteristic Form on Polygonal and Polyhedral Meshes

Dong, Zhaonan — Univ. of Leicester

Abstract: In this work, we consider hp-version discontinuous Galerkin finite element method (DGFEM) for the numerical approximation of partial differential equation with nonnegative characteristic form on general computational meshes consisting of polygonal/polyhedral element. In particular, new hp-a priori error bounds are derived in this work which improves the hp-bounds in the work by [P.Houston, C.Schwab, E.Süli - Discontinuous hp-Finite Element Methods for Advection-Diffusion-Reaction Problems, SIAM Journal on Numerical Analysis 39(6):2133-2163, 2002]. The presented method employs elemental polynomial bases of total degree P defined on the physical space, without the need to map from a given reference or canonical frame. Numerical experiments highlighting the performance of the proposed method are presented. Moreover, the competitiveness of the DGFEM employing total degree P basis in comparison to the DGFEM employing Q basis on tensor-product elements is studied numerically. This is the joint work with Andrea Cangiani, Emmanuil H. Georgoulis and Paul Houston.

MS-Tu-D-29 13:30–15:30 305
Multilevel Monte Carlo methods and applications - Part III of III
For Part 1, see MS-Mo-D-29
For Part 2, see MS-Mo-E-29

Organizer: TEMPONE, RAUL KING ABDULLAH Univ. OF Sci. & Tech.
Organizer: Giles, Michael Univ. of Oxford
Organizer: Nobile, Fabio MATHICSE - EPFL

Abstract: Monte Carlo methods are general, flexible sampling methods for the computation of expected values of observables arising in stochastic systems. Monte Carlo methods are very attractive since they are simple to implement and their rate of convergence is very robust. Still, in the context of random evolution of large systems arising from the discretization of differential equations subject to randomness, their cost can be too large for practical purposes. The recently created Multilevel Monte Carlo method extended, to multiple levels, the idea of using a coarse numerical approximation as a method for control variate to a finer one, reducing the variance and the required number of samples on the finer grid. Multilevel Monte Carlo changed the computational landscape of stochastic problems described in terms of differential equations, which are commonplace, for instance, when carrying out Uncertainty Quantification in applications. In this minisymposium we intend to present the latest algorithmic and theoretical contributions to Multilevel Monte Carlo methods, focusing also on novel applications arising in, among others, stochastic social, chemical and biological modeling, wireless communication networks, computational finance, stochastic particle systems and engineering modeling with random PDEs.

▶ MS-Tu-D-29-1 13:30–14:00
Optimization of Mesh Hierarchies in Multilevel Monte Carlo Samplers
Haji Ali, Abdul Lateef KAUST
Nobile, Fabio MATHICSE - EPFL
TEMPONE, RAUL KING ABDULLAH Univ. OF Sci. & Tech.

Abstract: We perform a general optimization of the parameters in the Multilevel Monte Carlo (MLMC) discretization hierarchy based on uniform discretization methods with general approximation orders and computational costs. We optimize hierarchies with geometric and non-geometric sequences of mesh sizes and show that geometric hierarchies are nearly optimal and have the same asymptotic computational complexity as non-geometric optimal hierarchies. To provide numerical grounds for our theoretical results, we test our hierarchies with the Continuation MLMC Algorithm.

▶ MS-Tu-D-29-2 14:00–14:30
MULTI-INDEX MONTE CARLO METHOD
Haji Ali, Abdul Lateef KAUST
Nobile, Fabio MATHICSE - EPFL
TEMPONE, RAUL KING ABDULLAH Univ. OF Sci. & Tech.

Abstract: We propose and analyze a novel Multi-Index Monte Carlo (MIMC) method for weak approximation of stochastic PDE models, that uses high-order mixed differences to achieve variance reduction, as opposed to first-order differences as in Multi Level Monte Carlo (MLMC).
We present complexity results which increase, with respect to MLMC, the set of parameters for which optimal convergence $1/tol^2$ is achieved, and propose a systematic construction of optimal sets of indices based on properly defined profits.

▶ MS-Tu-D-29-3 14:30–15:00
Multilevel Monte Carlo Simulations of Stochastic McKean-Vlasov Equations.
Lukasz, Szpruch Univ. of Edinburgh

Abstract: During this talk I will discuss Multilevel Monte Carlo simulation techniques for stochastic McKean-Vlasov equations. These are non-linear stochastic equations whose coefficients depend on the on the state variable and the law of its solution. Propagation of Chaos theory states that the solution to stochastic McKean-Vlasov equations can be approximated by system of interacting particles . Practical implementations of particle systems are computationally very costly - the issue I'm going to address in this talk.

▶ MS-Tu-D-29-4 15:00–15:30
A MULTILEVEL ADAPTIVE REACTION-SPLITTING SIMULATION METHOD FOR STOCHASTIC REACTION NETWORKS
TEMPONE, RAUL KING ABDULLAH Univ. OF Sci. & Tech.
Moraes, Alvaro KAUST
Vilanova, Pedro KAUST

Abstract: We develop novel hybrid Multilevel Monte Carlo methods for kinetic simulation of stochastic reaction networks. These ML hybrid algorithms adaptively switch between the Stochastic Simulation Algorithm and the Tau Leap method. They also control the global exit probability of any simulated path using a Chernoff-type bound and obtain accurate and computable estimates of the expected value of any smooth observable of the process with minimal computational work. Our numerical examples show substantial computational gains.

MS-Tu-D-30 13:30–15:30 VIP2-2
Numerical Analysis of Stochastic Differential Equations - Part I of II
For Part 2, see MS-Tu-E-30

Organizer: Neuenkirch, Andreas Univ. of Mannheim
Organizer: Jentzen, Arnulf ETH Zurich

Abstract: This session is devoted to the numerical analysis of all kinds of stochastic differential equations (SDEs) and related approximation problems. Among the studied equations, there will be SDEs with irregular coefficients, backward SDEs (BSDEs), stochastic partial differential equations (SPDEs) and SDEs with other driving noises than Brownian motion. The goal of this session is to present recent developments in the area of computational SDEs. Particular focus will be given to the interplay of the different topics in this area and to the identification of new research questions.

▶ MS-Tu-D-30-1 13:30–14:00
Approximating Irregular SDEs via Iterative Skorokhod Embeddings
Ankirchner, Stefan Univ. of Jena

Abstract: We provide a new method for approximating the law of a diffusion M solving a stochastic differential equation with possibly irregular coeffcients. To this end we construct Markov chains whose laws can be embedded into the diffusion M with a sequence of stopping times that have expectation 1/N, where N is a discretization parameter. We show that the Markov chains converge in distribution and we illustrate our results with several examples.

▶ MS-Tu-D-30-2 14:00–14:30
Renormalization and Stochastic PDEs
Shen, Hao Univ. of Warwick

Abstract: I will discuss some examples of stochastic nonlinear PDEs of parabolic type driven by Gaussian or more general noise. The solutions of these equations are very singular, so that it is hard to interpret what solutions mean. The naive approximations to these equations do not converge to non-trivial limits. I will explain Hairer's theory of regularity structures which provide solutions to these equations, in particular the renormalization techniques in this theory.

▶ MS-Tu-D-30-3 14:30–15:00
Finite Element Approximations for Fourth Order Stochastic Parabolic Equations
Zouraris, Georgios Univ. of Crete

Abstract: We consider an initial- boundary- value problem for a fourth order stochastic parabolic equation, forced by a space-time white noise or its space derivative. First, we propose an approximate stochastic parabolic problem discretizing the noise using linear splines. Then we construct fully-discrete approximations to the solution of the approximate problem combining a finite element method based on H^2-piecewise polynomials with several options for time stepping, and analyze its approximation.

▶ MS-Tu-D-30-4 15:00–15:30
N-term Galerkin Wiener Chaos Approximations of Elliptic PDEs with Lognormal Gaussian Random Inputs
Hoang, Viet Ha Nanyang Technological Univ.

Abstract: We consider diffusion equations with a log-normal coefficient. The weak solution is represented as Wiener-Ito Polynomial Chaos series of Hermite Polynomials of a countable number of i.i.d standard Gaussian random variables. We establish sufficient conditions on the random inputs for the norms of the chaos coefficients to be p-summable for some $0 < p < 1$. We prove rates of nonlinear, best N-term chaos approximations, and of their Finite Element approximations. (Joint work with Christoph Schwab (ETH, Zurich)).

MS-Tu-D-31 13:30–15:30 405
Numerical Computation with Functions and Chebfun - Part III of III
For Part 1, see MS-Mo-D-31
For Part 2, see MS-Mo-E-31

Organizer: Trefethen, Lloyd N. Univ. of Oxford
Organizer: Guettel, Stefan The Univ. of Manchester

Abstract: A recent theme in algorithms and software is efficient numerical computation with functions in a manner that "feels symbolic" since the accuracy is high and underlying discretizations (Chebyshev, Fourier,...) are hidden from the user. Projects of this kind include Chebfun, pychebfun, ApproxFun, and PaCAL. A pervasive theme in this work is the use of continuous analogues of familiar discrete mathematical objects and algorithms. This min-

isymposium will present new developments in the areas of (1) differential and integral equations, (2) working with functions, and (3) rootfinding and linear algebra.

▶ MS-Tu-D-31-1 13:30–14:00

Computing with Pencil Representations of Rational Functions

Guettel, Stefan — The Univ. of Manchester

Abstract: The newly developed MATLAB Rational Krylov Toolbox (available from http://guettel.com/rktoolbox) implements a class called RKFUN for representing and working with rational functions. In this talk I will explain the pencil representation underlying RKFUN and some of the methods we have implemented. This is joint work with Mario Berljafa.

▶ MS-Tu-D-31-2 14:00–14:30

Stability of Rootfinding in Chebyshev and Other Orthogonal Bases

Vanni, Noferini — Univ. of Manchester
Nakatsukasa, Yuji — Univ. of Tokyo
Perez Alvaro, Javier — Univ. of Manchester

Abstract: The roots of a polynomial expressed in the Chebyshev basis can be computed as the eigenvalues of its colleague linearization. Applying the QZ algorithm to the colleague pencil yields a backward stable rootfinder, whereas applying the QR algorithm to the colleague matrix is backward stable only under certain assumptions on the polynomial. We discuss the implication of our results for Chebfun roots algorithm, and present some generalizations to other polynomial bases.

▶ MS-Tu-D-31-3 14:30–15:00

A Practical Framework for Infinite-dimensional Linear Algebra

Olver, Sheehan — The Univ. of Sydney

Abstract: We describe a framework for solving a broad class of infinite-dimensional linear equations, consisting of almost banded operators, which can be used to resepresent linear ordinary differential equations with general boundary conditions and singular integral equations. In addition, special tensor product equations, such as partial differential equations on rectangles, can be solved by truncating the operator along one dimension and using a generalized Schur decomposition.

▶ MS-Tu-D-31-4 15:00–15:30

Numerical Computation with Periodic Functions

Montanelli, Hadrien — Univ. of Oxford

Abstract: Algorithms and underlying mathematics are presented for numerical computation with periodic functions via approximations to machine precision by trigonometric polynomials. Applications include the solution of nonlinear stiff PDEs and the computation of choreographies.

CP-Tu-D-32 13:30–15:50 307A

Probability, Finance and Management Science, Simulation and Modeling

Chair: Conrad, Patrick — Univ. of Warwick

Abstract:

▶ CP-Tu-D-32-1 13:30–13:50

Probability Measures on Numerical Solutions of ODEs for Uncertainty Quantification and Inference

Conrad, Patrick — Univ. of Warwick
Girolami, Mark — Univ. of Warwick
Stuart, Andrew — Univ. of Warwick

Abstract: Deterministic ODE solvers are widely used, but characterizing the error in numerical solutions within a coherent statistical framework is challenging. We successfully address this problem by constructing a probability measure over functions consistent with the ODE solution that provably contracts to a Dirac measure on the unique solution at rates determined by an underlying deterministic solver. The measure straightforwardly derives from important classes of numerical solvers and is illustrated on uncertainty quantification and inverse problems.

▶ CP-Tu-D-32-2 13:50–14:10

Investigation of Doubling-Time Probability Densities for Growth Processes

Allen, Edward — Texas Tech Univ.

Abstract: The doubling-time probability density for a growth process is the probability density of times for the initial magnitude to double. Doubling-time probability densities are useful in studying growth rates, for example, of organisms, populations, financial products, or chemical reactions. Three stochastic models of growth are investigated for their doubling-time probability densities. Two of the stochastic models have doubling-time probability densities which are inverse Gaussian. The third stochastic model's doubling-time density has no simple analytical form but it is approximately inverse Gaussian under a reasonable assumption on the model's parameters.

▶ CP-Tu-D-32-3 14:10–14:30

Uncertainty Quantification and Safety Boundary Analysis for Complex System Using Bayesian Statistics

He, Yuning — UARC

Abstract: Safe separation between all aircraft at all times in the controlled airspace is an extremely important safety requirement. Because the airspace near an airport is much more challenging, the Terminal Tactical Separation Assured Flight Environment (TTSAFE) is being developed. It tries to detect violations of separation as early as possible and make air traffic controllers aware of such situations. The separation algorithms in TTSAFE are governed by a large number of parameters. In order to ensure safe operation through verification and validation (V&V), we must analyze how uncertainties in those parameters influence the behavior of TTSAFE. Using our advanced Bayesian statistical analysis techniques we carried out an Uncertainty Quantification (UQ) analysis for the system. We have also developed a new statistical framework based upon sequential design of computer experiments that can incorporate domain knowledge to efficiently study safety boundaries of such complex system.

▶ CP-Tu-D-32-4 14:30–14:50

Mean-Reversion Trading under A Markov Chain Model

Zhang, Qing — Univ. of Georgia
Tie, Jingzhi — Univ. of Georgia

Abstract: This paper is concerned with a mean-reversion trading rule. In contrast to most market models treated in the literature, the underlying market is solely determined by a two-state Markov chain. The major advantage of such Markov chain model is its striking simplicity and yet its capability of capturing various market movements. The purpose of this paper is to study an optimal trading rule under such a model. The objective of the problem under consideration is to find a sequence stopping (buying and selling) times so as to maximize an expected return. Under some suitable conditions, explicit solutions to the associated HJB equations (variational inequalities) are obtained. The optimal stopping times are given in terms of a set of threshold levels. A verification theorem is provided to justify their optimality. Finally, a numerical example is provided to illustrate the results.

▶ CP-Tu-D-32-5 14:50–15:10

Spatially Explicit Modelling of European Wildfires

Baetens, Jan — Ghent Univ.
Dutta, Srabasti — Ashford Univ.
De Baets, Bernard — Ghent Univ.

Abstract: Since wildfires are causing substantial economic, ecological and social losses in many parts of the world, several fire-prone countries or regions have deployed so-called forest information systems. As a first step towards the further advancement of the European Forest Fire Information System, we show in this work how a spatially explicit model can be used to realistically simulate the propagation of wildfires in Europe.

▶ CP-Tu-D-32-6 15:10–15:30

An Accurate Simulation-based Approach to the Dynamic Portfolio Management Problem

Cong, Fei — TU Delft
Oosterlee, Cornelis — CWI -center for mathematics & computer Sci.

Abstract: We revisit a well-known dynamic portfolio management algorithm, the BGSS algorithm, proposed by Brandt, Goyal, Santa-Clara and Stroud (Review of Financial Studies, 18, 831-873, 2005). We equip this algorithm with a recently developed component, the Stochastic Grid Bundling Method, for calculating conditional expectations. When solving the first-order conditions for an optimum, we implement a Taylor series expansion based on a nonlinear decomposition to approximate the utility functions. In the numerical tests, we show that our algorithm is more accurate and robust in approximating the optimal investment strategies compared to other simulation- and regression-based algorithms.

▶ CP-Tu-D-32-7 15:30–15:50

Asymptotic Behavior of Randomly Weighted Sums of Dependent Heavy Tailed Random Variables

KK, Thampi — SNMC, Mahatma Gandhi Univ.

Abstract: Let Xi be a sequence of Weakly Negatively dependent (WND) random variables with semi exponential varying tails. Let Wi be a sequence of non-negative random variables, independent of Xi. The weighted random sums WiXi, and the tail probability of maximum of random sums, for k less than or equal to N, where N is a non-negative integer valued random variable. Under the assumption that Xi, Wi and N are mutually independent with some mild conditions,this paper establishes an asymptotic relationship for the tail probability P(SN ¿ x).

MS-Tu-D-33 13:30–15:40 406
Inverse problems for fractional diffusion equations

Organizer: Ting, Wei Lanzhou Univ.

Abstract: In recent years, fractional differential equations have attracted wide attention due to the fact that they have important applications in biology, physics, chemistry and finance. While much research on the direct problems for fractional differential equations has taken place, there is much less literature on inverse problems. In this minisymposia, we will present some new research on questions of uniqueness, numerical reconstructions and regularization methods in solving various inverse problems for fractional differential equations which include the backward problem and the identification problem of fractional order, as well as some new findings on the difference between the fractional differential equations and their classical counterparts. This minisymposia will provide a good opportunity for international communications on this topic and attract wide attention to this field.

▶ MS-Tu-D-33-1 13:30–14:00
Inverse Problems for Space Fractional Diffusion
Jin, Bangti Univ. College London

Abstract: In this talk I will discuss a few inverse problems for space fractional diffusion problems, e.g., inverse eigenvalue problem and the sideways problem. I will give the motivation for the inverse problems, describe mathematical and numerical challenges, and most importantly, show the unusual features of this class of inverse problems.

▶ MS-Tu-D-33-2 14:00–14:30
The Fundamental Solution for Fractional Diffusion Equations and Its Use in Various Undetermined Coefficient Problems.
Rundell, William Texas A&M Univ.
Jin, Bangti Univ. College London

Abstract: The role of the fundamental solution of the heat equation is very well know in both direct and inverse problems for parabolic equations. In this talk we look at the case of $D_t^\alpha - \triangle u = f$ with $\alpha \in (0,1)$ and consider the sequel. We will use the representation formulae involving this solution to examine the behaviour and reconstruction of a few undetermined coefficient/boundary value problems for the fractional case.

▶ MS-Tu-D-33-3 14:30–15:00
Inverse Problems of Determining Fractional Orders in the Fractional Diffusion Equations
Li, Gongsheng Shandong Univ. of Tech.

Abstract: We consider inverse problems: (I) To determine multiple orders in the multi-term time fractional diffusion equation; (II) To determine the time-space fractional orders in the Caputo-time Riesz-space fractional diffusion equation. Uniqueness for inverse problem (I) is proved on the basis of Laplace transform, and differentiation of the solution operator for inverse problem (II) is discussed with which the inverse problem is solvable under suitable initial conditions. Numerical inversions are performed by the homotopy regularization algorithm.

▶ CP-Tu-D-33-4 15:00–15:20
An Efficient Solver for 3D Simulations for Flow with Interface
Weishan, Deng Inst. of Software, CAS
Xu, Jin Inst. of Software

Abstract: An efficient solver using finite element method for flow with interface has been developed. It is based primarily on nodal basis on unstructured grid. The numerical method and parallel model are explained in detail, and benchmark results will be shown. It has been successfully applied in simulating some flows with interafce and some further applications of this solver will be present.

▶ CP-Tu-D-33-5 15:20–15:40
A Model for Mountain Pine Beetle Outbreaks in An Age Structured Forest: Predicting Severity and Outbreak-Recovery Cycle Period
Duncan, Jacob Utah State Univ.
Powell, James Utah State Univ.
Gordillo, Luis Utah State Univ.
Eason, Joseph Univ. of Utah

Abstract: The relationship between the mountain pine beetle (MPB) and lodgepole pine tree has historically been normative. However, since MPB require moderate winter and warm summer to achieve successful attacks, outbreaks have been more severe in recent decades due to increasing global temperatures. In this paper we develop an age-structured forest demographic model that incorporates temperature-dependent MPB infestation. Stability of fixed points is analyzed as a function of MPB growth rates, and indicates the existence of periodic outbreaks that intensify as growth rates increase. We devise analytical methods to predict outbreak severity and duration as well as outbreak return time. After incorporating a spatial aspect and controlling initial stand demographic variation, the model predicts cycle periods that fall within observed outbreak return time ranges. To assess future MPB impact on forests, we use our model-based approximation methods to predict potential severity of future outbreaks that reflects the effects of changing climate.

MS-Tu-D-34 13:30–15:30 112
Mathematics and Algorithms in Quantum Chemistry - Part I of III
For Part 2, see MS-Tu-E-34
For Part 3, see MS-We-D-34

Organizer: Melgaard, Michael Univ. of Sussex
Organizer: Shao, Sihong Peking Univ.

Abstract: Ab initio models of electronic structures has had an immense impact in the physics and chemistry communities, as well as the materials science community, due to the capacity for carrying out realistic computations. The mathematical formulation and the efficient numerical simulation of such models is a notoriously difficult problem for several reasons, e.g., high dimensional configurations spaces, multi-particle interactions, multiple scales, nonlinear effects, and/or degeneracies of eigenspaces. Further developments in this area require the integration of physical modeling, mathematical analysis, and algorithm development in order to obtain reliable computational tools. The mini-symposium aims to bring together quantum chemists, applied and computational mathematicians, physicists and materials scientists all of whom are working in quantum chemistry to exchange ideas and to share their recent progress on the frontiers of theory and numerical methods as well as applications in material science. The mini-symposium will particularly focus on three topics: Time-dependent problems and excited states; Wave function methods; Relativistic effects.

▶ MS-Tu-D-34-1 13:30–14:00
Fundamentals of Relativistic Molecular Quantum Mechanics
Liu, Wenjian Peking Univ.

Abstract: Relativistic molecular quantum mechanics (RMQM) consists of three components (i.e., Hamiltonian, wave function, and property), each of which is confronted with some fundamental issues, including, e.g., 'What is the appropriate relativistic many-electron Hamiltonian?', 'How to make explicit representation of relativistic wave functions?', 'How to formulate relativistic properties?', etc. In this lecture I shall try to address these fundamental issues from both conceptual and methodological standpoints, so as to establish the 'big picture' of RMQM.

▶ MS-Tu-D-34-2 14:00–14:30
Multi-scale Quantum Mechanics/Electromagnetics Method for Device Simulations
Yam, Chi Yung Beijing Computational Sci. Research Center

Abstract: As feature sizes of transistors inch towards 10 nanometer, simulations including quantum effects and atomistic details are inevitable. A hybrid quantum mechanics and electromagnetics method is developed to model electronic components at the nanoscale. QM and EM models are solved in different regions of the system in self-consistent manner. The method is expected to bridge the gap between quantum mechanics calculation and circuit modeling. Applications of the method to realistic electronic devices will be presented

▶ MS-Tu-D-34-3 14:30–15:00
Efficient Grid Methods for Solving Quantum Dynamics of Molecules
Sun, Zhigang Dalian Inst. of Chemical Physics

Abstract: In this talk, recently developed grid methods in our group for solving time-dependent and time-independent Schrodinger equation for electronic dynamics in molecules will be introduced. These include mapped discrete variable representation (DVR), mapped finite element DVR and a new accurate propagation method for dynamics involving Coulomb singularities. Numerical illustrations for solving electronic eigenstates of H2, H2+ and H_3^{2+} in cylindrical coordinates, and the interaction dynamics between H2+ and ultrashort laser pulses will be presented.

▶ MS-Tu-D-34-4 15:00–15:30
Numerical Methods and Comparison for the Dirac Equation in the Nonrelativistic Limit Regime
Bao, Weizhu National Univ. of Singapore

Abstract: We analyze rigorously error estimates and compare numerically spatial/temporal resolution of various numerical methods for the discretization of the Dirac equation in the nonrelativistic limit regime, involving a small di-

mensionless parameter which is inversely proportional to the speed of light. The numerical methods include finite difference time domain (FDTD) methods, time-splitting spectral (TSSP) method and exponential wave integrator spectral (EWI-Sp) method. Extensive numerical results are reported to support our error estimates.

MS-Tu-D-35 13:30–15:30 408

Numerical Algorithms for Stochastic Model and Uncertainty Quantification in High-Dimensional Complex Systems - Part I of II

For Part 2, see MS-Tu-E-35

Organizer: Wang, Peng Beihang Univ.
Organizer: Lin, Guang Purdue Univ.

Abstract: Uncertainty persists in most natural and engineering systems, from material discovery to reactive transport in porous media. Quantifying the uncertainty associated with the parameters in complex systems is critical, which can help us to verify our modern simulation codes and assess confidence levels. Our aim is to use accurate computational simulations to predict the behaviour of complex systems. For large number of random dimensions, advanced stochastic approximation techniques are necessary to minimize the complexity of mathematical models. This minisymposium will explore recent advances in numerical algorithms and applications for stochastic model, uncertainty quantification, and model reduction in large-scale high-dimensional complex systems.

▶ MS-Tu-D-35-1 13:30–14:00

Density Estimation with Transport Maps

Li, Jinglai shanghai jiaotong university

Abstract: Many machine learning problems such as Bayesian classifications require the estimation of density functions from data. In such problems, the dimensionality of the data can often pose a challenge for conventional approaches. In this talk we present a method for estimating densities by constructing a transport map from the parameter of interest to a multivariate Gaussian. In particular our method can strictly enforce the monotonicity of the map. Numerical examples are provided.

▶ MS-Tu-D-35-2 14:00–14:30

Adaptive ANOVA Based Reduced Basis Methods for Partial Differential Equations with High Dimensional Random Inputs

Liao, Qifeng ShanghaiTech Univ.
Lin, Guang Purdue Univ.

Abstract: We apply the ANOVA method to decompose high-dimensional random parameter spaces into a union of low-dimensional spaces. For each low-dimensional parameter space, a greedy algorithm is applied to identify the reduced problem for the corresponding spatial approximation. Numerical experiments suggest that this combination of parameter space decomposition and spatial space reduced order modeling leads to an efficient novel approach for high-dimensional uncertainty quantification problems.

▶ MS-Tu-D-35-3 14:30–15:00

The Hp Adaptivity of Minimum Action Method

Wan, Xiaoliang Louisiana State Univ.

Abstract: In this work, we develop an hp-adaptive minimum action method (MAM). MAM plays a critical role to minimize the Freidlin-Wentzell action functional, which is the central object of the Freidlin-Wentzell theory of large deviations for transitions induced by small noise. We use the arc length constraint to define an indicator of the effect of linear scaling, and the derivative recovery technique to construct an error indicator and a regularity indicator for hp refinement.

▶ MS-Tu-D-35-4 15:00–15:30

Enhance Sparsity Through Changing the Measure

Yang, Xiu Pacific Northwest Natl Laboratory
Huan, Lei Pacific Northwest Natl Laboratory
Baker, Nathan Pacific Northwest Natl Laboratory
Lin, Guang Purdue Univ.

Abstract: Compressive sensing based uncertainty quantification method attracts many attentions in recent years. We aim to find a new set of random variables through linear/nonlinear mapping such that the representation of the quantity of interest is much sparser with new basis functions associated with the new random variables. At the same time we keep the property of the measurement matrix (e.g., mutual coherence) almost unchanged, hence the number of samples for an accurate approximation decreases.

MS-Tu-D-36 13:30–15:30 409

Structure-preserving methods for nonlinear Hamiltonian systems III-III

Organizer: Feng, Bao-Feng The Univ. of Texas-Pan American
Organizer: Hu, Xing-Biao Inst. of Computational Mathematics, Chinese Acad. of Sci. (CAS), China
Organizer: Shang, Zaijiu AMSS, CAS
Organizer: Hong, Jialin Inst. of Computational Mathematics, Chinese Acad. of Sci. (CAS)

Abstract: During the last 50 years, there has been a wide interest in the study of nonlinear Hamiltonian systems, especially Hamiltonian PDEs. Among which an important class are integrable, in the sense that they can be solved exactly, admit enough number of conservation laws. On the other hand, there have been major advances in the numerical methods of integrable Hamiltonian systems. Symplectic, multi-symplectic and energy-preserving methods have been popular in simulating these equations. Nevertheless, an important question still deserve to be explored is how to appropriately discretize nonlinear Hamiltonian systems and to gain a superior performance for long time simulations while keeping their common features as many as possible. The purpose of this organized minisymposium is to bring together researchers from both integrable system and numerical analysis to discuss recent advances on numerical aspects of nonlinear Hamiltonian systems.

▶ MS-Tu-D-36-1 13:30–14:00

Higher Order Volume-preserving Schemes for Charged Particle Dynamics

Yajuan, Sun Acad. of Mathematics & Sys. Sci., Chinese Acad. of Sci.

Abstract: A class of higher order numerical methods for advancing the charged particles in a general electromagnetic field is developed based on processing technique. The new developed methods are volume-preserving, and preserve the conservative quantities of the Lorenz force system. By applying the numerical methods to the test equation, the linear stability analysis of the numerical method is also given.

▶ MS-Tu-D-36-2 14:00–14:30

Consistency of Differential and Difference Multisymplectic Structures via Variational Bicomplexes

Peng, Linyu Waseda Univ.

Abstract: Symplectic structure plays essential role in particular geometric integrators for both Lagrangian and Hamiltonian mechanics. As a generalisation, during last decades multisymplectic structures have been developed for understanding partial differential equations from geometric viewpoint. In this talk, we show how multisymplectic structures for PDEs and finite difference schemes arise natually from their Lagrangians (or Hamiltonians) when the variational bicomplexes are taken into consideration. A consistency theorem for variational integrators is hence achieved. Examples are provided.

▶ MS-Tu-D-36-3 14:30–15:00

Linear Stability of Symplectic Integrators

Shang, Zaijiu AMSS, CAS

Abstract: Dahlquist's theory of linear stability for numerical integration of ordinary diÆerential equations are successful in solving dynamic problems dominated by dissipations. For problems with conservative nature such as Hamilto- nian systems, most of the well-known numerical methods consistent with Dahlquist's stability theory are not applicable and the so-called structure-preserving methods such as symplectic integrators have been developed and widely used in scientiØc computing community. A challenging problem is to simulate long time behavior of dynamics of Hamiltonian systems of diÆeren- tial equations. The main step for such a simulation is to design integrators which possess as good as possible numerical stability and preserve as many as possible of the dynamic properties of the systems.
In this talk we will explain to what extent the symplectic integration methods can give a stable numerical simulation to the typical dynamics of Hamiltonian systems. The explanation is mainly based on KAM theory and linear stability analysis of symplectic methods. The linear stability analysis of symplectic integrators was inspired by Dahlquist's theory and the partial content was reported Ørst in the Numerical Analysis Seminar of Tuebingen University (2005) and then in Oberwolfach Workshop on Geometric Numeric Integration (2006).

▶ CP-Tu-D-36-4 15:00–15:20

The Optimal Level of Reliability for Non-repairable System

Yang, Guoxiao Beijing Inst. of Tech.

Abstract: The objective of this study is to evaluate, from financial and managerial standpoint, the optimal level of reliability for a non-repairable system. We first explore the revenue generation capability for a commercial non-

repairable system,based on its re-liability,then built a stochastic model to describe the cost for the non-repairable system to achieve the reliability,and the optimal level of reliability that maximizes the expected system's net present value – the financial value reliability provides by the system minus the cost to achieve this level of reliability could be founded .

MS-Tu-D-37 13:30–15:40 301B

A Statistical perspective of UQ: design, modeling and computations - Part III of III

For Part 1, see MS-Mo-D-37
For Part 2, see MS-Mo-E-37

Organizer: Wu, Jeff Georgia Inst. of Tech.
Organizer: Woods, David Univ. of Southampton
Organizer: Xiong, Shifeng Chinese Acad. of Sci.

Abstract: This minisymposium consists of three sessions. Each co-organizer will organize one session. They will address the three aspects of the title: design, modeling, and computations. The focus will be on these problems from the statistical perspective but will also bring in interface with work in applied mathematics on UQ. In design, both space-filling designs and sparse grids are considered. In modeling, both stochastic kriging and generalized polynomial chaos approximation are considered. Comparisons and contrasts between work in applied math and statistics will be emphasized. Computational challenges for high dimensions and big data are the third theme.

▶ MS-Tu-D-37-1 13:30–14:00

Accelerating Asymptotically Exact MCMC for Computationally Intensive Models via Local Approximations

Conrad, Patrick Univ. of Warwick
Marzouk, Youssef Massachusetts Inst. of Tech.

Abstract: We introduce a new framework for accelerating posterior sampling with computationally-intensive models. Previous efforts integrating approximate models into MCMC typically sacrifice either the sampler's exactness or efficiency; our work addresses these limitations by exploiting convergence characteristics of local approximations. We show that our approximate Markov chain samples asymptotically from the exact posterior distribution and describe variations that combine information from parallel chains. Results demonstrate that exploiting regularity of the likelihood can yield significant performance gains.

▶ MS-Tu-D-37-2 14:00–14:30

UQ Modeling in Photonic Bandgap Engineering Simulations

Wang, Weichung National Taiwan Univ.

Abstract: Studies of photonics crystal bandgap have forged promising technological revolution possibilities. Several structure parameters need to be suitably determined to achieve the largest bandgap. We will discuss how surrogates assisted tuning framework can be incorporated to solve this structure optimal design problem efficiently. To construct the surrogates, we consider the UQ models based on Kriging, co-Kriging, and Kriging with derivative information. Advantages and limitations of the proposed methods will be discussed with numerical simulation results.

▶ MS-Tu-D-37-3 14:30–15:00

Probability Measures on Numerical Solutions of ODEs and PDEs for Uncertainty Quantification and Inference

Conrad, Patrick Univ. of Warwick
Girolami, Mark Univ. of Warwick
Stuart, Andrew Univ. of Warwick

Abstract: Deterministic ODE and PDE solvers are widely used, but characterizing the error in numerical solutions within a coherent statistical framework is challenging. We successfully address this problem by constructing a probability measure over functions consistent with the solution that provably contracts to a Dirac measure on the unique solution at rates determined by an underlying deterministic solver. The measure straightforwardly derives from important classes of numerical solvers and is illustrated on uncertainty quantification and inverse

▶ CP-Tu-D-37-4 15:00–15:20

Data Assimilation for Shallow Water Equations: the Minimax Approach

Tirupathi, Seshu IBM Research - Ireland
Tchrakian, Tigran IBM Research - Ireland
Zhuk, Sergiy IBM
McKenna, Sean IBM Research

Abstract: The state of a system described by shallow-water equations was estimated using Discontinuous-Galerkin (DG) methods and a mimimax estimator. DG was used to reduce the shallow-water model to a system of ODEs to which the minimax estimator was then applied. We observed that this method is shock-capturing and stable even for sparse observations. We present the numerical algorithm and its sensitivity analysis, and compare it to existing methods (Ensemble Kalman Filter). Applications include urban flood forecasting.

▶ CP-Tu-D-37-5 15:20–15:40

An Experimental Test of Several Generalized Utility Functions in Post-Decision Identification

Soboleva, Olena Kharkiv National Univ. of Radio Electronics

Abstract: In this paper, we present usability analyses of different generalized utility's models. It's proposed to use following generalized utilities: informational entropy-type function, modified (by additional terms with inverse powers) polynomial and mixed additive-multiplicative functions. There are given the statistical results of post-decision identification's accuracy and difficulty for different generalized utilities.

MS-Tu-D-38 13:30–15:30 302A

Mining and Analytics for Big Data

Organizer: Wang, Fei Univ. of Connecticut

Abstract: We are in the era of big data. Data is everywhere, in every application, from healthcare to climate. The goal of this workshop is to bring together the researchers in the field of data mining and analytics, share their experience and opinions on the current status, challenges and future directions of big data mining and analytics. We will invite four keynote speakers and the topic of their talks cover different aspects of big data mining and analytics, from theory to practice.

▶ MS-Tu-D-38-1 13:30–14:00

Entity Linking with A Knowledge Base for Heterogeneous Data

Wang, Jianyong Tsinghua Univ.

Abstract: Entity knowledge bases are very useful in building semantic search and deep Q/A systems. As an important tool to enrich the knowledge bases, entity linking can link entity mentions with their corresponding mapping entities in a knowledge base. However, this task is challenging due to the entity ambiguity problem. In this talk, we will introduce some of our efforts on entity linking for heterogeneous data, and discuss its various applications too.

▶ MS-Tu-D-38-2 14:00–14:30

Data Analytics in Healthcare

Wang, Fei Univ. of Connecticut

Abstract: Healthcare is a field that closely related to everyone's daily life. Data driven healthcare is believed to be one of the most promising trend to transform healthcare and improve the quality of care delivery. The main goal of this talk is to briefly review the status of data analytics methods in healthcare, point out the challenges and future research directions.

▶ MS-Tu-D-38-3 14:30–15:00

Non-convex Optimization Problem in Machine Learning and Data Mining

Zhang, Changshui Tsinghua Univ.

Abstract: In machine and data mining, optimization is a very important problem. In this talk, we introduce optimization problems in machine learning, and describe three non-convex optimization algorithms: an algorithm for decomposable non-convex regularization, an algorithm for feature selection in multi-task learning, and an adaptive algorithm for non-convex regularization.

▶ MS-Tu-D-38-4 15:00–15:30

Incremental Learning in Big Data Era

Zhou, Zhi-Hua Nanjing Univ.

Abstract: In this presentation I am planning to talk about incremental learning, but not finalized yet.

MS-Tu-D-39 13:30–15:30 302B

Recent advances on inverse scattering problems - Part III of III

For Part 1, see MS-Mo-D-39
For Part 2, see MS-Mo-E-39

Organizer: Liu, Xiaodong Inst. of Applied Mathematics, Chinese Acad. of Sci.
Organizer: Liu, Hongyu Hong Kong Baptist Unversity
Organizer: Zhang, Bo Acad. of Mathematics & Sys. Sci., CAS

Abstract: The minisymposium intends to bring together leading experts working on inverse scattering problems and their applications to discuss recent advances and new challenges in this fascinating field.

▶ MS-Tu-D-39-1 13:30–14:00

Locating Buried Objects in A Two-layered Medium

Liu, Xiaodong Inst. of Applied Mathematics, Chinese Acad. of Sci.

Abstract: We develop an inverse scattering scheme to locate the multiple multiscale impenetrable anomalies buried in a two-layered medium. It makes use

of a single far-field measurement in the half-space above the anomalies, and works independently of the physical properties of of the anomalies. The proposed schemes is of a totally direct nature without any without any inversion involved.

▶ MS-Tu-D-39-2 14:00–14:30

On Reconstruction of Refractive Index in Inverse Scattering for Periodic Media

Yang, Jiaqing — Xi'an Jiaotong Univ.
Qu, Fenglong — Yantai Univ.

Abstract: This talk is concerned about the inverse problem of recovering the refractive index in inverse scattering by unbounded periodic media. We prove a global uniqueness result that, if the refractive index is piecewise constant, the total structure is uniquely determined from scattered field data measured only from one side of unbounded periodic media, corresponding to a countably infinite number of downward propagating incident waves

▶ MS-Tu-D-39-3 14:30–15:00

Inverse Scattering Problem from Phaseless Far-field Data

Zhang, Haiwen — Inst. of Applied Mathematics, Acad. of Mathematics & Sys. Sci., Chinese Acad. of Sci.
Zhang, Bo — Acad. of Mathematics & Sys. Sci., CAS

Abstract: We consider the inverse scattering problem from phaseless far-field data. It is observed that the translation invariance property of phaseless far-field pattern can be broken down with using a superposition of several incident plane waves as incident field. Based on this, two kinds of inversion algorithms are developed to reconstruct both the location and the shape of the obstacle simultaneously. Numerical examples are carried out to illustrate the effectiveness of our algorithms.

▶ MS-Tu-D-39-4 15:00–15:30

An Adaptive Finite Element Method for Reconstruction of the Robin Coefficient

Xu, Yifeng — Shanghai Normal Univ.

Abstract: An adaptive finite element method to recover the Robin coefficient in a diffusion system from some boundary measurement is proposed. The relevant a posteriori error estimator is derived from convergence analysis of the adaptive algorithm, which guarantees a convergent subsequence of discrete solutions in an energy norm to some exact triplet (the Robin coefficient, state and costate variables). This is a joint work with Jun Zou at The Chinese University of Hong Kong.

IM-Tu-D-40 13:30–15:30 303A

Particle systems and particulate flows in environmental, social and industrial applications

Organizer: Icardi, Matteo — KAUST
Organizer: Elsaadawy, Ehab — Saudi Aramco Oil Company
Organizer: Tartakovsky, Daniel — Univ. of California, San Diego
Organizer: TEMPONE, RAUL — KING ABDULLAH Univ. OF Sci. & Tech.

Abstract: Accurate simulations of particle systems are of crucial importance in many scientific and industrial applications such as poly-dispersed multiphase flows, social systems, colloidal particles in subsurface and microfluidics, and mixing-limited reactions. These phenomena can be described at multiple scales, many of which introduce stochastic fluctuations. For example, modeling processes, such as upscaling or coarse-graining, can account for unknown micro-scale (or fast time-scale) features by adding a random source term. These stochastic components are negligible only in the macroscopic (equilibrium) limit that is not often attainable, so a direct simulation of stochastic particle trajectories is needed. In some cases a probabilistic (or kinetic) interpretation can be used to retain some mesoscopic (mean-field) features of the system. In other problems, the stochastic particle representation is introduced purely as a computational tool to circumvent particularly complex or computationally costly partial differential equations. The random nature (or probabilistic interpretation) of these systems poses a number of computational difficulties and offers an opportunity of developing novel efficient algorithms targeting a wide class of applications. Another difficulty is often related to the coupling of the particle motion with an underlying flow, electric of force field that, in some cases, can be represented by discrete particles or by a continuum (mean-field) formulation. This mini-symposium aims to create an opportunity for researchers in different fields to share their modeling and computational approaches for: Particulate flows in chemical reactors: separators, filters, fluidized beds Colloid transport and reaction in heterogeneous porous materials and subsurface flows Particle-laden turbulent flows Transport in microfluidic devices and biological flows Monte Carlo, Gillespie and Molecular Dynamics methods for reactive particle systems Efficient simulation of Stochastic Differential Equations (Langevin, drift-diffusion processes) Kinetic and PDF methods for turbulent flows and population balance models Particle methods for complex flows and PDEs (Discrete Element Method, Smoothed Particle Hydrodynamics, etc.) Applications to social dynamics

▶ IM-Tu-D-40-1 13:30–14:00

Modeling and Simulation of Transport and Retention of Alumina Nanoparticles in Oil Reservoirs.

Mejia, Juan M. — Universidad Nacional de Colombia
Zabala, Richard — ECOPETROL
Chaparro Giglio Cobuzio, Mauricio Gabriel — Universidad Nacional de Colombia

Abstract: Alumina nanoparticles were successfully used in a recent pilot test well-stimulation in Cupuagua-sur field by promoting asphaltenes damage inhibition and wettability alteration. A significant oil-recovery factor was found after the stimulation. The understanding of physical-and-chemical processes taking place during injection/production periods is mandatory for lab test scale-up and for a field-scale application as well. We developed and adjusted a mathematical model for the nanoparticles transport and retention in the porous formation, based on mass-conservation equations.

▶ IM-Tu-D-40-2 14:00–14:30

A Fully Resolved Simulation Approach for the Transport of Non-Spherical Particles in Filtration Systems

Hahn, Friedemann — Univ. of Stuttgart

Abstract: Instead of relying on conventional Lagrangian particle tracking we present a simulation approach based on a fictitious domain method, allowing the coupled computation of fluid and particle motion as well as the realization of non-spherical particle geometries. We elaborate the mathematical foundation of the method and demonstrate its validity at the example of settling particles in confined geometries. Moreover, we will show its application for the analysis of filtration process dynamics under complex physical influences.

▶ IM-Tu-D-40-3 14:30–15:00

Monte Carlo Methods for Particle System

Haji Ali, Abdul Lateef — KAUST
TEMPONE, RAUL — KING ABDULLAH Univ. OF Sci. & Tech.

Abstract: We discuss using Monte Carlo methods to compute quantities of interests of a stochastic particle system, where each particle follows a stochastic differential equation. The particle system is assumed to converge to some mean-field limit as the number of particles tend to infinity. In that setting, we discuss how to apply Multilevel Monte Carlo and Multi-index Monte Carlo and the computational advantages of using these methods.

▶ IM-Tu-D-40-4 15:00–15:30

Cumulative Density Function Method for Stochastic Kinematic Wave Equation with Uncertain Parameters and Initial/boundary Conditions

Wang, Peng — Beihang Univ.
Tartakovsky, Daniel — Univ. of California, San Diego

Abstract: Kinematic wave equation with uncertain parameters and initial/boundary conditions is ubiquitous in a variety of fields from traffic flow to environmental runoff. Based on the cumulative density function method (CDF), we develop a probabilistic approach to quantify the uncertainty of flow in the first-order hyperbolic conservation laws (kinematic wave equations). The accuracy and robustness of the CDF framework for one such system describing the two-dimensional runoff is compared with results from Monte Carlo simulations.

MS-Tu-D-41 13:30–15:30 303B

Mathematical solutions of industrial applications

Organizer: Ide, Takanori — AISIN AW CO.,LTD
Organizer: Sakurai, Tetsuya — Univ. of Tsukuba
Organizer: Siltanen, Samuli — Univ. of Helsinki

Abstract: Mathematics plays an important role in modern industry, for instance as a tool for research & development and as algorithmic parts of products. This session presents success stories of industrial mathematics as a solution to various ¿business challenges. Several domains of industry are considered: automotive, information and communications technology, manufacturing, medical imaging and nanotechnology.
The following specific topics are included: 1. Data-driven development in industry, 2. Industrial applications of numerical linear algebra, 3. Inverse problems in medical X-ray imaging, 4. Structural optimization for automobile parts. Each talk will discuss the motivation, approaches and implementations based on mathematics.

▶ MS-Tu-D-41-1 13:30–14:00

Four-dimensional Tomography Based on A Level Set Method

Elefante, Paola Univ. of Helsinki

Abstract: A novel time-dependent tomographic imaging modality is discussed. The aim is to reconstruct a moving object, such as running engine, a mouse, or a beating human heart, from time-dependent radiographic sparse data ("X-ray videos"). The dynamic three-dimensional structure is reconstructed from projection data using a new computational method. Time is considered as an additional dimension in the problem, and a generalized level set method [Kolehmainen, Lassas, Siltanen, SIAM J Scientific Computation 30 (2008)] is applied

▶MS-Tu-D-41-2 14:00–14:30

Structural Optimization Methods to Design Light Weight Automatic Transmission of Vehicles

Toda, Kentaro Scientific Analysis Engineering Department, AISIN AW CO.,LTD
Ide, Takanori AISIN AW CO.,LTD

Abstract: We propose design process to achieve light weight structure for automatic transmissions of vehicles. Structural optimization method is commonly used to improve automobile performance such as NVH(Noise, Vibration and Harshness), durability and fuel consumption. Light weight structure is the essential factor to improve fuel consumption and protect environment. As the industrial application of structural optimization, we consider light weight gear box of FF (Front engine Front drive) type automatic transmission.

▶MS-Tu-D-41-3 14:30–15:00

Highly Parallel Eigenvalue Computation in Vibration Analysis Using A Complex Moment Based Eigensolver.

Futamura, Yasunori Univ. of Tsukuba
Sakurai, Tetsuya Univ. of Tsukuba
Ide, Takanori AISIN AW CO.,LTD
Toda, Kentaro Scientific Analysis Engineering Department, AISIN AW CO.,LTD

Abstract: In this talk, we show an algorithm and implementation of an eigenvalue solver which efficiently solve large-scale generalized eigenvalue problems derived from vibration analysis. The presented solver is a projection method based on complex moment and contour integral and it provides high parallelism since the algorithm consists of solving independent linear systems. We show the performance of our approach on state-of-the-art supercomputers with models of automatic transmissions.

▶MS-Tu-D-41-4 15:00–15:30

Sequential Human Choice Modeling

Takayuki, Osogami IBM Research - Tokyo

Abstract: We seek to model what a person is going to choose by observing the choices from varying choice sets. We optimize the choice sets via partially observable Markov decision process when a person makes choices multiple times. We also deal with the typical phenomena of human choice, including the attraction effect and the compromise effect, that make human choice modeling particularly difficult. This research was supported by CREST, JST.

MS-Tu-D-42 13:30–15:30 301A

Nonlinear waves in systems with dissipation and gain - Part I of II

For Part 2, see MS-Tu-E-42

Organizer: Yan, Zhenya Chinese Acad. of Sci.
Organizer: Konotop, Vladimir Univ. of Lisbon

Abstract: In a few recent years there was growing interest in propagation of nonlinear waves in media with gain and losses. These are systems with the parity-time (PT) symmetry, with localized gain or dissipation, with imbalances gain and dissipation but still allowing for linear real spectra, etc. Physically the respective models are relevant to optics, plasmonics, Bose-Einstein condensates, atomic gasses, mechanical systems, electric circuits, etc. This Minisymposia aims to joint researches working in the related areas ranging from experimental and theoretical physics to mathematics.

▶MS-Tu-D-42-1 13:30–14:00

Stationary States of Unidirectional Optical Wave Guides

Cartarius, Holger Univ. of Stuttgart

Abstract: Nonlinear PT-symmetric optical wave guides have shown to exhibit the effect of unidirectionality, which is usually studied in terms of propagating waves. We investigate this effect in the context of stationary states. In a mathematically equivalent system, viz. a Bose-Einstein condensate in a PT-symmetric double-well potential, it is well known that these stationary states possess complicated stability properties influenced by the nonlinearity. The relations of these two effects are analyzed.

▶MS-Tu-D-42-2 14:00–14:30

PT Symmetric Nonlinear Metamaterials

Wunner, Guenter Inst. of Theoretical Physics, Univ. of Stuttgart

Abstract: Although originally discussed in the context of non-Hermitian quantum mechanics, PT symmetry has been demonstrated experimentally in optics and other areas. Recently, PT symmetry has also entered the experimental f ield of metamaterials (see, e.g., Lawrence et al, Phys. Rev. Lett 113, 093901 (2014)). Investigations so far have been restricted to linear wave propagation in metasurfaces. In this paper we will study the effects of nonlinearity on PT symmetry in metamaterials.

▶MS-Tu-D-42-3 14:30–15:00

PT-Symmetric Nonlinear Metamaterials with Nonlocal Interactions, N. Lazarides & G.P. Tsironis

Lazarides, Nikos Univ. of Crete

Abstract: PT-symmetric nonlinear metamaterials relying on gain and loss and comprising split-ring resonators (SRRs) have been recently introduced. In the presence of nonlinearity, they support gain-driven, breather-like excitations. In most SRR-based metamaterial models, the dipole-dipole interaction between SRRs is limited to nearest neighbors. However, the nonlocal interelement interaction affects significantly both the linear and nonlinear properties PT metamaterials. In the presence of nonlinearity, it may generate novel solutions not appearing in locally coupled metamaterials.

▶MS-Tu-D-42-4 15:00–15:30

Integrable Nonlocal Nonlinear Schrödinger Equation

Musslimani, Ziad Florida State Univ.

Abstract: A new integrable nonlocal nonlinear Schrödinger equation is introduced. It possesses a Lax pair and an infinite number of conservation laws and is PT symmetric. The inverse scattering transform and scattering data with suitable symmetries are discussed. A method to find pure soliton solutions is given. An explicit breathing one soliton solution is found. Key properties are discussed and contrasted with the classical nonlinear Schrödinger equation.

MS-Tu-D-43 13:30–15:30 VIP4-1

Algorithmic game theory

Organizer: Chen, Xujin Acad. of Mathematics & Sys. Sci., Chinese Acad. of Sci.

Abstract: Algorithmic Game Theory (AGT) is a multidisciplinary field at the interface of operations research, computer science, game theory and economics. It studies game theory and economics from a computational perspective. The primary objective of AGT is to design algorithms in strategic environments. AGT has not only profound theories but also diverse applications. The topics of this mini-symposium on AGT include: algorithmic mechanism design, computational social choices, equilibrium computation and analysis in games and markets.

▶MS-Tu-D-43-1 13:30–14:00

Moneyless Strategy-proof Mechanism on Single-sinked Policy Domain: Characterization and Applications (joint with Qiaoming Han)

Du, Donglei Univ. of New Brunswick

Abstract: We completely characterize deterministic and anonymous strategy-proof and group strategy-proof mechanisms on single-dipped public policy domain, complementing the well-known results on single-peaked policy domain first investigated by Moulin (1980). Moreover, as applications of our characterization, we extend existing models and results and resolve several open questions related to the obnoxious facility location game from the algorithmic mechanism design literature.

▶MS-Tu-D-43-2 14:00–14:30

Pricing in Social Networks with Negative Externalities

Cao, Zhigang Acad. of Mathematics & Sys. Sci., Chinese Acad. of Sci.
Chen, Xujin Acad. of Mathematics & Sys. Sci., Chinese Acad. of Sci.
Hu, Xiaodong Acad. of Math & Sys. Sci., CAS
Wang, Changjun Acad. of Mathematics & Sys. Sci., Chinese Acad. of Sci.

Abstract: We study the problems of pricing an indivisible product to consumers who are embedded in a given social network. The goal is to maximize the revenue of the seller. A consumer buys the product as soon as the seller posts a price not greater than the consumer's valuation of the product. The valuation is determined a fixed consumer-specified intrinsic value and a variable negative externality that is exerted from the consumer's neighbors in a linear way.

▶ MS-Tu-D-43-3 14:30–15:00

Stacklebergly Repeated Prisoner's Dilemma Games

Qu, Xinglong — Acad. of Mathematics & Sys. Sci. within Chinese Acad. of Sci.
Cao, Zhigang — Acad. of Mathematics & Sys. Sci., Chinese Acad. of Sci.
Mu, Yifen — Acad. of Mathematics & Sys. Sci., Chinese Acad. of Sci.
Yang, Xiaoguang — Chinese Acad. of Sci.

Abstract: We study the Stackleberg variant of the repeated prisoner's dilemma game. In our work, the two players are asymmetric.One player(the leader) chooses a strategy for the repeated games firstly and her strategy and then the other player (the follower) chooses his strategy after seeing the leader's strategy. Assuming complete rationality, we find (i) the sub-game perfect equilibrium payoff profile is unique; (ii) the leader has optimal strategies that are one-step memory.

▶ MS-Tu-D-43-4 15:00–15:30

Approximate Composable Truthful Mechanism Design

Zhang, Guochuan — Zhejiang Univ.

Abstract: We provide a technique for designing truthful mechanisms for a kind of combinatorial optimization problems, which require composition algorithms. We show that the composition algorithm A*B is monotone if the algorithm A and the algorithm B are both monotone. Then, we apply this technique to the two-dimensional orthogonal knapsack problem and the multiple clusters scheduling problem with provable approximation bounds.

MS-Tu-D-44 13:30–15:40 VIP2-1

Integrated Production and Distribution Scheduling

Organizer: Chen, Zhi-Long — Univ. of Maryland

Abstract: In the supply chains for many make-to-order or time-sensitive products, finished orders are often delivered to customers immediately or shortly after production. Consequently, there is little or no finished product inventory and production scheduling and finished product delivery scheduling must be integrated in order to achieve a desired level of delivery performance at minimum total cost. Because in such applications the planning horizon is typically short and speedy delivery of finished orders is often critical, strategic or tactical planning models are not applicable to such applications. Instead, they require detailed scheduling models that integrate production and outbound distribution of finished orders at the individual order level. Examples of such applications that have been reported in the literature include: (1) assembly and delivery of custom-made electronics under the assemble-to-order business model, (2) production and distribution of fashion apparel and some toys, (3) production and delivery of perishable products such as ready-mix concrete paste and industrial adhesive materials, (4) printing and distribution of newspapers, (5) mail processing and distribution.
Such problems involve both machine scheduling (for order processing) and vehicle scheduling and routing (for order delivery). Although pure machine scheduling problems and pure vehicle routing problems have been studied extensively in the past several decades, most of the work on integrated production and scheduling problems was published or done in the last ten years or so. This is in sharp contrast to the fact that various integrated production-distribution models at the strategic and tactical planning levels have been extensively studied in the literature in the last several decades. We believe that the area of integrated production and distribution scheduling remains as a relatively new research area that clearly needs much more research.
In this symposium, the five speakers will present their latest research in this area. The first speaker Weiya Zhong will present two flowshop scheduling problems involving interstage transportation of jobs and discuss heuristics and their performance for the problems. The second speaker Hua Gong will present several integrated production and distribution scheduling problems that arise in steel production and discuss their complexity and algorithms for solving these problems. The third speaker Lingfa Lu will focus on a single machine scheduling problem with families of jobs and job delivery and discuss an approximation algorithm and its performance. The fourth speaker Guoqing Wang will present a multi-item lot-sizing problem and an approximation algorithm for solving the problem. The last speaker Baoqiang Fan will present two family scheduling problems with batch delivery that arise in the building materials industry and discuss computational complexity of these problems.

▶ MS-Tu-D-44-1 13:30–14:00

The Coordinated Scheduling Problems of Production and Transportation in Iron and Steel Industry

Gong, Hua — Northeastern Univ.
Tang, Lixin — Inst. of Industrial Engineering & Logistics Optimization, Northeastern Univ.
Chen, Zhi-Long — Univ. of Maryland
Yiyang, Liu — Inst. of Industrial Engineering & Logistics Optimization, Northeastern Univ.

Abstract: We present the coordinated scheduling problems of production and transportation in the iron and steel industry in order to achieve equipment utilization and reduce energy consumption. Depending on specific characteristics of production operations, this paper includes three parts: the problems in steelmaking-continuous casting stage, the problems in continuous casting-hot rolling stage, and the problems in hot rolling-cold rolling stage. For each of problems studied, we analyze their computational complexity, and provide the corresponding algorithms.

▶ MS-Tu-D-44-2 14:00–14:30

Flowshop Scheduling with Interstage Job Transportation

Zhong, Weiya — shanghai Univ.
Chen, Zhi-Long — Univ. of Maryland

Abstract: There are a variety of joint job production and transportation scheduling problems that arise in modern manufacturing systems. In this paper, we study two such problems that arise in a flowshop environment where there are two processing stages and a single transporter that is available to deliver the finished jobs from the first stage to the second. In the first problem, there is a single machine in each of the two flowshop stages and jobs have different sizes when loaded onto the transporter. In the second problem, there are two parallel machines in the first stage and a single machine in the second stage, and the transporter can carry only one job in each shipment. The objective of both problems is to minimize the makespan, i.e. the completion time of the last job in the second stage. The two problems are both strongly NP-hard. For each problem, we propose a fast heuristic and show that the heuristic has a tight worst-case bound of 2.

▶ MS-Tu-D-44-3 14:30–15:00

An Improved Approximation Algorithm for Scheduling with Family Jobs and Delivery Coordination

Lu, Lingfa — Zhengzhou Univ.
Zhang, Liqi — Henan Agricultural Univ.
Liu, Qijia — Zhengzhou Univ.

Abstract: In this paper, we consider the single machine scheduling problem with family jobs and delivery coordination. The objective is to minimize the maximum delivery completion time of the jobs. For this problem, Li and Yuan [S.S. Li, J.J. Yuan, Scheduling with families of jobs and delivery coordination under job availability. Theoretical Computer Science 410, 4856-4863, 2009] showed that this problem is NP-hard and then presented a $\frac{3}{2}$-approximation algorithm for this problem. However, it is open whether this bound $\frac{3}{2}$ is tight or not. We first present an instance to show that the bound $\frac{3}{2}$ of Li and Yuan's algorithm is tight even when all families have the zero setup time or all families have the unit delivery time. Furthermore, we also present an improved $\frac{4}{3}$-approximation algorithm for this problem.

▶ CP-Tu-D-44-4 15:00–15:20

Spatio-temporal Patterns of An Insect-pest in Intercropping Systems

Ferreira, Claudia — Unesp

Abstract: A cellular automata model and clustering analysis were used in order to investigate habitat manipulation as a strategy to regulate natural population densities of an insect-pest that explores different host during its development. Habitat manipulation with different agricultural plants used as hosts by this herbivore was used to compose intercropping landscapes. Available biological parameters for the insect-pest obtained under laboratory conditions were used to group the homogeneous landscapes, composed by each host plant, by a similarity measure of host suitability either for larval survival and development, and adult survival and fecundity. The results permit to choose the landscape intercropping that reduces insect spread. A cellular automata model was proposed to simulate the physiological and behavioural traits of this insect, and also different spatial configurations of the intercropping. Spatio and temporal patterns of insect population permits us to discuss the landscape configuration efficacy to reduce insect spread

▶ CP-Tu-D-44-5 15:20–15:40

Extending the Mixed Algebraic-Analysis Fourier-Motzkin Method for Classifying Linear Semi-infinite Programs

Kortanek, Kenneth — The Ubiversity of Pittsburgh
Zhang, Qinghong — Northern Michigan Univ.

Abstract: By applying an amended Fourier-Motzkin elimination method to a linear semi-infinite inequality system, we obtain a reduced primal-dual pair

of a linear semi-infinite programming problem. Working with this reduced pair, we reproduce all the theorems that lead to the full eleven possible duality state classification theory. Establishing classification results with the Fourier-Motzkin method means that the two classification theorems for linear semi-infinite programming, 1969 and 1974, have been proved by this new and exciting method.

MS-Tu-D-45 13:30–15:30 213A

Triangular decomposition of polynomial systems: solvers and applications - Part III of IV

For Part 1, see MS-Mo-D-45
For Part 2, see MS-Mo-E-45
For Part 4, see MS-Tu-E-45

Organizer: Moreno Maza, Marc — The Univ. of Western Ontario
Organizer: Chen, Changbo — Chinese Acad. of Sci.

Abstract: The Characteristic Set Method of Wen Tsun Wu has freed Ritt’s decomposition from polynomial factorization, opening the door to a variety of discoveries in polynomial system solving. In the past three decades the work of Wu has been extended to more powerful decomposition algorithms and applied to different types of polynomial systems or decompositions: differential systems, difference systems, real parametric systems, primary decomposition, cylindrical algebraic decomposition. Today, triangular decomposition algorithms provide back-engines for computer algebra system front-end solvers, such as Maple’s solve command and have been applied in various areas both in the academia and in the industry.

In this proposed workshop, we hope to gather researchers who have applied and extended the works Joseph Fels Ritt and Wen Tsun Wu. Our goals are, first, to disseminate the techniques and software tools which have been developed by this vibrant community and, second, to stimulate further developments and applications of polynomial system decomposition by means of characteristic sets.

At the International Congress on Mathematical Software (ICMS 2014), a satellite conference of the International Congress on Mathematics, in Seoul (South Korea), a session on the same topics as the proposed one had gathered 9 talks, see `http://www.csd.uwo.ca/~moreno/ICMS_Triangular_Decomposition_Session.html`

About another 30 researchers had expressed interest in participating to this session but were not able to do so at that time the year or in that location. Moreover, three other sessions of ICMS 2014 had talks on this subject of polynomial system decomposition by means of characteristic sets.

In a sum, the proposed workshop for ICIAM 2015 is expected to be well attended and to generate rich interactions. At the same time, the available software such as the RegularChains library (see http://www.regularchains.org) will support software demonstration of the applications of the Characteristic Set Method.

▶ MS-Tu-D-45-1 13:30–14:00

A Numeric Method for Solving Parametric Polynomial Systems with Constraints

Wu, Wenyuan — CIGIT
Chen, Changbo — Chinese Acad. of Sci.

Abstract: In this paper we introduce a numerical approach based on homotopy continuation methods to solve square polynomial systems with two parameters. For various applications these parameters are restricted in some finite region and we are interested in exploring the properties of real solutions when parameters are chosen in the region. This paper aims to decompose the region into finitely many cells such that some property is unchanged for any values of parameters in each cell.

▶ MS-Tu-D-45-2 14:00–14:30

A New Triangular Decomposition Algorithm for Differential Polynomial Systems

Gao, Xiao-Shan — Acad. of Mathematics & Sys. Sci., Chinese Acad. of Sci.
Zhu, Wei — AMSS, Chinese Acad. of Sci.

Abstract: In this talk, a new triangular decomposition algorithm will be presented for ordinary differential polynomial systems, which has triple exponential computational complexity. The key idea is to eliminate one algebraic variable from a set of polynomials in one step using the theory of multivariate resultant. This seems to be the first differential triangular decomposition algorithm with elementary computation complexity.

▶ MS-Tu-D-45-3 14:30–15:00

Better Handling of Equational Constraints in Cylindrical Algebraic Decomposition

Davenport, James — Univ. of Bath
England, Matthew — Univ. of Bath
Bradford, Russell — Univ. of Bath

Abstract: Traditionally, a Cylindrical Algebraic Decomposition (CAD) was sign-, or order-, invariant for the polynomials, meaning it could answer ALL questions about those polynomials, for the given variable order. More recently, McCallum showed we can do better if there is a global equational constraint, and produce a CAD invariant for all the polynomials only where the equational constraint is satisfied. In this talk, we describe work to do similar with only local equational constraints.

▶ MS-Tu-D-45-4 15:00–15:30

Modelling and Verification for Stochastic Hybrid Systems

Zhan, Naijun — Inst. of Software, Chinese Acad. of Sci.
Peng, Yu — Inst. of Software, Chinese Acad. of Sci.
Wang, Shuling — Inst. of Software, Chinese Acad. of Sci.

Abstract: Stochastic hybrid systems exist in many real embedded systems that operate in the presence of uncertainty and randomness. They are so complex with interacting discrete computation, continuous and stochastic dynamics, thus it is very hard to analyze and verify their behavior. In this paper, we propose a deductive approach for modelling and verification of stochastic hybrid systems. First, we define a variant of Hybrid CSP (HCSP), called stochastic HCSP, as the formal modelling language of stochastic hybrid systems, in which the deterministic differential equations for the continuous flows of HCSP are replaced by the stochastic differential equations and the nondeterministic choice by probabilistic choice. We then define a compositional logic for reasoning about stochastic HCSP processes and prove its soundness. In the logic, we present the proof rules for each process construct to specify the probability with which the properties hold before and after the corresponding process is executed.

MS-Tu-D-46 13:30–15:30 306B

Theoretical and Computational Aspects of Geometric Shape Analysis - Part I of II

For Part 2, see MS-Tu-E-46

Organizer: Narayan, Akil — Univ. of Massachusetts Dartmouth
Organizer: Micheli, Mario — Univ. of San Francisco
Organizer: Kushnarev, Sergey — Singapore Univ. of Tech. & Design

Abstract: The analysis, classification, and processing of geometric shapes is a timely and increasingly important problem in engineering, computer science, and mathematics. Modern strategies for shape analysis span several disciplines: statistical cliquing, differential geometry, data processing, and numerical optimization. The aim of this minisymposium is to present state-of-the-art methods for geometric shape analysis, and to discuss open problems, applications, and future directions for research of interest to the imaging science community. This minisymposium brings together researchers from diverse backgrounds to foster collaboration between the fields of computer vision, image processing, and mathematical shape analysis.

▶ MS-Tu-D-46-1 13:30–14:00

A Class of Riemannian Metrics for Shape Deformation Analysis.

Micheli, Mario — Univ. of San Francisco

Abstract: In this talk we explore a class of matrix-valued kernels that induce Riemannian translation- and rotation-invariant metrics on the group of diffeomorphisms. Once such metrics are established, they can be used to compute distances in shape spaces (i.e. between curves in two or three dimensions, surfaces, images, tensor fields, or sets of feature points). We discuss metrics whose geodesics are generated by curl-free or divergence-free vector fields, and discuss applications.

▶ MS-Tu-D-46-2 14:00–14:30

Multiscale Covariance Fields, Local Scales, and Shape Transforms

Memoli, Facundo — The Ohio State Univ.

Abstract: We introduce the notion of multiscale covariance tensor fields associated with a probability measure on Euclidean space and use these fields to define local scales at a point and to construct shape transforms. Local scales at x may be interpreted as scales at which key geometric features of the data organization around x are revealed. Shape transforms are employed to identify points that are most salient in terms of the local-global shape of a probability

▶ MS-Tu-D-46-3 14:30–15:00

Deformable Shape Tracking by Using A New Region-Based Sobolev Metric

Sundaramoorthi, Ganesh — KAUST

Abstract: In this talk, we discuss the problem of segmentation and tracking of objects in videos. This problem is central to computer vision and remains a challenge because of nuisances in image formation that generate infinite vari-

ations and shape and appearance of the object. We present a new approach that seeks to model nuisances arising from occlusions and viewpoint change or object deformations. We will show a new optimization technique based on a new shape metric.

▶ MS-Tu-D-46-4 15:00–15:30

Intrinsic Statistical Framework for Biological Shape Analysis

Joshi, Shantanu UCLA

Abstract: We present a statistical framework for characterizing and comparing morphological variation in biological shapes. The statistical framework makes use of the tangent principal component approach to achieve dimension reduction on the space of infinite-dimensional, non-linear, quotient space of shapes and enables computation of shape averages and covariances on the shape space in an intrinsic manner (adapted to the shape space). We will present applications to biomedical imaging, computer vision, paleontology, and brain morphometry.

MS-Tu-D-47 13:30–15:30 108

Flow patterns in high-Reynolds numbers - Part I of II

For Part 2, see MS-Tu-E-47

Organizer: Okamoto, Hisashi Kyoto Univ.

Abstract: Recent increase of computer power enables us to have good understanding and prediction of fluid flows if the Reynolds number is not very large. However, flows display singular phenomena if the Reynolds number is very large. Here we need, in addition to computer power, a good combination of mathematical analysis and accurate numerical methods. In this mini-symposium we present singular or strange characters of fluid flows at high Reynolds numbers. For instance, we report on our recent discovery of large scale structures which appear only in 2D high Reynolds number flows and called unimodal patterns. Streamlines of the unimodal solutions are topologically simple, but under its apparent simplicity there lie internal layers, which results from the singular perturbation nature of the Navier-Stokes equations. We propose an asymptotic analysis which agrees with the numerical data. Also some of us review applications to geophysics. In particular solutions of the 2D Navier-Stokes equations or Euler equations are computed on a sphere or a spheroid. They are compared with atmospheric data. We show that what is called a zonal flow, which is observed in fluid motion in planetary scale, can be reproduced in our computations.

▶ MS-Tu-D-47-1 13:30–14:00

Unimodal Patterns Appearing in the 2D Navier-Stokes Equations at Large Reynolds Numbers

Okamoto, Hisashi Kyoto Univ.

Abstract: We consider Kolmogorov's problem for the 2D Navier-Stokes equations. We study numerically stability and bifurcation of stationary and time-periodic solutions. Specifically we look for a unimodal solution, which is characterized by having a large, topologically simple patterns of stream-lines. A new version of conjecture about unimodal solutions is presented. We will present evidence that such patterns emerge at large Reynolds.

▶ MS-Tu-D-47-2 14:00–14:30

Unimodal Patterns Appearing in the 2D Navier-Stokes Equations at Large Reynolds Numbers II

Kim, Sun-Chul Chung-Ang Univ.
Okamoto, Hisashi Kyoto Univ.

Abstract: This second part deals with some asymptotic and numerical results on a self-similar Navier-Stokes flows (Proudman-Johnson flows) confirming the unimodality for this simpler case. Also, for the general 2D Navier-Stokes flows, we present some numerical computation of the confinuation of a time periodic solution emerging from the Hopf bifurcation.

▶ MS-Tu-D-47-3 14:30–15:00

On the Numerical Detection for Blow-up

Cho, ChienHong Chung Cheng Univ.

Abstract: The problem concerning global existence and finite-time blow-up for solutions of differential equations is an important issue in many mathematical models and physical problems. Although there are many mathematical methods used for establishing blow-up, we would like to explore the phenomenon in this talk from a numerical point of view. Our recent results will be reported.

▶ MS-Tu-D-47-4 15:00–15:30

Stability of One-directional Flow on A Rotating Sphere

Yamada, Michio Kyoto Univ.

Abstract: Linear and nonlinear stability of a zonal flows on a rotating sphere is discussed numerically and analytically. The problem is similar to the traditional stability problem of plane parallel flows, but the rotation which has no effect in the case of non-divergent two-dimensional flows plays an important role in the spherical case. It is shown that fast rotation strongly stabilizes the zonal flow under a zonal forcing even at high Reynolds numbers.

MS-Tu-D-48 13:30–15:30 212B

Regularization of Inverse Problems in Imaging Sciences: Theoretical and Numerical Aspects - Part I of II

For Part 2, see MS-Tu-E-48

Organizer: Fadili, Jalal CNRS & ENSICaen
Organizer: Peyre, Gabriel CNRS & Universite Paris-Dauphine
Organizer: Zhang, Xiaoqun Shanghai Jiao Tong Univ.

Abstract: Inverse problems have become a central theme in various fields of sciences and engineering such as imaging sciences. This field draws from various mathematical disciplines including linear algebra, differential geometry, harmonic analysis, functional analysis, mathematical physics, numerical analysis, optimization, PDE’s, stochastic and statistical methods. The fields of application encompass medical and astronomical imaging, radar, optics, etc. The goal of the mini-symposium is to present recent theoretical, numerical and applicative advances in these fields. It will focus on ill-posed inverse problems, variational regularization theory, recovery guarantees, and numerical algorithms to solve the corresponding optimization problems.

▶ MS-Tu-D-48-1 13:30–14:00

Disparity and Optical Flow Partitioning Using Extended Potts Priors

Fitschen, Jan Henrik Univ. of Kaiserslautern

Abstract: This talk addresses the problems of disparity and optical flow partitioning. We investigate new variational approaches to these problems using Potts priors and propose a modified alternating direction method of multipliers. This iterative algorithm requires the computation of global minimizers of classical univariate Potts problems. Global and local minimality of the resulting model are investigated as well as convergence of the proposed algorithm. Numerical examples demonstrate the very good performance of our partitioning method.

▶ MS-Tu-D-48-2 14:00–14:30

Edge-preserving Regularization for Electrical Impedance Tomography

Siltanen, Samuli Univ. of Helsinki

Abstract: The D-bar method provides a non-iterative solution to the full nonlinear problem of Electrical Impedance Tomography, based on a low-pass filter in the (nonlinear) frequency domain. However, the D-bar reconstructions are smooth. A new “TV-Enhanced D-bar Method” is introduced, producing reconstructions with sharper edges and improved contrast while still solving the full nonlinear problem. This is achieved by using the Total Variation-induced edges to increase the truncation radius of the nonlinear transform.

▶ MS-Tu-D-48-3 14:30–15:00

Rates for Coordinate and Block-descent Algorithms

Chambolle, Antonin CMAP, Ecole Polytechnique, CNRS

Abstract: This work is based on very simple (old) observations relating Dykstra's-like alternating minimization algorithms and forward-backward splitting. Based upon these remarks, we discuss some cases where it is possible to use standard accelerated descent algorithms based on over-relaxation to improve the rate of convergence. This is a joint work with Thomas Pock from T.U. Graz.

▶ MS-Tu-D-48-4 15:00–15:30

Multiscale Adaptive Learning Algorithms for High-dimensional Data

Liao, Wenjing Duke Univ. & SAMSI
Maggioni, Mauro Duke Univ.

Abstract: Many data sets in image analysis are in a high-dimensional space but exhibit a low-dimensional structure. We will discuss a multiscale geometric method for building a dictionary which provides sparse representations for these data. Our method is based on a multiscale partition of the data and then constructing piecewise affine approximations. It features adaptivity in the sense that our algorithm automatically learns the distribution of the data and chooses the right partition to be used.

MS-Tu-D-49 13:30–15:30 107
Rare Events in Complex Physical Systems - Part III of IV
For Part 1, see MS-Mo-D-49
For Part 2, see MS-Mo-E-49
For Part 4, see MS-Tu-E-49

Organizer: Cameron, Maria Univ. of Maryland
Organizer: Li, Tiejun Peking Univ.
Organizer: Lu, Jianfeng Duke Univ.
Organizer: Weare, Jonathan Univ. of Chicago
Organizer: Zhou, Xiang City Univ. of Hong Kong

Abstract: Many problems arising from chemistry, physics and materials science involve rare but significant exit events and/or transition events between stable states. The transitions happen on a time scale much longer than the intrinsic time scale of the dynamical system. Examples of such events are conformational changes of biomolecules, chemical reactions, etc. The purpose of this minisymposium is to bring together experts working in theory, numerical algorithms and application issues, such as analysis of models for metastable systems, free energy calculation, importance sampling, accelerated dynamics, and sampling of transition pathways.

▶ MS-Tu-D-49-1 13:30–14:00
Rare Events and Energy Landscape for the Chemical Reaction Kinetics
Li, Tiejun Peking Univ.

Abstract: Rare event study attracts much attention in the chemical reaction kinetics recent years. It is also intimately related to the so-called energy landscape construction for biological systems. We start from a genetic switching system with positive feedback to develop rigorous two-scale large deviations. Based on the obtained results, we construct the quasi-potential energy landscape of the considered model. It is also successfully applied to the budding yeast cell cycle system.

▶ MS-Tu-D-49-2 14:00–14:30
Statistical Mechanics of Random Walks, with Application to Molecular Evolution
Morozov, Alexandre Rutgers Univ.

Abstract: Understanding transport in complex media is crucial for many areas of science. I will describe an efficient recursive approach to studying random walks on weighted networks and landscapes with arbitrary structure. After demonstrating the approach on simple examples, I will apply it to the problem of protein adaptation, investigating how the fact that most proteins can only function when folded gives rise to evolutionary coupling between the traits of folding stability and binding strength.

▶ MS-Tu-D-49-3 14:30–15:00
Iterative Minimization Formulation and Algorithm for Transition State Calculation
Zhou, Xiang City Univ. of Hong Kong

Abstract: Calculation of transition states on energy landscape is very important in computational chemistry, material sciences, etc. These transition states are index-1 saddle points. We present a mathematical formulation for the min-mode methodology: Iterative Minimization Formulation (IMF) as well as their numerical implementations. IMF is a generalization of the Gentlest Ascent Dynamics (GAD) , with quadratic iterative rate. The computational efficiency of the resulting iterative minimization algorithm will be demonstrated versus other methods.

▶ MS-Tu-D-49-4 15:00–15:30
Stochastic Surface Walking Method for Global Structure Search and Pathway Sampling
Liu, Zhipan Fudan Univ.

Abstract: The algorithm and the extension of stochastic surface walking method will be overviewed. In particular, the latest progress of the automated pathway sampling in solid-solid phase transition will be presented.

MS-Tu-D-50 13:30–15:30 207
Nonlinear Subdivision Schemes and Applications - Part I of II
For Part 2, see MS-Tu-E-50

Organizer: Donat, Rosa Universitat de Valencia
Organizer: LIANDRAT, Jacques Centrale Marseille/I2M

Abstract: Subdivision schemes and their associated multiscale algorithms have led, over the past 20 years, to important breakthroughs in scientific computing including computer-aided geometric design, signal analysis, harmonic analysis and numerical analysis. Non-linearities appear rapidly in data dependent approaches or in connection to nonlinear constraints of the framework. Applications of, and mathematical approaches to, non-linear subdivision schemes are wide and diverse.

The goal of the minisymposium is to gather mathematicians covering the different approaches, in order to discuss the challenges in applications and establish links with ongoing work.

▶ MS-Tu-D-50-1 13:30–14:00
Kriging Theory: A Flexible Framework to Construct Data-dependent Subdivision Schemes
Baccou, Jean IRSN
LIANDRAT, Jacques Centrale Marseille/I2M

Abstract: This work lies in the intersection of stochastic data modelling and multiscale approximation. It is devoted to the construction of data-dependent kriging subdivision schemes. The originality of such schemes stands in their mask which takes into account the spatial dependence of the data and in the possibility to switch from an interpolatory to a non-interpolatory prediction. A full analysis is performed and applications to the reconstruction of discontinuous and noisy signals are provided as well.

▶ MS-Tu-D-50-2 14:00–14:30
Nonlinear Subdivision Schemes, An Overview
LIANDRAT, Jacques Centrale Marseille/I2M

Abstract: Since their definition in the 80th, subdivision schemes have evolved adapting to various appeals from approximation theory, data compression, geometric design and statistical approach. From linear and translation invariant operators at the beginning, they evolved towards position-dependant, data-dependant and non-linear operators. Analysis tools have been developped to control their properties, mainly convergence and satbility. We will review these evolutions and their motivations through some examples and their applications.

▶ MS-Tu-D-50-3 14:30–15:00
Nonlinear Thresholding of Multiresolution Decompositions Adapted to the Presence of Discontinuities II: the Cell-average Case
Amat, Sergio U.P.Cartagena
LIANDRAT, Jacques Centrale Marseille/I2M
Ruiz, Juan Alcala Univ.

Abstract: A new nonlinear representation of cell-average multiresolution decompositions and new thresholding adapted to the presence of discontinuities are presented and analyzed. They are based on a nonlinear modification of the multiresolution details coming from an initial (linear or nonlinear) scheme and on a data dependent thresholding. Stability results are derived. Numerical advantages are demonstrated on various numerical experiments.

▶ MS-Tu-D-50-4 15:00–15:30
Analysis of Geometric Subdivision Schemes
Ewald, Tobias TU Darmstadt

Abstract: Geometric subdivision schemes are characterized by the fact that the refinement rules commutate with similarities. If such schemes reproduce linear polygons, as Dodgson-Sabin's circle preserving scheme does, $C^{1,\alpha}$-regularity can be established automatically and rigorously by means of numerical computations. For the important subclass of locally linear schemes, $C^{2,\alpha}$-regularity is inherited from a related linear scheme. This talk is based on a joint work with Ulrich Reif and Malcolm Sabin.

MS-Tu-D-51 13:30–15:30 209A
Lyapunov Function Method in Mathematical Biology - Part II of II
For Part 1, see MS-Mo-E-51

Organizer: Shuai, Zhisheng Univ. of Central Florida
Organizer: Wang, Chuncheng Harbin Inst. of Tech.
Organizer: Wang, Jinliang Heilongjiang Univ.

Abstract: The method of Lyapunov functions is a standard tool to analyze models arising in mathematical biology. These models often incorporate complex interactions among multiple species, age structure, behavior and spatial heterogeneity, and different time scales, and are in the form of ordinary differential equations, partial differential equations, functional differential equations, integro-differential equations, etc. A difficulty in applying the method is the ad hoc nature of the construction of a suitable Lyapunov function. This minisymposium will gather researchers employing a variety of mathematical techniques that guide the construction of Lyapunov functions for ecological and epidemiological models.

▶ MS-Tu-D-51-1 13:30–14:00
Constructing Lyapunov Functionals from Lyapunov Functions
McCluskey, Connell Wilfrid Laurier Univ.

Abstract: Consider an ordinary differential equation for which there is a known Lyapunov function. Now suppose that delays are introduced to the system. We determine circumstances under which a Lyapunov functional for the de-

layed system can be easily constructed.
Additionally, we obtain a test that allows one to determine terms that can incorporate delay without affecting the global asymptotic behaviour of the system.

▶ MS-Tu-D-51-2 14:00–14:30
Lyapunov Functions for Epidemic Models with Discretized and Continuous Heterogeneity
Kuniya, Toshikazu — Kobe Univ.

Abstract: To consider the heterogeneity of each individual is important for the formulation of more realistic epidemic models. Often, such models are formulated as partial differential equations and the construction of suitable Lyapunov functions for them is sometimes a difficult problem. Under discretization, such PDEs are rewritten to corresponding ODEs and the problem can become easier. In this talk, I demonstrate such analytic method for epidemic models with age structure and spatial diffusion.

▶ MS-Tu-D-51-3 14:30–15:00
Lyapunov Functions and Stability Analysis for Epidemic Model with Constant Latency and Infectious Periods
Huang, Gang — China Univ. of GeoSci. (Wuhan)

Abstract: An age-infection model is presented for the delay SEIR epidemic model, such that the properties of global asymptotic stability of the equilibria of the age-infection model imply the same properties for the original delay-differential epidemic model. By introducing suitable Lyapunov functions, we study the global stability of the disease free equilibrium and of the endemic equilibria of the age-infection model, which infer the corresponding global properties for the delay SEIR model.

▶ MS-Tu-D-51-4 15:00–15:30
Modeling HIV-1dynamics with Both Cell-free Virus Infection and Cell-to-cell Trasmission
Lai, Xiulan — Renmin Univ. of China

Abstract: Direct cell-to-cell transfer of HIV-1 is found to be a more potent and efficient means of virus propagation than virus-to-cell infection. In this talk, we propose a mathematical model to consider these two modes of viral infection and spread, in which infection age is also incorporated. By applying Lyapunove method, we show that the model demonstrates a global threshold dynamics, fully described by the basic reproduction number, which is identified explicitly.

MS-Tu-D-52 13:30–15:30 212A
Stochastic Dynamics in Cellular-Scale Biology - Part I of II
For Part 2, see MS-Tu-E-52
Organizer: Kramer, Peter — Rensselaer Polytechnic Inst.
Abstract: Many physical processes involving cells and associated entities such as viruses involve inherent irregularities due to thermal fluctuations or other noisy aspects of protein function, arising from the small scales, flexible structures, and/or reliance on diffusive transport of small numbers of biomolecules. The quantitative study of such systems generally relies on stochastic models which integrate the uncertain noisy aspect in a physically, or sometimes phenomenologically, motivated manner. The speakers in this minisymposium will illustrate how stochastic models can be deployed and analyzed to obtain insights on a broad variety of cellular processes.

▶ MS-Tu-D-52-1 13:30–14:00
Stochastic Dynamics and Cellular Systems: Theories and Computational Challenges
Qian, Hong — Univ. of Washington, Applied Mathematics

Abstract: We introduce Delbruck-Gillespie multi-dimensional birth-and-death process for biochemical signaling reaction dynamics of single cells. Using this formalism, we (1) illustrate the relation between nonlinear saddle-node bifurcation and first- and second-order phase transition; (2) introduce a thermodynamic theory for entropy and entropy production that provides a mathematical definition of what is an open chemical system with metabolic fluxes and prove 1st and 2nd Laws-like theorems; (3) suggest a jump process, with punctuated equilibria, for cellular evolution.

▶ MS-Tu-D-52-2 14:00–14:30
Stochastic Models of Collective Force Generation and Information Processing in A Living Cell
Chowdhury, Debashish — Indian Inst. of Tech., Kanpur

Abstract: A living cell has strong similarities with a micro-factory where spatio-temporally coordinated operation of molecular machines sustains, and propagates, life. We analyze stochastic models based on Fokker-Planck equation to describe the kinetics of collective force generation by polymerizing-depolymerizing microtubule bundles. We also account for some modes of gene regulation by formulating master equations for traffic-like collective movements of polymerases and ribosomes on their respective nucleic acid tracks.

▶ MS-Tu-D-52-3 14:30–15:00
Chemotaxis, Velocity Jump Processes, and the Keller-Segel Equation
Xue, Chuan — Ohio State Univ.

Abstract: Chemotaxis of a run-and-tumble bacterium is most accurately modeled by a velocity jump process, with internal dynamics representing intracellular signaling. At the population level, velocity jump models reduce to the Keller-Segel chemotaxis equation when the external signal changes slowly, but the latter becomes inadequate when the signal changes fast. The analysis yields representations of macroscopic parameters in terms of measurable microscopic parameters, and elucidates the molecular origin of logarithmic sensitivity of chemotaxis.

▶ MS-Tu-D-52-4 15:00–15:30
Fluctuation Models for Suspensions of Swimming Microorganisms
Kramer, Peter — Rensselaer Polytechnic Inst.

Abstract: The collective dynamics of swimming microorganisms (“microswimmers”) such as bacteria and algal cells have been of considerable recent interest, both as paradigms of collective patterns arising from individual autonomous agents and for their relevance to technological issues such as biofilm formation and power sources for microdevices. We will discuss some recent efforts to incorporate stochastic fluctuations and correlations into a continuum “mean field” partial differential equation framework for the effective microswimmer dynamics in a suspension.

MS-Tu-D-53 13:30–15:30 311B
Optimal stopping with applications in finance and engineering
Organizer: Ludkovski, Mike — UC Santa Barbara
Organizer: Leung, Tim — Columbia Univ.
Organizer: Zhang, Hongzhong — Columbia Univ.
Abstract: This minisymposium presents four talks on optimal single/multiple stopping problems in finance. The problem formulations and solution techniques will be relevant to number of financial applications such as mean-reversion/pairs trading, optimal capital structure, stock loans, and real options.

▶ MS-Tu-D-53-1 13:30–14:00
Optimal Stopping with Omega Default under Spectrally Negative Levy Model
Rodosthenous, Neofytos — Queen Mary, Univ. of London
Zhang, Hongzhong — Columbia Univ.

Abstract: The Omega default model models the default as the first time when the occupation time over some domain exceeds an independent exponential random variable with unit mean. In this work, we consider the problem of optimal stopping with an Omega default under spectrally negative Levy models. We show that, both the value function and the optimal stopping strategy may exhibit strikingly distinct features depending on the level of the default intensity and model parameters.

▶ MS-Tu-D-53-2 14:00–14:30
An Analytic Recursive Method for Optimal Multiple Stopping: Canadization and Phase-Type Fitting
Yamazaki, Kazuoshi — Kansai Univ.
Zhang, Hongzhong — Columbia Univ.
Leung, Tim — Columbia Univ.

Abstract: We study an optimal multiple stopping problem driven by a spectrally negative Levy process. The stopping times are separated by constant refraction times, and the discount rate can be positive or negative. The computation involves a distribution of the Levy process at a constant horizon and hence the solutions in general cannot be attained analytically. Motivated by the maturity randomization (Canadization) technique by Carr (1998), we approximate the refraction times by i.i.d. Erlang random variables.

▶ MS-Tu-D-53-3 14:30–15:00
Capped American Lookback
Kyprianou, Andreas — Univ. of Bath
Ott, Curdin — Univ. of Bath

Abstract: We consider the case of a capped American Lookback option in the setting of a risk asset driven by a spectrally negative Levy process. The resulting optimal stopping problem is solved by looking at excursions and a threshold which moves as a function of local time at the maximum. We also make some interesting connections with Peskir’s maximality principle.

▶ MS-Tu-D-53-4 15:00–15:30
Optimal prediction of the time of the ultimate maximum of a Lévy process
Baurdoux, Erik — LSE

Schaik, Kees Van — London School of Economics

Abstract: Optimal prediction of the ultimate maximum is a non-standard problem since the pay-off function depends on a process not adapted to the given filtration. We consider the perpetual case for general Lévy processes drifting to minus infinity. Using properties of the all time maximum of a Lévy process and a reformulation of the problem as a standard optimal stopping problem, we find an optimal stopping time as a first passage time of the reflected process.

MS-Tu-D-54 13:30–15:30 VIP1-2
Minisymposium Computational Finance - Part III of III
For Part 1, see MS-Mo-D-54
For Part 2, see MS-Mo-E-54

Organizer: Teng, Long — Bergische Universität Wuppertal
Organizer: Guenther, Michael — Bergische Universität Wuppertal
Organizer: Ehrhardt, Matthias — Univ. of Wuppertal

Abstract: In recent years the variety and complexity of financial mathematics models has witnessed a tremendous growth. For the resulting computational complexity, advanced numerical techniques are imperative for the applications in financial industry. The aim is to deeper understand complex financial models and to develop effective and robust numerical schemes for solving linear and nonlinear problems arising from the mathematical theory of pricing financial derivatives and related financial products. The motivation for this minisymposium is to exchange and discuss current insights and ideas, and to lay groundwork for future collaborations. Finally, it should serve as a kick-off for the special interest group (SIG) Computational Finance within ECMI (European Consortium for Mathematics in Industry).

▶ MS-Tu-D-54-1 13:30–14:00
Pricing Derivatives with Transaction Costs with Non-constant Risk-aversion
Polvora, Pedro — Comenius Univ.

Abstract: Stochastic utility maximization models can be used for the pricing of derivatives under transaction costs. We present a study on different type of utility functions and derivatives payoffs. In these models, the price of the derivative will be the solution of HJB variational inequalities. We present some results on the numerical solution of the HJB Equations arising from the model.

▶ MS-Tu-D-54-2 14:00–14:30
High Order ADI Scheme for Option Pricing in Stochastic Volatility Models
Miles, James — Univ. Of Sussex

Abstract: This presentation combines high-order compact finite difference approximations with an Alternating Direction Implicit method to obtain numerical solutions to the convection diffusion equation with mixed second-order derivative terms. This method has useful applications in financial option pricing problems which I shall demonstrate by solving the stochastic volatility Heston model as an example. In this case, the problem reduces to a convection diffusion equation with non-constant coefficients in two spatial dimensions.

▶ MS-Tu-D-54-3 14:30–15:00
Calibration of Local-stochastic Volatility Models to Barrier Options Using A Dupire-type PDE
Reisinger, Christoph — Oxford Univ.

Abstract: We derive a forward equation for arbitrage-free barrier option prices in terms of Markovian projections of a stochastic volatility process. This provides a Dupire-type formula for the coefficient derived by Brunick and Shreve for their mimicking diffusion and can be interpreted as the canonical extension of local volatility for barrier options. Alternatively, a forward partial-integro differential equation (PIDE) is introduced which provides up-and-out call prices for the complete set of strikes, barriers and maturities.

▶ MS-Tu-D-54-4 15:00–15:30
The Volatility Factors Analysis of the International Crude Oil Futures
Chen, Xiaoguo — Guangdong Univ. of Petrochemical Tech.

Abstract: In this paper, starts from the actual market datas, uses Logarithmic - log-linear regression model, Grange model, ARCH model to study the influence of various factors on the crude oil futures price volatility. And then using bivariate regression model with linear feature to establish the model of crude oil futures prices only considering the dollar index volatility, the EIA of crude oil inventory changes. Finally, offers some risk aversion strategies to the company which need

MS-Tu-D-55 13:30–15:30 106
Theoretical Understanding of Charged Particles in Complex Environments - Part II of II
For Part 1, see MS-Mo-E-55

Organizer: Xu, Zhenli — Shanghai Jiao Tong Univ.
Organizer: Lu, Benzhuo — Acad. of Mathematics & Sys. Sci., CAS

Abstract: The theoretical understanding of ion interaction and transport has been attracting longstanding interest in different branches of mathematics, such as potential theory, numerical PDEs, computational physics and mathematical biology. Complex environments, including interfaces, dielectric inhomogeneities, many-body and dynamic interactions, have led to recent wide attention in math community. This mini-symposium will bring together of active researchers to discuss recent progress in this exciting field of disciplinary areas for computational and modeling issues of particle and interface motion in complex environments. There will be mathematical and numerical issues, such as variational approaches, finite element methods, high-performance computing, mesh generation, various coarse-grained techniques, and asymptotic analysis.

▶ MS-Tu-D-55-1 13:30–14:00
Stability Analysis of A Solute-Solvent Interface: Effect of Geometry, Hydrodynamics, and Electrostatics
Zhou, Shenggao — Univ. of California, San Diego

Abstract: The solute-solvent interface that separates biological molecules from their surrounding aqueous solvent characterizes the conformation and dynamics of such molecules. In this talk, we study the stability analysis of the equilibrium solute-solvent interface under the influence of geometry, hydrodynamics, and electrostatics. This is a joint work with Dr. Bo Li and Dr. Hui Sun.

▶ MS-Tu-D-55-2 14:00–14:30
TMSmesh: A Robust Method for Meshing Large Biomolecular Gaussian Surface and Its Applications in Implicit Solvent Modeling
Chen, Minxin — Soochow Univ.

Abstract: Recently, with the developments of advanced mathematical modeling in the field of implicit solvent modeling and simulation, providing surface meshes with good qualities efficiently for large real biomolecular systems becomes an urgent issue. In this talk, I will introduce our recently developed method and tool, TMSmesh, for meshing molecular Gaussian surface. The meshes generated by TMSmesh have been successfully tested in BEM and FEM computations of the implicit solvent model for large biomolecular systems.

▶ MS-Tu-D-55-3 14:30–15:00
Biomolecular System Modelled by PNP Equations and Its Modified Versions, Size-modified PNP and FMT-PNP
Qiao, Yu — Chinese Acad. of Sci.
Lu, Benzhuo — Acad. of Mathematics & Sys. Sci., CAS

Abstract: Ionic finite size can impose considerable effects to both the equilibrium and non-equilibrium properties of a solvated molecular system, such as the solvation energy, ionic concentration and transport in a channel. The nonuniform size effects deduced from the extended Borukhov et al' s free energy functional and the fundamental measure theory (FMT) are incorporated into the Poisson-Nernst-Planck (PNP) equations to investigate ion size effects.

▶ MS-Tu-D-55-4 15:00–15:30
Bridging Coarse Grained Molecular Dynamics of Proteins and Continuum Deformation of Protein Complexes
Zhou, Yongcheng — Colorado State Univ.

Abstract: Here we propose to compute the strain-stress constitutive relations from steered coarse-grained molecular dynamics simulations of proteins. These relations will be applied to the solution of three-dimensional continuum elastic equations for large scale deformations of proteins or protein complexes. We expect our approach will greatly reduce the computational complexity in simulating the related biological procedures.

MS-Tu-D-56 13:30–15:30 403
Modeling Techniques for Complex Biological Systems

Organizer: Tran, Hien — North Carolina State Univ.

Abstract: Mathematical models when used in conjunction with data can be powerful tools in uncovering mechanisms in complex biological systems. These data-oriented mathematical models require modeling techniques such as sensitivity analysis, generalized sensitivity functions, and parameter subset selection for the model building process. In addition, application of models to data from multiple subjects requires that the model must be integrated into

a statistical framework to recognize within subject variation, as well as variation across the population. In this mini-symposium, invited speakers will discuss these mathematical and statistical modeling concepts in the context of biological applications such as malignant brain tumor, pharmacokinetic of Metformin, cardiovascular system, and drug delivery in the nasal passages.

▶ MS-Tu-D-56-1 13:30–14:00

Modeling Surgical Outcomes and Drug Delivery in the Nasal Passages

Frank-Ito, Dennis Duke Univ.

Abstract: Outcomes from nasal surgery are sometimes difficult to predict a priori in treatment of nasal diseases; and little is known if topical medications are reaching targeted sites inside the human nasal airway. This in part is due to the complexity of the nasal passage. This talk will focus on computational fluid dynamics modeling of fluid flow and transport of particulate matter in the nose before and after surgical therapy in the treatment of nasal diseases.

▶ MS-Tu-D-56-2 14:00–14:30

Mathematical Modeling of Malignant Brain Tumor with Immunostimulatory Glycoprotein, T11 Target Structure.

Banerjee, Sandip Indian Inst. of Tech. Roorkee

Abstract: T11 Target structure, a membrane glycoprotein isolated from sheep erythrocytes, reverses the immune suppressed state of brain tumor induced animals by boosting the functional status of the immune cells. This study aims at aiding in the design of more efficacious brain tumor therapies with T11 target structure as a potent immune stimulator. We propose a mathematical model for brain tumor (glioma) and the immune system interactions, which aims in designing efficacious brain tumor therapy.

▶ MS-Tu-D-56-3 14:30–15:00

A Stochastic Approach to Nonlinear Mixed Effects Modeling: Applications to Pharmacokinetics Modeling of Metformin

Tran, Hien North Carolina State Univ.

Abstract: Nonlinear mixed effects modeling (NLME) is a statistical framework involving both fixed-effects and random effects for population parameters incorporating uncertainty associated with intra- and inter-subject variability. Using stochastic differential equations (SDE) within the NLME framework allows the decoupling of the measurement error from the model misspecification. In this talk, we will compare the model development results using an SDE approach to common practice of using ordinary differential equations for the Metformin clinical pharmacokinetic data.

▶ MS-Tu-D-56-4 15:00–15:30

Generalized Sensitivity Functions and Parameter Subset Selection for A Model of the Cardiovascular System

Kappel, Franz Univ. of Graz

Abstract: Demands on accuracy of models, particularly in life sciences, lead to models involving large numbers of parameters. Moreover, clinical applications require to adapt models to individual patients. Limited data available require systematic methods, like parameter subset selection (PSS) and generalized sensitivity functions (GSF), to select parameters which can be identified with sufficient accuracy on the basis of available data. We present PSS and GSF together with applications to a compartment model for the cardiovascular system.

MS-Tu-D-57 13:30–15:30 402A

Advances in Numerical Methods for Porous Media Flow - Part I of IV

For Part 2, see MS-Tu-E-57
For Part 3, see MS-We-D-57
For Part 4, see MS-We-E-57

Organizer: Wang, Hong Univ. of South Carolina
Organizer: Sun, Shuyu King Abdullah Univ. of Sci. & Tech.
Organizer: Rui, Hongxing Department of Mathematics, Shandong Univ.

Abstract: Porous media flow has wide applications in many areas, including environmental, energy, biological and engineering applications. They lead to strongly coupled transport processes also with nonlinear chemical reactions, which are computationally challenging, for it demands high accuracy and local mass conservation. Porous media manifest dramatically differently at different spatial and temporal scales. Heterogeneity, anisotropy, and discontinuity of medium properties require special treatment. The aim of this minisymposium is to bring together researchers in the aforementioned field to highlight the current developments, to exchange the latest research ideas, and to promote further collaborations in the community.

▶ MS-Tu-D-57-1 13:30–14:00

An Improved Polymer Model for 3D Reservoir Simulators

Wheeler, Mary Fannett THE Univ. OF TEXAS AT AUSTIN

Abstract: A three-dimensional, shear-thinning polymer model is described for use in reservoir simulators. The viscosity calculations are based upon direction dependent shear-rates. This provides an accurate representation of the non-Newtonian flow behavior in a three dimensional porous medium. This model is implemented in a reservoir simulator IPARS (Integrated Parallel Accurate reservoir Simulator) to evaluate mobility control scenarios during field scale polymer flooding. A number of numerical results including field scale studies are presented to demonstrate model.

▶ MS-Tu-D-57-2 14:00–14:30

Studies of Hybrid Steam-Solvent Processes for Oil Recovery

Chen, Zhangxin Xi'an Jiaotong Univ. & Univ. of Calgary

Abstract: The main drawbacks associated with steam based recovery processes for oil reservoirs, such as steam flooding, cyclic steam stimulation (CSS) and steam assisted gravity drainage (SAGD), are their high energy demand and significant environmental impacts. The current research focuses on co-injection of steam and solvent as one of the alternative recovery processes to reduce the energy intensity and environmental impacts of pure steam processes. The co-injection has been studied under various commercial names such as solvent aided process (SAP), solvent aided SAGD (SA-SAGD), expanding solvent-SAGD (ES-SAGD) and liquid addition to steam enhanced recovery (LASER). Improved oil production rates and ultimate recovery factors as well as lower steam demand in co-injection, compared to the pure steam processes, have been reported in the literature.
The oil recovery in co-injection involves complex interactions of multiphase mass and energy flow with effects of gravity and phase behavior. Although various laboratory and numerical experiments and filed pilot tests are reported in the literature, their results are specific to the experimental conditions or reservoir properties considered. The main objectives of this research are: 1) to identify the key mechanisms of co-injection that are responsible for oil rate improvement, ultimate recovery factor improvement and steam demand reduction, 2) to develop a sound mathematical model to capture these mechanisms and to predict the performance of co-injection, and 3) to improve the economics of the processes by providing key guidelines on making an optimum choice of solvent, its concentration, and co-injection strategy. This presentation will address these issues.

▶ MS-Tu-D-57-3 14:30–15:00

New Analysis of Characteristics Type FEMs for Nonlinear Convection-dominanted Diffusion Equations

Sun, Weiwei City Univ. of Hong Kong

Abstract: The method of characteristics type is especially effective for convection-dominated diffusion problems. Due to the nature of characteristic temporal discretization, the method often allows one to use a large time step in many practical computations, while all previous theoretical analyses always required certain restrictions on the time stepsize. In this talk, we present our recent work on establishing unconditionally optimal error estimates for modified methods of characteristics for N-S equations and miscible displacement problem.

▶ MS-Tu-D-57-4 15:00–15:30

Physics-preserving Numerical Methods for Compositional Multiphase Flow

Sun, Shuyu King Abdullah Univ. of Sci. & Tech.
Kou, Jisheng Huibei Univ. of Engineering

Abstract: We consider numerical simulation of compositional multiphase flow in porous media, and we show the importance and significance in preserving certain physics. We demonstrate in particular that local conservation is a necessary condition for many scenarios if one wants to ensure both accuracy and global conservation. We propose new algorithms to address the loss of accuracy and/or loss of global conservation which can occur when flow and transport schemes are not compatible.

MS-Tu-D-58 13:30–15:30 401

Surface diffusion and related problems and flows. - Part III of III

For Part 1, see MS-Mo-D-58
For Part 2, see MS-Mo-E-58

Organizer: Novick-Cohen, Amy Technion IIT

Abstract: Motion by surface diffusion, in which the normal velocity of an evolving surface is proportional to minus the surface Laplacian of its mean curvature, constitutes a geometric motion which plays a critical role in many technological applications, from thin film drug delivery, optical coatings, printing, and spray technology. While surface diffusion has been discussed in the material science literature to 1950s, much concerning its mathematical theory remains to be developed. The aim of the proposed minisymposium is consid-

er surface diffusion and related problems from a variety of aspects, including existence, uniqueness, self-similarity, numerical methods, and issues related to applications. SIAG-MS sponsored.
(Comment: the actual area might best reflect A04 as well as A24, and the organizer is a member of two siags: SIAG-APDE as well as SIAG-MS)

▶ MS-Tu-D-58-1 13:30–14:00
Some Consequences of New Local Regularity for the Surface Diffusion Flow
Wheeler, Glen Univ. of Wollongong

Abstract: Recently new local regularity for the curve diffusion flow has become available, giving strong local space-time control of the (hyper)surface diffusion flow in dimensions one (curves), two (surfaces) and three (3-manifolds). This local control is significantly different in each case, as the character of the flow and the lack (or abundance) of good scale-invariant functionals influences the analysis in a fundamental way. In the talk we discuss some consequences of these new estimates.

▶ MS-Tu-D-58-2 14:00–14:30
The Method of Viscosity Solutions for Analysis of Singular Diffusion Problems Appearing in Crystal Growth Problems
Rybka, Piotr The Univ. of Warsaw

Abstract: We use the methods of viscosity solutions, to study singular parabolic equations arising in crystal growth problems. These problems may be viewed as a weighted mean curvature flow.
We present a few consequences of this theory and the comparison principle: 1) uniqueness of evolution of simple closed curves driven by wmc; 2) preservation of vertexes; 3) behavior of a system with two competing singular slopes, arising when we localize the wmc near a vertex.

▶ MS-Tu-D-58-3 14:30–15:00
Numerical Approximation of Multicomponent Phase-field Models for Multiphase Flow.
Banas, Lubomir Bielefeld Univ.

Abstract: We propose finite element based numerical approximations of some phase-field models for mixtures of incompressible fluids with variable densities and viscosities. We discuss theoretical and practical issues related to the proposed numerical approximations and present some computational experiments to demonstrate the usefulness of our approach.

▶ MS-Tu-D-58-4 15:00–15:30
Phase-field Modeling of Morphological Evolution for Arbitrary Surface-energy Anisotropy
Voigt, Axel TU Dresden

Abstract: By means of a suitable Phase-Field approach we investigate the evolution towards equilibrium of three-dimensional structures characterized by arbitrary facets. A convenient and general formulation of anisotropic surface energy density is introduced and a proper regularization is considered to treat the strong anisotropy regime. After illustrating applications yielding equilibrium crystal shapes, we focus our attention on the evolution of far-from-equilibrium morphologies for which a conventional Wulff-plot analysis would fail. The generality and numerical robustness of the approach is proved by several applications to systems of utmost interest (quantum dots, quantum wires, patterned substrates) in present material science.

MS-Tu-D-59 13:30–15:30 402B
Modeling, Simulation and Analysis of Interface and Defect Problems in Solids - Part I of III
For Part 2, see MS-Tu-E-59
For Part 3, see MS-We-D-59
Organizer: Xiang, Yang Hong Kong Univ. of Sci. & Tech.
Abstract: Interfaces or defects in crystalline materials, such as vacancies, dislocations, cracks, grain boundaries, and surfaces, play important roles in the mechanical, electronic, and plastic properties of these materials. The complexity of modeling microstructures of these defects and their evolution at various length and time scales presents new challenges for mathematical modeling and analysis. Multiphysics models are required to accurately describe the complicated interactions among various defects involved in the equilibrium and dynamics processes. The speakers in this minisymposium will discuss recent advances in the modeling approaches and new findings obtained in analysis and simulations.

▶ MS-Tu-D-59-1 13:30–14:00
Continuum Framework for Dislocation Structure, Energy and Dynamics of Dislocation Arrays and Low Angle Grain Boundaries
Zhu, Xiaohong Jinan Univ.
Xiang, Yang Hong Kong Univ. of Sci. & Tech.

Abstract: We present a continuum framework for dislocation structure, energy and dynamics of dislocation arrays and low angle grain boundaries which may be nonplanar and nonequilibrium. We define a dislocation density potential function on the dislocation array surface or grain boundary to describe the orientation dependent continuous distribution of dislocations. The continuum formulations incorporate both the long-range dislocation interaction and the local dislocation line energy, and are derived from the discrete dislocation model.

▶ MS-Tu-D-59-2 14:00–14:30
Numerical Methods for Modeling Dynamic Interfaces
Leung, Shingyu Hong Kong Univ. of Sci. & Tech.

Abstract: The talk summarizes several new numerical approaches for modeling dynamic interfaces. We present algorithms including the Grid Based Particle Method (GBPM), the Cell Based Particle Method (CBPM) and some other recent progress based on the Level Set Method. This is a joint work with Sean Hon, Ka Wah Wong, Hongkai Zhao and John Lowengrub.

▶ MS-Tu-D-59-3 14:30–15:00
Homogenisation of A Row of Dipoles
Zhu, Yichao The Hong Kong Univ. of Sci. & Tech.

Abstract: The collective behaviour of a row of dislocation dipoles is here studied with the matched asymptotic techniques. The discrete-to-continuum transition is facilitated by introducing two field variables, one describing macroscopic density distribution of dipoles and the other depicting the local patterns of dipoles. The evolution of the two fields is found hierarchic in time, and such findings may shed light on the incorporation of dislocation-dipole-like structures (small but non-vanishing) into macroscopic models of crystal plasticity.

▶ MS-Tu-D-59-4 15:00–15:30
The Relaxation of A General Family of Broken Bond Crystal Surface Models.
Marzuola, Jeremy UNC, Chapel Hill

Abstract: With Jon Weare (Chicago), we study the continuum limit of a family of kinetic Monte Carlo models of crystal surface relaxation that includes both the solid-on-solid and discrete Gaussian models. With computational experiments and theoretical arguments we are able to derive several partial differential equation limits identified (or nearly identified) in previous studies and to clarify the correct choice of surface tension appearing in the PDE.

IM-Tu-D-60 13:30–15:30 310
Industrial Mathematics Around the World - Part III of VIII
Activities on Industrial-Mathematics in Europe
For Part 1, see IM-Mo-D-60
For Part 2, see IM-Mo-E-60
For Part 4, see IM-Tu-E-60
For Part 5, see IM-We-D-60
For Part 6, see IM-We-E-60
For Part 7, see IM-Th-BC-60
For Part 8, see IM-Th-D-60
Organizer: Cai, Zhijie Fudan Univ.
Organizer: Chen, Gui-Qiang G. Univ. of Oxford
Organizer: Huang, Huaxiong York Univ.
Organizer: LU, Liqiang Fudan Univ.
Organizer: Ockendon, Hilary Univ. of Oxford
Organizer: Ockendon, John Univ. of Oxford
Organizer: Peng, Shige Shandong Univ.
Organizer: Tan, Yongji Fudan Univ.
Organizer: Wake, Graeme Massey Univ.,
Organizer: Zhu, Yichao The Hong Kong Univ. of Sci. & Tech.
Organizer: CHENG, JIN Fudan Univ.
Abstract: The aim of this section is to boost the use of mathematics as an industrial resource in China and around the world. It will highlight (i) the global experience in industrial mathematics and (ii) the new mathematical ideas that these activities have created as well as the exploitation of existing technologies to new applications. Participants will come from both academia and industry and, for this purpose, the section is proposed to consist of eight minisymposia. Four of them will overview the identification and solution of industrially-driven mathematical problems and the mechanisms that have evolved to deal with them in different regions: China, other Asia-Pacific countries, Europe and North America. Three of the remaining minisymposia will focus on the problems coming from different industrial sectors: financial industry, petroleum industry and industrial areas in which wave propagation is important. The last minisymposium will involve an open discussion on how the global mathematics community can best respond to the increasing de-

mand from industry for applied and computational mathematics; the agenda will include both the mechanisms for academic / industrial collaboration and the areas where it will be most fruitful.

▶ IM-Tu-D-60-1 13:30–14:00

Industrial Mathematics in Europe - the First 50 Years

Ockendon, John Univ. of Oxford

Abstract:
Although industrial mathematics in Europe started in the 1960s there was an explosion in the 1980s which nucleated many new initiatives including the first continental network of academic and industrial mathematicians (ECMI). This talk will focus on (1) the key mechanisms that have underpinned this new interface for mathematics and (2) on the intellectual impact that it has had, with special reference to the pantograph equation and the theory of free boundary problems.

▶ IM-Tu-D-60-2 14:00–14:30

An Overview over the Successful Mathematical Technology Transfer in Spain and the Added Value for Both Companies and Research Groups

Quintela, Peregrina Spanish Network for Mathematics & Industry; Univ. of Santiago de Compostela

Abstract: The advantages, disadvantages and difficulties arising in the mathematical technology transfer, both from the point of view of researchers, technicians and businesses, will be discussed. In particular, the solution provided by the Spanish mathematicians to promote the transfer, launching of the Spanish Network for Mathematics and Industry, and how companies can get access to it will be shown. Through some successful cases, the added value for both companies and research groups involved will be displayed.

▶ IM-Tu-D-60-3 14:30–15:00

New Developments in the Danish Study Group Activity

Hjorth, Poul G. Technical Univ. of Denmark

Abstract: In Denmark, Study Groups have been conducted for more than 15 years, alternating location between Technical University of Denmark, and University of Southern Denmark. I will highlight a few cases of mathematics impacting on Danish companies, and also discuss a recent extension of the activity, into a 'Flying Corps1, which can with short notice assemble an ad hoc team of mathematicians, and perform a quick assessment of an industrial maths problem.

▶ IM-Tu-D-60-4 15:00–15:30

The Need for A Successful European Strategy in Supporting Industrial Mathematics

Guenther, Michael Bergische Universität Wuppertal

Abstract: In my talk will try to explain in which sense we consider it mandatory that the EU policy towards mathematics recognizes that mathematical modelling-simulation- optimization (MOS) is a key tool for innovation and for increasing competitivness of European industry. In this sense MOS should be considered as a KET (key enabling technology) and funded accordingly. Some recent and ongoing attempts that European mathematicians have done will be described.

CP-Tu-D-61 13:30–15:30 101

Real and Complex Analysis

Chair: AGARWAL, PRAVEEN Anand Internatioal College of Engineering

Abstract:

▶ CP-Tu-D-61-1 13:30–13:50

SOME GENERAL PROPERTIES OF A FRACTIONAL SUMUDU TRANSFORM IN THE CLASS OF BOEHMIANS

AGARWAL, PRAVEEN Anand Internatioal College of Engineering

Abstract: In literature, there are several works on the theory and applications of integral transforms of Boehmian spaces, but fractional integral transforms of Boehmians have not yet been reported. In this paper, we investigate the fractional Sumudu transform of arbitrary order on some space of integrable Boehmians. The fractional Sumudu transform of an integrable Boehmian is well-deÖned, linear and sequentially complete in the space of continuous functions. Two types of convergence are also discussed in details.

▶ CP-Tu-D-61-2 13:50–14:10

Trends in Polar Orthogonal Polynomilas

Abdelhamid, Rehouma Department of Mathematic Univ. of Eloued Algeria

Abstract: We aim studying a new corresponding set of monic polynomials corresponding to a General orthogonal polynomials wich called polar general orthogonal polynomials. We speaking some open question relating to asymptotic behavior and recurrence relations and other comparison question between this general orthogonal polynomials and its polar polynomials.More special cases was taken into account as : polar monic orthogonal polynomials with respect to the measure supported on the unit circle.

▶ CP-Tu-D-61-3 14:10–14:30

From Dirichlet Space to Bergman Space: A Bernstein-Szego Inequality

Artes, Rosalio Mindanao State Univ.- Iligan Inst. of Tech.
Arco, Roxanne Mindanao State Univ.- Iligan Inst. of Tech.

Abstract: The Dirichlet space and the Bergman space are reproducing kernel Hilbert spaces (RKHS) of analytic functions on the unit disk. In this paper, we establish a Bernstein-Szego inequality on the Dirichlet space by taking bounded linear operators from the Dirichlet space into the Bergman space and obtain an estimate using the Gram-Schmidt Orthonormalization Process and Bessel's inequality.

▶ CP-Tu-D-61-4 14:30–14:50

Monotonicity Properties of Orthogonal Laurent Polynomials

Das, Sourav Indian Inst. of Tech. Roorkee
Swaminathan, Anbhu Indian Inst. of Tech. Roorkee

Abstract: The zeros of Szego polynomials are all lie in the unit disc, whereas the corresponding Para orthogonal polynomials on the unit disc are interesting because their zeros lie on the unit circle and useful in quadrature formulae. Orthogonal Laurent polynomials defined on the unit disc are obtained by the three term recurrence relation involving Szego polynomials. In this work, certain monotonicity properties of these orthogonal polynomials are obtained that are useful in discussing their zeros. Further certain continued fraction expressions are also obtained and investigated to discuss the behaviour of these polynomials in relation with certain self analytic maps on the unit disc. Several interesting applications in these direction for these polynomials are obtained.

CP-Tu-D-62 13:30–15:30 102

Partial Differential Equations

Chair: Kannappan, Karuppiah Bharathiar Univ.

Abstract:

▶ CP-Tu-D-62-1 13:30–13:50

Inverse Source Problem, Coupled Hyperbolic-parabolic System, Quasi-solution

Kannappan, Karuppiah Bharathiar Univ.

Abstract: In this paper we study the inverse problem of determining two source terms in the coupled hyperbolic-parabolic system. Apart from the initial and Dirichlet boundary conditions, we consider the additional Dirichlet type output measured data. Further we provide several necessary and sufficient results to prove the existence of a quasi-solution of the considered inverse problem.

▶ CP-Tu-D-62-2 13:50–14:10

Lifespan of Classical Discontinuous Solutions to General Quasilinear Hyperbolic Systems of Conservation Laws with Small BV Initial Data

Shao, Zhiqiang Fuzhou Univ.

Abstract: In the present paper, the author investigates the global structure stability of Riemann solutions for general quasilinear hyperbolic systems of conservation laws under small BV perturbations of the initial data, where the Riemann solution contains rarefaction waves, while the perturbations are in BV but they are assumed to be C^1-smooth, with bounded and possibly large C^1-norms. Combining the techniques employed by Li-Kong with the modified Glimm's functional, the author obtains a lower bound of the lifespan of the piecewise C^1 solution to a class of the generalized Riemann problem, which can be regarded as a small BV perturbation of the corresponding Riemann problem. This result is also applied to the system of traffic flow on a road network using the Aw-Rascle model.

▶ CP-Tu-D-62-3 14:10–14:30

Boundedness of Solutions to A Quasilinear Parabolic–parabolic Keller–Segel System with Supercritical Sensitivity and Logistic Source

Jiashan, Zheng Beijing Inst. of Tech.
Yifu, Wang Beijing Inst. of Tech.

Abstract: We study global solutions of a class of chemotaxis systems

$$\begin{cases} u_t = \nabla\cdot(\phi(u)\nabla u) - \chi\nabla\cdot(\psi(u)\nabla v) + au - bu^r, & x\in\Omega, t>0, \\ v_t = \Delta v - v + u, & x\in\Omega, t>0, \end{cases}$$

in a bounded convex domain $\Omega\subset\mathbb{R}^N(N\geq 1)$ with smooth boundary $\partial\Omega$, $\phi(u)=(u+1)^{-\alpha}, \psi(u)=u(u+1)^{\beta-1}$, parameters $r>1, a\geq 0, b, \chi>0$ and $\alpha,\beta\in\mathbb{R}$. There are three nonlinear mechanisms included in the model: the nonlinear diffusion, aggregation and logistic absorption. The interaction among the triple nonlinearities shows that together with the nonlinear

diffusion, the logistic absorption will dominate the aggregation such that the unique classical solution of the system has to be global in time and bounded, regardless of the initial data, whenever $\frac{2}{N} \leq \alpha + \beta < r - 1 + \alpha$, which enlarges the parameter range $\alpha + \beta < \frac{2}{N}$ (see L. Wang, Y. Li, C. Mu (Discrete Contin. Dyn. Syst. Ser. A., 34(2014), 789–802) and Y. Tao, M. Winkler, J. Diff. Eqns., 252(2012), 692–715).

▶ CP-Tu-D-62-4 14:30–14:50

On Bounds and Non-existence in the Problem on Bounds and Non-existence in the Problem of Steady Waves with Vorticity.

Kozlov, Vladimir — Link ”Oping Univ.

Abstract: For the problem describing steady gravity waves with vorticity on a two-dimensional unidirectional flow of finite depth the following results will be presented. (i) Bounds are found for the free-surface profile and for Bernoulli’ s constant. (ii) If only one parallel shear flow exists for a given value of Bernoulli’ s constant, then there are no wave solutions provided the vorticity distribution is subject to a certain condition.
Applications of these results will be given. In particular, it will be obtained non-existence results for solitary and Stokes waves
This is joint work with N.Kuznetsov (St Petersburg, Russia) and E.Lokharu (Link
”Oping University, Sweden).

▶ CP-Tu-D-62-5 14:50–15:10

Elliptic and Parabolic Equations in Fractured Media

Yeh, Li-Ming — National Chiao Tung Univ.

Abstract: The elliptic and the parabolic equations in fractured media are considered. The fractured media consist of a periodic connected high permeability sub-region and a periodic disconnected matrix block subset with low permeability. Let ε^2 ∈(0,1] denote the size ratio of the matrix blocks to the whole domain and let ω^2 ∈(0,1] denote the permeability ratio of the disconnected subset to the connected sub-region. It is proved that the $W^{1,p}$ norm of the elliptic and the parabolic solutions in the high permeability sub-region are bounded uniformly in ε, ω. However, the $W^{1,p}$ norm of the solutions in the low permeability subset may not be bounded uniformly in ε, ω. For the elliptic and the parabolic equations in periodic perforated domains, it is also shown that the $W^{1,p}$ norm of their solutions are bounded uniformly in ε.

▶ CP-Tu-D-62-6 15:10–15:30

Floquet Theory Solution for A Highly Nonlinear Earth-Satellite Pitch Attitude Liberation Equation

Aidoo, Anthony — Eastern Connecticut State Univ.

Abstract: We derive the dynamical equations that characterizes the pitch librations of an earth-satellite. To obtain analytical solution of the resulting highly nonlinear equation, we adopt a scheme that successively augments the non linearity level of the equation by adding nonlinear terms. This leads to the use of Floquet theory version of linear systems theory. The nonlinear solution is expressed in terms of series, enabling it to be expressed more accurately in terms of periodic functions.

CP-Tu-D-63	13:30–15:30	103
Numerical Analysis		

Chair: Kaur, Harpreet — Lovely Professional Univ.,Jalandhar(Punjab)

Abstract:

▶ CP-Tu-D-63-1 13:30–13:50

Haar Wavelet Based Time Discretization Scheme for Solving Benjamin Bona-Mahony Equation

Kaur, Harpreet — Lovely Professional Univ.,Jalandhar(Punjab)
Mishra, Vinod — SLIET, Longowal
Mittal, R.C. — IIT Roorkee

Abstract: In this paper, a numerical scheme is developed to find the numerical solutions of general nonlinear partial differential equations. The time discretization scheme is developed using the properties of uniform Haar wavelets with quasi-linearization process. In order to test the efficiency of the scheme well known nonlinear Benjamin Bona-Mahony equation is solved for different values of parameter. The plots of and show efficiency of proposed method at different time level. The quasi-linearization is iterative process but after combining with wavelet based proposed technique gives excellent numerical results without any iteration. Results are compared with available results by finding and errors. It is shown that the proposed method is working well and produces the satisfactory results

▶ CP-Tu-D-63-2 13:50–14:10

A Fifteenth-Order Convergent Method for Solving Non-local Elliptic Model with Strong Allee Effect

Akanksha, Srivastava — Indian Inst. of Tech. Gandhinagar

Abstract: The paper deals with a non-local elliptic model of population growth arising in computational biology satisfying strong Allee effect growth pattern defined on a bounded polygonal domain. The non-local term involved in the strong formulation essentially increases the complexity of the problem and the necessary total computational work. The non-linear weak formulation of the problem is reduced to a linear one suitable for applications of Newtonian type iterative methods. A discrete problem is obtained by the finite element method. A fast and stable iterative method with fifteenth-order of convergence is applied for solving the discrete problem. The iterative algorithm is described by pseudo-code. The method is computer implemented and the approximate solutions are presented graphically for varying the dispersal of the population. Numerical simulations are performed to demonstrate the superiority of our method with comparisons.

▶ CP-Tu-D-63-3 14:10–14:30

On Fifth Order Runge-Kutta Methods

Butcher, John — Univ. of Auckland

Abstract: Methods of orders 2, 3 and 4 were derived by Runge (1895), Heun (1900) and Kutta (1901). The beautifully simple method due to Kutta, based on Simpson’ s rule, is well-known and widely used. By taking the method of analysis used by these pioneers further, a method of order 5 will be constructed, satisfying the 16 condition necessary for this order. Using the same test problem used by Runge and others, the advantage of high order will be illustrated by numerical comparisons. When the comparisons are repeated using an alternative test problem, based on a vector-valued differential equation, the fifth order method now acts as though it is only fourth order. The reason for this discrepancy is that in the modern theory of order, which will be briefly surveyed, there are not 16, but 17, order conditions.

▶ CP-Tu-D-63-4 14:30–14:50

On Some Tau Method Applications

Rappoport, Juri — Russian Acad. of Sci.

Abstract: Tau method computational scheme is developed for the constructive approximation of modified Bessel functions of the second kind with arbitrary complex order and real argument. The differential equations of hypergeometric type and their systems are considered. The minimality conditions for the perturbation term in the form of a shifted Chebyshev polynomial are obtained. The numerical solution of some mixed boundary value problems for the Helmholtz equation in wedge domains is elaborated.

▶ CP-Tu-D-63-5 14:50–15:10

Spectral Method for Fractional Differential/integral Equations with Generalized Fractional Operator

Xu, Qinwu — Peking Univ.

Abstract: In this talk, we propose a new spectral approximation to the generalised fractional operators, including Erdelyi-Kober operator, Hadamard operator, et al. Based on this approximation, a collocation method is derived for problems with generalised fractional operator. The proposed method is applied to solution of Hadamard boundary value problem and generalised grey Brownian motion. Characteristics of the equations are studied and accuracy of the proposed method is confirmed.

▶ CP-Tu-D-63-6 15:10–15:30

Nonlinear Finite Volume Scheme Preserving Discrete Maximum Principle for Diffusion Equations on General Meshes

Yuan, Guang-wei — Inst. of Applied Physics & Computational Mathematics, Beijing, China

Abstract: New nonlinear finite volume schemes for diffusion equations are constructed on polygonal meshes. We will prove that the schemes satisfy the discrete maximum principle and the existence of the solutions to the nonlinear schemes.

CP-Tu-D-64	13:30–15:30	104
Control and Systems Theory		

Chair: Quan-Fang, Wang — The Chinese Univ. of Hong Kong

Abstract:

▶ CP-Tu-D-64-1 13:30–13:50

Optimal Control for Cahn-Hilliard Equation

Quan-Fang, Wang — The Chinese Univ. of Hong Kong

Abstract: In this talk, optimal control theory and numerical approach are presented to nonlinear Cahn-Hilliard equation using the framework of variational method in Hilbert spaces. For industrial and engineer fields, a binary system is usually described by C-H equation, through theoretical and computer-aided computational control, real-time adjustment and confinement would be applying to a class of Cahn-Hilliard issues. It is a connecting work from applied mathematics and control areas to industrial area.

▶ CP-Tu-D-64-2 13:50–14:10

Chaos Synchronization and Hybrid Chaos Synchronization of Identical Hyperchaotic Systems by Control Method

Prasad, Ram Pravesh Univ. of Delhi, Delhi

Abstract: In this paper, we discuss the chaos synchronization and hybrid chaos synchronization of identical Hyperchaotic Wang systems by active nonlinear control method. The sufficient condition for achieving the stability results are derived by using Lyapunov stability theory. Since the Lyapunov exponents are not required for these calculations, the active control method is very effective for achieving chaos synchronization and hybrid chaos synchronization and numerical simulations shows the effectiveness of the proposed method.

▶ CP-Tu-D-64-3 14:10–14:30

The Kalman-Yakubovich-Popov Lemma for Differential-Algebraic Systems

Voigt, Matthias Technische Universität Berlin

Abstract: The Kalman-Yakubovich-Popov lemma is a popular result that is typically used, e.g., to assess the feasibility of linear-quadratic optimal control problems or to characterize dissipativity of a linear system. We present an extension of this result to differential-algebraic equations by dropping typical restrictions that are made in the available literature. A powerful tool used for the derivation is a new condensed form of the system under feedback equivalence.

▶ CP-Tu-D-64-4 14:30–14:50

Constrained Controllability of Neutral Fractional Integrodifferential Systems

Shanmugam, Divya Bharathiar Univ., Coimbatore, Tamilnadu

Abstract: In this paper, we formulate the linear and nonlinear neutral fractional Volterra's integro-differentialsystem with prescribed control variables and investigate the controllability condition for the steering process which can be accomplished using continuous controls with arbitrary prescribed initial and final values. Such kind of problems involve a number of problems on complex media. For example, the Volterra's model for population growth of a species within a closed system is characterized by a nonlinear fractional integro-differential equation [1]. Sufficient conditions for the controllability results of fractional dynamical systems are obtained using the contraction mapping principle and the controllability Grammian matrix which defined by the Mittag-Leffler matrix function. Further, the main results and hypothesis of the paper are validated using the example. References [1] H. Xu, Analytical approximations for population growth model with fractional order, Communications in Nonlinear Science and Numerical Simulation 14, (1978- 1983) 2009.

▶ CP-Tu-D-64-5 14:50–15:10

Numerically Efficient Algorithm to Check Controllability and Computing Controllability Indices

Khare, Swanand Indian Inst. of Tech. Kharagpur

Abstract: In this paper, we propose a numerically efficient algorithm to check whether a given system described by the pair (A;B) is controllable. In order to do so we construct a sequence of structured matrices from the pair (A;B). We prove an equivalent criterion to the controllability of the pair (A;B) in terms of nullity of an appropriate matrix in this sequence. We propose a numerical method involving QR decomposition of this structured matrix to check its rank. We can perform these computations efficiently because of the special structure of this matrix. We show that the computational complexity of this procedure is comparable to the computational complexity of checking controllability using classical controllability matrix approach. We further prove a relation between nullities of structured matrices in the sequence and the controllability indices associated with the pair (A;B). We illustrate the results through numerical examples.

▶ CP-Tu-D-64-6 15:10–15:30

Controllability of Nonlinear Neutral Fractional Integrodifferential Systems with Distributed Delays in Control

Balachandran, Krishnan Bharathiar Univ.

Abstract: Many models in various fields of science and engineering are represented by fractional differential equations. One of the important qualitative properties of a dynamical system is controllability which means that it is possible to steer any initial state to any final state of the system in finite time using an admissible control. In many applications delays are inherent in control and more specifically, models with distributed delays in control occur in the study of agricultural economics and population dynamics. A simplified model for compartmental systems with pipes is represented by neutral Volterra integrodifferential equations which can be remodeled as neutral fractional Volterra integrodifferential equations. In this paper, we establish sufficient conditions for the controllability of nonlinear neutral fractional Volterra integrodifferential systems with distributed delays in control. The results are obtained by using the Mittag-Leffler function and the Schauder fixed point theorem.

CP-Tu-D-65 13:30–15:30 105

Optimization and Operations Research

Chair: Osinuga, Idowu Ademola FEDERAL Univ. OF AGRICULTURE, ABEOKUTA

Abstract:

▶ CP-Tu-D-65-1 13:30–13:50

Comparison of Norms for Facility Location Problem on Planar Surfaces

Osinuga, Idowu Ademola FEDERAL Univ. OF AGRICULTURE, ABEOKUTA

Abstract: The facility location problem is the task of optimally placing a given number of facilities in a certain subset of the plane. In this paper, we consider the planar facility location problem with Euclidean metrics, the rectangular metrics and the lift metrics to solve to provable optimality. We present computational results of sample problems, as well as compare the objective values resulting from the modified Weizfeld's approach.

▶ CP-Tu-D-65-2 13:50–14:10

A Solid Transportation Model with Product Blending and Parameters as Rough Variables

Kundu, Pradip Indian Inst. of Sci. Education & Research Kolkata, India

Abstract: A practical solid transportation problem with product blending is Introduced. This problem is formulated such a way, that raw materials from different sources with different quality are to be transported to some destinations so that the materials received at each destination can be blended together into final product to meet minimum quality requirement. Also the problem is formulated with the transportation parameters as rough variables. We construct rough chance-constrained programming model to solve the

▶ CP-Tu-D-65-3 14:10–14:30

A New Strategy for Restarting Conjugate Gradient Methods

Al-Baali, Mehiddin Sultan Qaboos Univ.

Abstract: The conjugate gradient class of methods for large-scale unconstrained optimization will be analyzed, based on exact and inexact line search frameworks. To rectify certain drawbacks of these methods, a new strategy for restarting the iteration of any conjugate gradient method will be considered to enforce the known descent property for the method. Hence, the practical global convergence result of Al-Baali, for the Fletcher-Reeves method with inexact line search, will also be extended to other known conjugate gradient methods. Numerical results will be described to illustrate the behavior of certain members of the class of methods (in particular, that of Fletcher-Reeves and Polak-Ribière). It will be shown that the proposed strategy works better than that of Powell and Gilbert and Nocedal in several cases.

▶ CP-Tu-D-65-4 14:30–14:50

Globalizing Stabilized SQP by Smooth Primal-dual Exact Penalty Function

Solodov, Mikhail IMPA

Abstract: An iteration of the stabilized sequential quadratic programming method (sSQP) consists in solving a certain quadratic program in the primal-dual space, regularized in the dual variables. The advantage with respect to the classical sequential quadratic programming (SQP) is that no constraint qualifications are required for fast local convergence (i.e., the problem can be degenerate). In particular, for equality-constrained problems the superlinear rate of convergence is guaranteed under the only assumption that the primal-dual starting point is close enough to a stationary point and a noncritical Lagrange multiplier pair (the latter being weaker than the second-order sufficient optimality condition). However, unlike for SQP, designing natural globally convergent algorithms based on the sSQP idea proved quite a challenge and, currently, there are very few proposals in this direction. For equality-constrained problems, we suggest to use for the task linesearch for the smooth two-parameter exact penalty function, which is the sum of the Lagrangian with squared penalizations of the violation of the constraints and of the violation of the Lagrangian stationarity with respect to primal variables. Reasonable global convergence properties are established. Moreover, we show that the globalized algorithm preserves the superlinear rate of sSQP under the weak conditions mentioned above. We also present some numerical experience on a set of degenerate test problems. One of the important conclusions is that, when far from the solution, development of some modifications of the sSQP direction/subproblem itself appears to be needed to improve performance.

▶ CP-Tu-D-65-5 14:50–15:10

Prey Predator Algorithm with Adaptive Step Length
Tilahun, Surafel — Univ. of KwaZulu-Natal
Melese, Silieshi — Univ. KwaZulu-Natal

Abstract: Prey predator algorithm is one of the recently developed meta-heuristic optimization algorithm which mimics the interaction between a predator and prey. Randomly generated feasible solutions will be assigned as a predator, a best prey and ordinary prey based on their performance in the objective function. The updating is done in such a way that the predator run after the weak prey, a prey with worst performance, and also will explore the solution space to scare and urge the other solutions to explore the solution space. The best prey will perform a local search only whereas the other prey tend to follow better prey and also run away from the predator. The algorithm parameter includes a step length for local search, another relatively bigger step length for exploration and probability of follow-up which guides if an ordinary prey should follow better solutions or run as far as possible from the predator. The improvement of the performance of the best prey decreases as it approaches a solution due to the step length become larger than the distance between the nearest solution and the best prey itself. Hence in order to come over this problem, in this paper the step length for local search will be made adaptive which will vary through iteration so that the quality of the final solution will be improved compared to a fixed step length for local search, which means with adaptive step length the probability of improvement will be larger when the best solution approaches the nearest optimal solution. A simulation result on selected benchmark problems shows that having adaptive step length improves the quality of the final solutions.

▶ CP-Tu-D-65-6 — 15:10–15:30
A Case Study on Land Allocation Planning of Seasonal Crops Using Multiobjective Fuzzy Chance Constrained Programming:
Biswas, Animesh — Univ. of Kalyani
Modak, Nilkanta — Univ. of kalyani

Abstract: In this article a fuzzy multiobjective chance constrained programming model is developed using fuzzy goal programming for solving land allocation problems of seasonal crops. Optimization of production as well as expenditure for seasonal crops are taken as objectives keeping view in proper utilization of total cultivating land and different farming resources which are expressed in the form of fuzzy numbers and fuzzy random variables. In the solution process, fuzzy probabilistic model is converted into an equivalent multiobjective programming model using chance constrained programming in fuzzy environment with the help of α –cut and decomposition theorem. Then, fuzzy goal programming technique is used to achieve the highest degree of the membership goals by minimizing under deviational variables in the decision making environment. The potential use of this methodology is illustrated through a case example of land allocation problem of seasonal crops in a district.

MS-Tu-D-66 — 13:30–15:30 — VIP4-3
Recent Advances of Sparse Optimization in Signal Processing
Organizer: Liu, Ya-Feng — Acad. of Mathematics & Sys. Sci., Chinese Acad. of Sci.

Abstract: In recent years, there has been an increasing merge of sparse optimization, signal processing, wireless communications, information theory, machine learning, data mining, and statistics. This minisymposium addresses the interdisciplinary topics of sparse optimization and its various applications to signal processing. The goal of this minisymposium is to give an introduction to recent advances of sparse optimization theory, algorithms, applications, as well as emerging challenges. The speakers shall particularly talk about recent interesting applications of sparse optimization techniques to solve problems arising from signal processing, wireless communications, and information theory.

▶ MS-Tu-D-66-1 — 13:30–14:00
To Prove or to Disprove: Information Inequalities and Sparse Optimization
Tan, Chee Wei — City Univ. of Hong Kong

Abstract: To prove or disprove an information inequality is a crucial step in the coding theorems of networks. When networks scale up, this is a computationally difficult task. We show how the framework of linear information inequalities by R. Yeung can be used to explicitly construct the shortest proof of an information inequality or the smallest counterexample to disprove it if the inequality is not true in general, and automate these tasks by cloud computing.

▶ MS-Tu-D-66-2 — 14:00–14:30
Sparse Beamforming for Cloud Radio Access Network
Yu, Wei — Univ. of Toronto

Abstract: We consider a wireless cloud radio access network (C-RAN) in which the base-stations are connected to a central computing cloud with high-capacity backhaul links and jointly beamform to the user terminals. We illustrate the role of sparse optimization in the network utility maximization problem over design variables including the transmission powers, beamformers, backhaul capacity allocation, and user scheduling.

▶ MS-Tu-D-66-3 — 14:30–15:00
Flexible ADMM for Block Structured Convex and Nonconvex Optimization
Hong, Mingyi — Iowa State Univ.

Abstract: The alternating direction method of multipliers (ADMM) is a very popular algorithm for solving large-scale optimization problems, convex or nonconvex, in many engineering fields. Key applications include signal processing, large-scale wireless networking, big data optimization, energy systems and so on. In this talk we discuss a flexible framework for ADMM type algorithm, and present theoretical analysis of these algorithms for both convex and nonconvex problems.

▶ MS-Tu-D-66-4 — 15:00–15:30
EXTRA: An Exact First-Order Algorithm for Decentralized Consensus Optimization
Ling, Qing — Univ. of Sci. & Tech. of China

Abstract: We propose EXTRA, an EXact firsT-oRder Algorithm to solve the decentralized consensus optimization problem where a network of agents collaboratively find the minimizer of their aggregate objective function while each agent can only communicate with its neighbors. EXTRA has the best known convergence rates among the existing first-order decentralized algorithms for minimizing convex differentiable functions.

EM-Tu-E-01 — 16:00–18:30 — 311A
Third Workshop on Hybrid Methodologies for Symbolic-Numeric Computation - Part IV of VIII
For Part 1, see EM-Mo-D-01
For Part 2, see EM-Mo-E-01
For Part 3, see EM-Tu-D-01
For Part 5, see EM-We-D-01
For Part 6, see EM-We-E-01
For Part 7, see EM-Th-BC-01
For Part 8, see EM-Th-D-01
Organizer: Giesbrecht, Mark — Univ. of Waterloo
Organizer: Kaltofen, Erich — North Carolina State Univ.
Organizer: Safey El Din, Mohab — Univ. Pierre & Marie Curie
Organizer: Zhi, Lihong — Acad. of Mathematics & Sys. Sci.
Abstract: Hybrid symbolic-numeric computation methods, which first appeared some twenty years ago, have gained considerable prominence. Algorithms have been developed that improve numeric robustness (e.g., in quadrature or solving ODE systems) using symbolic techniques prior to, or during, a numerical solution. Likewise, traditionally symbolic algorithms have seen speed improvements from adaptation of numeric methods (e.g., lattice reduction methods). There is also an emerging approach of characterizing, locating, and solving “interesting nearby problems”, wherein one seeks an important event (for example a nontrivial factorization or other useful singularities), that in some measure is close to a given problem (one that might have only imprecisely specified data). Many novel techniques have been developed in these complementary areas, but there is a general belief that a deeper understanding and wider approach will foster future progress. The problems we are interested are driven by applications in computational physics (quadrature of singular integrals), dynamics (symplectic integrators), robotics (global solutions of direct and inverse problems near singular manifolds), control theory (stability of models), and the engineering of large-scale continuous and hybrid discrete-continuous dynamical systems. Emphasis will be given to validated and certified outputs via algebraic and exact techniques, error estimation, interval techniques and optimization strategies.
Our workshop will follow up on the seminal SIAM-MSRI Workshop on Hybrid Methodologies for Symbolic-Numeric Computation held in November 2010 and the Fields Institute Workshop on Hybrid Methodologies for Symbolic-Numeric Computation, November 16-19, 2011 at the University of Waterloo, Canada. We will provide a forum for researchers on all sides of hybrid symbolic-numeric computation.

▶ EM-Tu-E-01-1 — 16:00–16:30
Approximate Polynomial Smith Decomposition
Lichtblau, Daniel — Wolfram Research

Abstract: There is considerable literature for effectively computing the Smith

decomposition of a univariate polynomial matrix. This has applications in many areas and, in particular, finds use in computational control theory. The literature has by and large assumed the entries are exact, that is, polynomial coefficients are integer or rational numbers. This is far from the situation encountered in practice. In this talk I describe how to obtain viable results from low precision input.

▶ EM-Tu-E-01-2 16:30–17:00

A Hybrid Approach for the Center-focus Problem

Hauenstein, Jonathan Univ. ot Notre Dame

Abstract: For systems of differential equations, one often investigates stability. The center-focus problem aims to compute conditions on the parameters to distinguish between a center and a local focus. We developed a hybrid symbolic-numerical approach and used it to obtain center conditions for a three-dimensional system of differential equations, which was previously not possible using traditional, purely symbolic computational techniques.

▶ EM-Tu-E-01-3 17:00–17:30

Connectivity Queries on Space Curves

Schost, Eric Western Univ.

Abstract: Given two points in a real algebraic set, the motion planning problem consists in building a continuous path connecting them, if possible.
Canny introduced a "roadmap algorithm" that reduces this general question to a problem in dimension one: testing whether two points on a space curve can be connected. This talk focuses on the latter problem. I will describe ongoing work aiming at performing these dimension-one connectivity queries in an efficient manner.

▶ EM-Tu-E-01-4 17:30–18:00

The Nearest Polynomial with Two or More Given Zeros

Sekigawa, Hiroshi Tokyo Univ. of Sci.

Abstract: For a given real polynomial f and two or more given zeros, we consider a problem of describing the distance between f and the nearest polynomial $\tilde{f}$ to f having given zeros. Here, the distance is measured by a norm of the vector of coefficients of $\tilde{f} - f$.

▶ EM-Tu-E-01-5 18:00–18:30

Certifying and Computing the Simple Zeros of Over-determined Polynomial Systems.

Cheng, Jin-San Chinese Acad. of Sci.

Abstract: In this talk, I will present a method to certify and compute numerically the simple zeros of an over-determined polynomial system.

EM-Tu-E-02 16:00–18:00 309A

Differential Algebra and Related Topics - Part IV of VIII

For Part 1, see EM-Mo-D-02
For Part 2, see EM-Mo-E-02
For Part 3, see EM-Tu-D-02
For Part 5, see EM-We-D-02
For Part 6, see EM-We-E-02
For Part 7, see EM-Fr-D-02
For Part 8, see EM-Fr-E-02

Organizer: Feng, Ruyong Acad. of Mathematics & Sys. Sci.,CAS
Organizer: Guo, Li Rutgers Univ. at Newark, USA
Organizer: Gao, Xiao-Shan Acad. of Mathematics & Sys. Sci., Chinese Acad. of Sci.

Abstract: This meeting is to offer an opportunity for participants to present original research , to learn of reserch progress and new developments on differential algebra and related topics, particularly, the applications of differential algebra to control theory, physics, chemistry, biology and so on.

▶ EM-Tu-E-02-1 16:00–16:30

Rota-Baxter Algebras and Quantum Algebras

Jian, Run-Qiang Dongguan Univ. of Tech.

Abstract: In this talk, we will provide some relations between Rota-Baxter algebras and quantum algebras. We will discuss constructions of Rota-Baxter algebras from quantum algebras including quantum quasi-shuffle algebras and quantum groups. We will establish representations of quantum quasi-shuffle algebras from Rota-Baxter algebras as well. As an application, we will give an new approach of multiple q-zeta values from this point of view.

▶ EM-Tu-E-02-2 16:30–17:00

On Integral-differential Algebras

Gao, Xing Lanzhou Univ.
Guo, Li Rutgers Univ. at Newark, USA
Rosenkranz, Markus Univ. of Kent
Zheng, Shanghua Lanzhou Univ.

Abstract: In this talk, we introduce integral-differential algebras. By using the method of Grobner-Shirshov bases, we give the constructions of free commutative integro-differential algebras and free non-commutative integro-differential algebras.

▶ EM-Tu-E-02-3 17:00–17:30

Rings of Partial Rota-Baxter Operators: An Algebraic Approach to the Linear Substitution Rule

Rosenkranz, Markus Univ. of Kent
Gao, Xing Lanzhou Univ.
Guo, Li Rutgers Univ. at Newark, USA

Abstract: We set up an algebraic theory of multivariable integration, based on a hierarchy of Rota-Baxter operators and an action of the matrix monoid as linear substitutions. Given a suitable coefficient domain with a bialgebra structure, this allows us to build an operator ring that acts naturally on the given Rota-Baxter hierarchy. We conjecture that the operator relations are a noncommutative Groebner basis for the ideal they generate.

▶ EM-Tu-E-02-4 17:30–18:00

Classification of Rota-Baxter Type Operators

Guo, Li Rutgers Univ. at Newark, USA

Abstract: A long standing problem of Rota asks for the classification of all algebraic identities that can be satisfied by linear operators on algebras. In a previous work, we consider Rota's problem for differential type operators. In this talk we discuss Rota's problem for Rota-Baxter type operators and relate it to rewriting systems and Groeber-Shirshov bases. This is a joint work with Xing Gao, William Sit and Shanghua Zheng.

MS-Tu-E-03 16:00–18:00 306A

Applied Integrable Systems - Part IV of V

For Part 1, see MS-Mo-D-03
For Part 2, see MS-Mo-E-03
For Part 3, see MS-Tu-D-03
For Part 5, see MS-We-D-03

Organizer: Hu, Xing-Biao Inst. of Computational Mathematics, Chinese Acad. of Sci. (CAS), China
Organizer: Kajiwara, Kenji Kyushu Univ.
Organizer: Kakei, Saburo RIkkyo Univ.
Organizer: Maruno, Kenichi Waseda Univ.

Abstract: In recent years, there have been major developments in applications of integrable systems. Originally, integrability has been recognized through solitons, which are particle-like nonlinear waves in various physical systems. Thanks to rich mathematical structure of integrable systems, recent applications of integrable systems extend to a wide range of pure/applied mathematics and physical sciences, such as algebraic geometry, combinatorics, probability theory, numerical algorithms, cellular automata, (discrete) differential geometry, computer visualizations, statistical physics, nonlinear physics and so on. The purpose of this minisymposium is to bring together researchers to discuss recent advances on various aspects of applied integrable systems.

▶ MS-Tu-E-03-1 16:00–16:30

Integrability Detectors in Discrete Systems

Kilkothur Munirathinam, K.M.Tamizhmani Pondicherry Univ.

Abstract: In this talk, we discuss about two integrability detectors, namely, singularity confinement approach and algebraic entropy method.for discrete systems.The power of these methods are demonstrated by deriving discrete Painleve equations and linearizable systems.

▶ MS-Tu-E-03-2 16:30–17:00

Integrability Test in Terms of Co-prime Condition of the Discrete Dynamical Systems

Masataka, Kanki Univ. of Tokyo

Abstract: We propose a so-called "co-prime condition", which can be used as one of the integrability criteria for discrete equations. We re-formulate the famous "singularity confinement test" in an algebraic manner by focusing on the appearance of common factors between the iterates of the given equations. We also give an application of the co-prime condition to obtaining the algebraic entropy of the systems.

▶ MS-Tu-E-03-3 17:00–17:30

Nonsingular rational solutions to several nonlinear models

Hu, Xing-Biao Inst. of Computational Mathematics, Chinese Acad. of Sci. (CAS), China

Abstract: In the literature, there have been considerable interests in the s-

tudy of nonsingular rational solutions for nonlinear models.These nonsingular rational solutions have appeared with different names in a variety of nonlinear systems. In some cases, these nonsingular rational solutions are named as algebraic solitons or algebraic solitrary waves. The typical examples are the BO equation and modified KdV equation. For the KPI equation, the corresponding nonsingular rational solutions are called lump solutions. More importantly, these nonsingular rational solutions have played a key role in the study of rogue waves.
In the talk, we will give some other examples of nonlinear models which exhibit nonsingular rational solutions.

IM-Tu-E-04 16:00–18:00 308
Mathematics and Algorithms in Computer-Aided Manufacturing, Manufacturing Systems and Numerical Control - Part IV of VI
For Part 1, see IM-Mo-D-04
For Part 2, see IM-Mo-E-04
For Part 3, see IM-Tu-D-04
For Part 5, see IM-We-D-04
For Part 6, see IM-We-E-04
Organizer: Li, Hongbo Acad. of Mathematics & Sys. Sci., Chinese Acad. of Sci.
Organizer: Shpitalni, Moshe Technion, Israel
Abstract: The fast development of advanced manufacturing technology has witnessed the growing importance of mathematical methods and algorithms, ranging from algebraic geometry, discrete geometry and differential geometry to differential equations, computational mathematics and computer mathematics. Conversely, problems arising from the field of advanced manufacturing have also stimulated the development of such branches in pure and applied mathematics as computational geometry and mathematics mechanization.
Mathematics and Algorithms for Computer-Aided Manufacturing, Engineering and Numerical Control is intended to be an interdisciplinary forum focusing on the interaction between the side of mathematical methods and algorithms, and the other side of computer-aided manufacturing (CAM), computer-aided engineering (CAE) and computer numerical control (CNC). It concentrates on (but is not restricted to) the following topics: tool path planning, multiscale simulation, feature-based process chain with CAM/CNC coupling, interpolation for CNC controllers.
The proposed industrial mini-symposium of 20 talks will provide an excellent platform for the participants to get acquainted with new research results, to exchange new ideas, and to create new collaboration.
To ensure full success of the proposed mini-symposium, we have invited 8 speakers from abroad. All are knowledgeable world experts in their fields, with impressive records of research, publications and awards, as well as solid background of mathematics. The invited speakers are from various countries and represent different aspects in Manufacturing, Manufacturing Systems and Computer Numerical Control.

▶ IM-Tu-E-04-1 16:00–16:45
Scripted Geometry Processing for Manufacturing
Grandine, Thomas The Boeing Company
Abstract: Manufacturing process planning frequently requires complex geometric computations to be performed. Milling requires tool path generation while composite tape deposition requires calculation of geodesics and geodesic offsets. Frequently, the calculations required are specific to particular combinations of machine tool, part, and tool tip. Moreover, achieving high performance can lead to complex trajectory optimization problems. This talk presents a general framework for organizing these computations so that they can be scripted in very high-level ways.

▶ IM-Tu-E-04-2 16:45–17:30
Research on Key Technologies of Wafer Stage of Lithography
Zhu, Yu Department of Mechanical Engineering, Tsinghua Univ.
Abstract: Nanometer-level synchronized movement accuracy is the key factor to guarantee the pattern transfer with high fidelity for wafer stage of lithographic tool. It's highly challengeable with the IC technology node shrinking. This report mainly talks about the achievement of nanometer-level motion accuracy of a wafer stage from mechanics, six degree of freedom of ultra-precision measurement and multi-axis synchronized motion control. Finally, the progress of the wafer stage developed by Tsinghua is introduced.

▶ IM-Tu-E-04-3 17:30–18:00
Structural Optimization Based on Eigen-Mode Analysis for 3D Printing
Yang, Zhouwang Univ. of Sci. & Tech. of China
Abstract: In this paper, we propose a novel solution to the structural optimization problem that provides minimal deformation of the frame structure under various distributions of force. Such a solution is obtained in two steps. First, we perform an eigen-mode analysis to find the greatest deformation for all normalized distribution of force. Second, we vary the the design variables of the frame structure to minimize the deformation.

MS-Tu-E-05 16:00–18:00 215
Insights from Mathematical Models into Disease Dynamics and Assessment of Control Strategies
Organizer: Pawelek, Kasia Univ. of South Carolina Beaufort
Organizer: Liu, Shengqiang Harbin Inst. of Tech.
Abstract: This mini-symposium will focus on mathematical modeling of human infections caused by various pathogens. Mathematical models represent an important tool in preparation for disease outbreaks and evaluation of control strategies. Talks will consist of mathematical analysis of local and global stability of models based on the ordinary and delay differential equations. Designed models will also be validated by comparison with the surveillance data and abatement strategies will be assessed. Presentations will highlight insights from mathematical models to the disease epidemics and showcase collaborative and interdisciplinary research.

▶ MS-Tu-E-05-1 16:00–16:30
Modeling Dynamics of Mosquito Populations and Assessing Abatement Strategies for West Nile Virus
Pawelek, Kasia Univ. of South Carolina Beaufort
Abstract: West Nile virus (WNV) is a vector-borne pathogen spread by mosquitoes throughout the continental U.S. and other regions of the world. We designed a mathematical model, based on the system of ODEs, and compared it with surveillance data to obtain more reliable disease outbreak predictions and performed numerical simulations to find optimal control strategies of mosquito population to lower the possibility of WNV transmission.

▶ MS-Tu-E-05-2 16:30–17:00
Modeling and Evaluating Entry-exit Screening Measures on the Spread and Control of Infectious Diseases
Liu, Shengqiang Harbin Inst. of Tech.
Abstract: A multi-patch epidemic model is formulated to investigate the long-term impact of entry-exit screening measures on the spread of infectious diseases. A threshold dynamics determined by the basic reproduction number is established. As an application, several screening strategies are explored to examine the impacts of screening on the control of the 2009 influenza A (H1N1) Pandemic.

▶ MS-Tu-E-05-3 17:00–17:30
The Impact of Resource and Temperature on Malaria Transmission
Hui, Wan Nanjing Normal Univ.
Abstract: In this talk, we extend the famous Ross's model to establish a new model for malaria to incorporate the impact of blood meal resource for mosquitoes and temperature on the transmission of malaria. It is shown that with the new mosquito growth rate, the transmission dynamics of malaria becomes more complex and the Hopf bifurcation may occur which induces sustained oscillations not only in the mosquito population but also in the infected human.

▶ MS-Tu-E-05-4 17:30–18:00
A Within-host Virus Model with Multiple Infected Stages under Time-varying Environments
Xia, Wang Shaanxi Normal Univ.; Xinyang Normal Univ.
Liu, Shengqiang Harbin Inst. of Tech.
Abstract: In this paper, we propose a within-host virus model with multiple stages for infected cells under time-varying environments, to study how the multiple infected stages affect on the counts of viral load and CD4+ T cells. We establish the sufficient conditions for both permanence and extinction of the system based on two positive constants R_*, R^*; Furthermore, numerical simulations are carried out to verify our analytical results.

MS-Tu-E-06 16:00–18:00 201
Divergence-free elements, grad-div stabilization, and related methods for incompressible flow problems - Part II of II
For Part 1, see MS-Tu-D-06
Organizer: Linke, Alexander Weierstrass Inst.
Organizer: John, Volker Weierstrass Inst.
Organizer: Rebholz, Leo Clemson Univ.
Abstract: Description In recent years, great progress has been achieved in

the construction and understanding of divergence-free methods for incompressible flow problems, and in understanding the role of related stabilization methods for mixed finite elements like the grad-div stabilization. Especially, a lack of robustness of classical mixed methods with respect to large irrotational forces makes divergence-free methods appear attractive. The idea of the minisymposium is to gather researchers from around the world, who are active in this field, in order to discuss new ideas and to reflect on possible application fields, where divergence-free methods could outperform classical discretization approaches.

▶ MS-Tu-E-06-1 16:00–16:30

Stokes Elements Yielding Divergence–free Approximations

Neilan, Michael Univ. of Pittsburgh

Abstract: We construct conforming finite element spaces for the Stokes and Navier–Stokes problem in two and three dimensions that yield divergence–free velocity approximations. The derivation of the finite element pairs is motivated by a smooth de Rham complex that is well–suited for the Stokes problem. We discuss the stability and convergence properties of the new elements and outline the construction of reduced elements that have fewer unknowns.

▶ MS-Tu-E-06-2 16:30–17:00

Three Dimensional Simplicial Elements for Stokes That Produce Divergence Free Velocities

Guzman, Johnny Brown Univ.

Abstract: We define three dimensional stokes elements in three dimensions. We supplement piecewise polynomial basis functions of the velocity by rational functions that are divergence free. This is joint work with Michael Neilan.

▶ MS-Tu-E-06-3 17:00–17:30

Robust Arbitrary Order Mixed Finite Element Methods for the Incompressible Stokes Equations

Matthies, Gunar TU Dresden
Linke, Alexander Weierstrass Inst.
Tobiska, Lutz Otto-von-Guericke Univ.

Abstract: We present a novel approach for constructing inf-sup stable mixed finite element methods of arbitrary order which deliver optimal and pressure-independent velocity errors for both conforming and nonconforming velocity approximations in 2d and 3d. The approach replaces discretely divergence-free test functions in some operators of the weak formulation by divergence-free ones. Optimal L2 error estimates for the pressure are given. Several numerical examples illustrate the results.

▶ MS-Tu-E-06-4 17:30–18:00

Recent Advances in Isogeometric Divergence-Conforming Discretizations for Computational Fluid Dynamics

Evans, John Univ. of Colorado Boulder

Abstract: In this talk, I will discuss several recent advances in isogeometric divergence-conforming discretizations for computational fluid dynamics. These includes: (i) divergence-conforming multiscale modeling for incompressible turbulent flow, (ii) divergence-conforming discretizations for fluid-structure interaction, and (iii) divergence-conforming discretizations for incompressible magnetohydrodynamics. I will discuss the mathematical properties of the aforementioned technologies with an emphasis on structure preservation of physical balance laws, and I will present illustrative numerical results.

MS-Tu-E-07 16:00–18:00 202A

Sparsity-promoting seismic data analysis - Part I of II

For Part 2, see MS-We-D-07

Organizer: Ma, Jianwei Harbin Inst. of Tech.
Organizer: Fomel, Sergey The Univ. of Texas at Austin

Abstract: The objective of this high-level mini-symposia is to bring international experts in geophysics and applied mathematics together to present their recent research work, to exchange ideas, and to develop new visions for the future of the area. The mini-symposia will focus on the sparsity-promoting seismic data analysis. The invited speakers are all well-known experts from the fields of exploration geophysics, optimization, harmonic analysis and computing methods. The mini-symposia will provide an opportunity for participants both from university and industry to share information and experiences, and a platform for their research collaboration.
We are also submitting the list of speakers (including eight professors from MIT, Stanford, etc) and titles of their presentations. The mini-symposia could include two sessions.

▶ MS-Tu-E-07-1 16:00–16:30

Sparse Decomposition of Seismic Data Using Regularized Non-stationary Regression

Fomel, Sergey The Univ. of Texas at Austin

Abstract: Seismic wave propagation in the Earth is strongly affected by frequency attenuation. In addition, seismic data exhibit variations in local slope, which can be described using multidimensional non-stationary spectral analysis. I will describe some recent applications of time-frequency decompositions and local slope decompositions and recently developed time-frequency analysis techniques, involving regularized non-stationary regression. A particularly sparse representation of multidimensional seismic data can be achieved by combining slope decompositions with the seislet transform.

▶ MS-Tu-E-07-2 16:30–17:00

Regularization of the Inverse Scattering Problem Using Shearlet Frames

Kutyniok, Gitta Technische Universität Berlin
Mehrmann, Volker TU Berlin
Petersen, Philipp Technische Universität Berlin

Abstract: In this talk, our focus will be on regularization techniques for the numerical solution of inverse scattering problems in two space dimensions. Assuming that the boundary of a scatterer is its most prominent feature, we exploit as model the class of cartoon-like functions. Since functions in this class are asymptotically optimally sparsely approximated by shearlet frames, we consider shearlets as a means for regularization. We will discuss both theoretical results and numerical experiments.

▶ MS-Tu-E-07-3 17:00–17:30

Sparsity Representation of Seismic Data by Asymmetric Chirplet Transform

Ma, Jianwei Harbin Inst. of Tech.

Abstract: we use the Asymmetric Gaussian Chirplet Model (AGCM) to establish a dictionary free variant of the Orthogonal Matching Pursuit (OMP), a Greedy algorithm for sparse approximation of seismic data. The element atoms of AGCM, so-called chirplets, display oneside oscillation-attenuation properties, which make the AGCM very suitable for sparse representation of absorption decay seismic signals. The model parameters such as envelope amplitude and arrival-time will be useful to processing and interpretation of the seismic data.

▶ MS-Tu-E-07-4 17:30–18:00

Sparse Deconvolution of Seismic Data with A Regularized Norm Ratio

Repetti, Audrey Univ. of Paris-Est
Pham, Mai Quyen IFP Energies nouvelles
Duval, Laurent IFP Energies nouvelles
Chouzenoux, Emilie Univ. of Paris-Est
Pesquet, Jean-Christophe Univ. of Paris-Est

Abstract: Sparse blind seismic deconvolution aims at jointly estimating an unknown sparse signal (reflectivity) and an unknown impulse response (seismic wavelet). The main difficulty stems from the non-uniqueness of the solutions. They may be regularized by sparsity enforcing norm ratios (Gray, 1978) which are non convex. In this work, we propose an alternating preconditioned method, based on forward-backward iterations, to solve this type of problem, involving a regularized norm ratio, assorted with theoretical convergence results.

MS-Tu-E-08 16:00–18:00 202B

Inverse Problems for Medical Imaging - Part II of II

For Part 1, see MS-Tu-D-08

Organizer: Lee, Eunjung Yonsei Univ.
Organizer: Song, Yizhuang Shandong Normal Univ.

Abstract: This minisymposium focuses on imaging methodologies, mathematical models, and computational algorithms on inverse problems for biomedical applications. The imaging problems in this topic can be formulated as inverse problems that are intrinsically nonlinear. Experiences over the last three decades showed that symbiotic interplay among theoretical mathematics, computational mathematics, and experiments is crucial for understanding and solving these nonlinear problems in practice. With this minisymposium we hope to introduce inverse problems related to biomedical applications, to show how a various methods can solve them, and to present new schemes to solve these inverse problems.

▶ MS-Tu-E-08-1 16:00–16:30

Depth Formula in Anomaly Detection Using EIT: Independent on Anomaly Size and Admittivity Contrast

Lee, Eunjung Yonsei Univ.

Abstract: X-ray mammography is currently the most common breast cancer diagnostic imaging technique. Both false-negative and false-positive results are recorded reasonably frequently; therefore, there is great demand for the development of supplemental imaging techniques. The electrical impedance tomography(EIT) is potential supplemental tool for breast cancer detection.

We consider the trans-admittance mammography system. A formula for TAM is proposed here that can estimate the depth of an anomaly independent of its size and the admittivity contrast.

▶ MS-Tu-E-08-2 16:30–17:00

Regularization Matrices Construction for Inverse Problems and Its Application on Electrical Impedance Tomography

Tiantian, Chang — Xi'an Univ. of Posts & Telecommunications

Abstract: Tikhonov regularization is a commonly used technique to solve discrete ill-posed problems, which approximate the given discrete ill-posed problem by a penalized least-squares problem, and the penalization term is defined by a regularization matrix, whose choice may affect the quality of the computed solution significantly. Several regularization matrices construction methods were discussed here, and electrical impedance tomography was induced for performance evaluation based on different regularization matrices.

▶ MS-Tu-E-08-3 17:00–17:30

Discrete Flow Measurement Based on Markov Process

Yue, Shihong — Tianjin Univ.
Zhang, Hao — tianjin Univ.
Zhang, Yujing — tianjin Univ.

Abstract: Currently an electromagnetic flowmeter often is needed in working in a battery powered state, and thus the original measuring values has to be decomposed into a series of discrete measurements to keep the applicable time of the battery. To reconstruct the original measuring values by these existing discrete measurements, a Markov prediction method is introduced based on the theory of electromagnetic flow measurement.

▶ MS-Tu-E-08-4 17:30–18:00

Reconstruction of Blood Flow Velocity in Left Ventricle Using Doppler Ultrasound

Jang, Jaeseong — Yonsei Univ.

Abstract: Although Doppler echocardiography is a powerful method to observe the blood flow in LV, its 1-dimensional information is limited to observe the vortex structure of blood flow in LV. In this paper, reconstruction model is designed by combining the measured data with Navier-Stokes equation. To reduce computational cost, we deal with the Navier-Stokes equations in various ways. The reconstruction method is applied to a synthetic Doppler measurement in order to reconstruct the corresponding synthetic flow.

MS-Tu-E-09 16:00–18:30 203A

Nonlocal problems: modeling, analysis and computation - Part I of III

For Part 2, see MS-We-D-09
For Part 3, see MS-We-E-09

Organizer: Lipton, Robert — LSU
Organizer: Du, Qiang — Columbia Univ.
Organizer: Mengesha, Tadele — The Univ. of Tennessee

Abstract: The goal of this minisymposium is to bring together researchers work- ing on problems related to the nonlocal modeling of physical phenomena and their mathematical analysis. The theme is on modeling, analysis and simulation with a focus on nonlocal continuum equations that arise from applications. The session will be multifaceted so as to cover work related nonlocal modeling and computational simulations of models, and analyti- cal and numerical aspects such as well-posedness of nonlocal stationary and evolution equations, regularity of solutions and numerical approximations.

Nonlocal mathematical models arise naturally in many important fields and they are found to be useful where classical (local) models cease to be predictive. Moreover, nonlocal models are suitable for multiscale modeling as they can be effective in capturing the underlying nonsmooth microscale fields. An example is peridynamics, a nonlocal reformulation of the basic equations of motion of continuum mechanics, which is being used to model cracks and discontinuous fields in solid mechanics. Other areas of application include image processing, modeling population aggregation, wave propaga- tion, pattern formation, and porous media flow. In this minisymposium, research works which have produced novel analytical and numerical methods for nonlocal problems will be presented.

▶ MS-Tu-E-09-1 16:00–16:30

Incorporating Local Boundary Conditions into Nonlocal Theories

Aksoylu, Burak — TOBB Univ. of Economics & Tech.

Abstract: We study nonlocal wave equations on bounded domains related to peridynamics. We generalize the standard integral based convolution to an abstract convolution operator defined by a Hilbert basis. This operator is a function of the classical operator which allows us to incorporate local boundary conditions into nonlocal theories. We present a numerical study of the solutions. For discretization, we employ a weak formulation based on a Galerkin projection which allows discontinuites on element boundaries.

▶ MS-Tu-E-09-2 16:30–17:00

Peridynamics and Material Interfaces

Alali, Bacim — Kansas State Univ.
Gunzburger, Max — Florida State Univ.

Abstract: The convergence of peridynamics inside heterogeneous media in the limit of vanishing nonlocality is analyzed. It is shown that the operator of linear peridynamics diverges when material interfaces are present. A peridynamics material interface model is introduced which generalizes the classical interface model of elasticity. The model consists of a new peridynamics operator along with nonlocal interface conditions. The new peridynamics interface model converges to the classical interface model of linear elasticity.

▶ MS-Tu-E-09-3 17:00–17:30

A Coupling Strategy for Local and Nonlocal Continuum Models

D'Elia, Marta — Sandia National Laboratories

Abstract: This work presents an optimization-based method for the coupling of local and nonlocal continuum models. We formulate the coupling as a control problem where the objective is to minimize the mismatch of the local and nonlocal solutions on the overlap of their domains and the controls are volume constraints and boundary conditions. We consider local and nonlocal linear elasticity models and we provide numerical examples illustrating the accuracy and efficacy of the method.

▶ MS-Tu-E-09-4 17:30–18:00

Nonlocal Convection-diffusion Problems and Finite Element Approximations

Tian, Hao — Beijing Computational Sci. Research Center
Ju, Lili — Univ. of South Carolina
Du, Qiang — Columbia Univ.

Abstract: In this talk, we present and compare some nonlocal models for convection-diffusion problems and study their finite element approximations by piecewise constant and piecewise bilinear basis functions.Through analysis and numerical experiments, we demonstrate the advantage of the upwind model which is more consistent with the physical nature and allows more stable and robust numerical approximations. On the other hand, the central model may produce unphysical oscillations.

▶ MS-Tu-E-09-5 18:00–18:30

Diffusions, Fractional Laplacians and Traveling Waves

Gui, Changfeng — Univ. of Connecticut

Abstract: Fractional Laplacians can be used to model physical phenomena involving abnormal diffusion. In this talk, I will discuss how abnormal diffusion may affect the propagation of certain materials/species. In particular, the effects of abnormal diffusion on the existence of traveling wave will be examined. For three important classes of diffusion-reaction models with monostable, combustion and bistable nonlinearities, we will show rigorous results for abnormal diffusion and compare them with the results for the classical models.

MS-Tu-E-10 16:00–18:00 206B

Propagation, destruction and recovery dynamics for localized patterns in dissipative systems Part II

Organizer: Nishiura, Yasumasa — Tohoku Univ., WPI-AIMR
Organizer: Iima, Makoto — Hiroshima Univ.

Abstract: Spatially localized patterns arise ubiquitously in many fields including nerve systems, chemical reaction, binary fluids and bio-convection. This minisymposium especially highlights issues concerning wave-particle duality of the traveling spots, destruction of photo sensitive BZ waves, self-recovery property of multi-state network dynamics, and collective motion of self-propelled particles as well as emerging patterns in bioconvection of Euglena gracilis. All these problems are related to the interactive dynamics among the localized species and/or with external environments so that our goal is to extract the underlying common mechanism behind those variety of dynamics. In part I we will focus on the destruction and recovery properties of traveling spots and pulses in reaction diffusion systems. In part II more physical and biological aspect of localized pattern dynamics will be discussed.

▶ MS-Tu-E-10-1 16:00–16:30

Collective Motion of Rotating Self-propelled Particles Through Short-range Orientational Interaction

Nagai, Ken — JAIST

Abstract: Some species of fish are known to keep their rotating speed for a while. We investigated the role of the correlation time of the rotating speed in collective motion using the mathematical models. We found that the vortex lattice of particles are formed through the long correlation time of the rotating

speed and short-range orientational interaction. This type of collective motion was observed in the collective motion of microtubules running on a glass plate.

▶ MS-Tu-E-10-2 16:30–17:00

Chaotic Dynamics in An Integro-differential Reaction-diffusion System in the Presence of 0:1:2 Resonance

Ogawa, Toshiyuki Meiji Univ.

Abstract: The dynamics and bifurcation structure of the normal form in the presence of 0:1:2 resonance are studied. It is proved that connecting orbits exist on the normal form. In fact, by considering the Z_2 equivariant unfolding of codimension three singularities, sufficient conditions for the existence of heteroclinic cycles in a scaling family of the 0:1:2 normal form are obtained. These results give a reasonable explanation for the behaviors of the solutions to an integro-reaction-diffusion system.

▶ MS-Tu-E-10-3 17:00–17:30

Spatially Localized Structures in Systems with A Conservation Law

Knobloch, Edgar Univ. of California at Berkeley

Abstract: Systems with a conserved quantity possess a large-scale neutral mode that interacts with pattern-forming instabilities. I will discuss the effects of such a mode on the properties of spatially localized states in two hydrodynamic systems: magnetoconvection and convection in a fluid layer rotating about the vertical. The presence of this mode gives rise to three main effects, which will be explained using (nonlocal) amplitude equations valid in the vicinity of the primary pattern-forming instability.

▶ MS-Tu-E-10-4 17:30–18:00

Collective Behavior and Localized Bioconvection Patterns of Euglena Suspension Illuminated from Below

Iima, Makoto Hiroshima Univ.

Abstract: Euglena is a phototactic microorganism. Their behavioral response to light causes a spatially localized macroscopic pattern. We discuss the macroscopic patterns based on the hydrodynamic model based on the response functions that has been measured so far. The response behavior of individuals is also characterized by the directional statistics. The connection between the microscopic and macroscopic behavior is discussed.

MS-Tu-E-11 16:00–18:00 203B

Applied Mathematics Open Online: Julia, Python, Sage, OpenCourseWare, Mobile

Organizer: Strang, Gilbert MIT

Organizer: Grinfeld, Pavel Drexel Univ.

Abstract: The Internet plays a crucial part in modern applied mathematics. New languages can spread quickly. Users learn the system and test it. New code is contributed and the language is extended. The whole effort stays opensource – free to all and open for everyone to join and contribute. This minisymposium will show examples of successful and ongoing growth: Julia, Python, and Sage.

At the same time the Internet can teach applied mathematics: the central ideas and the details of specific applications. We all post slides and research papers. It is NOT difficult to prepare and stream video. The experience with ocw.mit.edu indicates a great demand worldwide for education – up to date materials that are free to the student. Those will start at school, here we stay at ICIAM level. Using mobile technology in education is a very important challenge.

▶ MS-Tu-E-11-1 16:00–16:30

Teaching Online with Video Lectures

Strang, Gilbert MIT

Abstract: I will share my experience in preparing video lectures for basic mathematics courses. Linear Algebra and also Computational Science came directly from the MIT classroom. Calculus and the new Differential Equations were filmed without students. The videos are uploaded to OpenCourseWare ocw.mit.edu.

Using a blackboard can still be more effective than slides (but there is a place for slides). Your voice and movements make a human connection that can change lives.

▶ MS-Tu-E-11-2 16:30–17:00

Online Learning is A Remarkable Opportunity for Dialog

Grinfeld, Pavel Drexel Univ.

Abstract: I will talk about Lemma, a new online learning platform currently under testing and further development. Lemma attempts to transform the online learning experience into a dialog between the student and the educator. Computers and tablets offer unique opportunities for capturing student feedback and for facilitating two-way interaction between the student and the educator which, at times, may be even more effective than face to face encounters.

▶ MS-Tu-E-11-3 17:00–17:30

SageMathCloud and IPython/Jupyter Notebooks for Teaching and Research

LeVeque, Randall Univ. of Washington

Abstract: SageMathCloud is a cloud platform that allows users to create projects (each a separate linux VM) that can be accessed via a web browser. Bash terminals, IPython/Jupyter notebooks, Sage worksheets, and a WYSIWYG LaTeX editor can all be used from the browser, and worked on collaboratively from different browsers. I will describe recent experiences using this as a platform for teaching, collaborating on research, and sharing code, results and tutorials.

▶ MS-Tu-E-11-4 17:30–18:00

Julia in the Classroom

Edelman, Alan MIT

Abstract: This talk will describe the Julia language and describe how it was possible to build an online education homework system entirely out of juliabox. This is joint work with Shashi Gowda, Tanmay Mohapatra, and Viral Shah.

MS-Tu-E-12 16:00–18:00 208B

Applied and computational complex analysis II

Organizer: Takashi, Sakajo Kyoto Univ.

Abstract: This session is the part two of minisymposia organized by the international research network initiative, Applied and computational complex analysis (ACCA), between UK and Japan. The first one is organized by Prof. Beatrice Pelloni in the group of ACCA-UK and the second one is done by Prof. Takashi Sakajo in the group of ACCA-JP. We share the same focus with the first symposium and we will invite additional four speakers who apply complex analysis to a wide variety of problems arising in physical and industrial applications. The topics include numerical conformal mapping technique to construct flows in oceans, efficient numerical integrations of oscillatory functions, a new wing design problem. The close cooperation between the two minisympoia by the ACCA networks enhances not only exchanging new ideas on applications of complex analysis, but also fostering future international research collaborations between speakers and participants.

▶ MS-Tu-E-12-1 16:00–16:30

Moving Frames and Noether's Conservation Laws

Mansfield, Elizabeth Univ. of Kent

Abstract: In 2018 is the centenary of Noether's paper in which conservation laws are calculated from a Lie group symmetry of a variational pronblem. I will show how rewriting these laws in terms of invariants and a moving frame gives insight into the structure of the solution set. I will show also how the frame can be used to integrate the Euler Lagrange equations.

▶ MS-Tu-E-12-2 16:30–17:00

Analytical Study of the Dynamics of the Separation Vortices from the Body Using Single Vortex Approximation

Iima, Makoto Hiroshima Univ.

Abstract: Separation vortices from bodies greatly contribute to lift and moment generation. We study this problem analytically using single vortex approximation, by which a separation vortices structure is approximated by one point vortex alone. Flow around plate or V-shape object in a uniform flow is analyzed. Under this approximation, the system is described by dynamical systems with just four dimensions. Vector field of this system will be used to discuss the effect of the separation vortices.

▶ MS-Tu-E-12-3 17:00–17:30

Vortices and Polynomials

Clarkson, Peter Univ. of Kent

Abstract: In this talk I shall discuss special polynomials associated with rational solutions for the Painleve equations. I shall illustrate how these special polynomials arise in vortex dynamics.

▶ MS-Tu-E-12-4 17:30–18:00

Contour Surgery in Multiply Connected Domains

Nelson, Rhodri Kyoto Univ.

Abstract: In this talk we present a new method for computing the motion of vortex patches in multiply connected domains. The method works by first solving for the velocity field owing to an unbounded vortex at appropriate points on the boundaries (as if the boundaries weren't present). A modified Schwarz-problem is then solved to give a 'correction' field so that the no-normal flow boundary condition is satisfied on all boundaries present.

MS-Tu-E-13 16:00–18:00 VIP3-2
Vanishing viscosity limit and incompressible flow - Part I of II
For Part 2, see MS-We-D-13

Organizer: Lopes Filho, Milton Universidade Federal do Rio de Janeiro
Organizer: Jiu, Quansen Capital Normal Univ.

Abstract: Much of the research on fluid dynamics is concerned with the phenomena of boundary layers and of turbulence. Both of these physical phenomena are associated with flows in the large Reynolds number regime and therefore are directly related with the mathematical study of the vanishing viscosity limit. Vanishing viscosity limits are an active área of research, focusing both on boundary-related issues, motivated by boundary layers, and on bulk flow issues more closely related to turbulence. The purpose of this minisymposium is to showcase current developments along both these lines, primarily focusing on describing the behavior of solutions of the Navier-Stokes and related system when viscosity is very small.

▶ MS-Tu-E-13-1 16:00–16:30
Weak Solutions of the Euler Equations Obtained as Limit of Vanishing Viscosity.
Lopes Filho, Milton Universidade Federal do Rio de Janeiro

Abstract: In this talk we are interested in qualitative properties of weak solutions of the incompressible 2D Euler equations which are limits of vanishing viscosity. We examine the literature on this problem, specially concerning transport of vorticity and conservation of energy.

▶ MS-Tu-E-13-2 16:30–17:00
Initial-boundary Layer Associated with the Nonlinear Darcy-Brinkman Model.
Wang, Xiaoming Florida State Univ.

Abstract: We study the interaction of initial layer and boundary layer in the nonlinear Darcy-Brinkman system at the vanishing Darcy number limit. In particular, we show the existence of a function of corner layer type (so called initial-boundary layer) in the solution of the nonlinear Darcy-Brinkman system. An approximate solution is constructed by the method of multiple scale expansion in space and in time. We establish the optimal convergence rates in various Sobolev norms.

▶ MS-Tu-E-13-3 17:00–17:30
Stability of Boundary Layers in Compressible Flows
Wang, Yaguang Shanghai Jiaotong Univ.

Abstract: In this talk, we shall study the stability of boundary layers in two dimensional non-isentropic compressible flows with non-slip boundary conditions when the viscosity and heat conduction coefficients go to zero, from which we obtain the interaction behavior of viscous layers and thermal layers.

▶ MS-Tu-E-13-4 17:30–18:00
Optimal Control of Second Grade Fluids
Cipriano, Fernanda New Univ. of Lisbon

Abstract: We study optimal control problems of systems describing the flow of incompressible second grade fluids. we prove existence of optimal solutions and derive the corresponding necessary optimality conditions. We also consider the asymptotic behavior of these conditions when the visco parameter α goes to zero, recovering the necessary optimality conditions for the Navier-stokes equations.
This is a joint work with Nadir Arada.

MS-Tu-E-14 16:00–18:30 111
Optimality in reduced order modeling and inversion - Part I of II
For Part 2, see MS-We-D-14

Organizer: Mamonov, Alexander Schlumberger
Organizer: Zaslavsky, Mikhail Schlumberger-Doll Research

Abstract: In a wide range of applications, the model reduction techniques provide a well-established tool for efficient approximation of the transfer functions of large dynamical systems with multiple inputs and outputs. Rather recently the range of applications was extended to reducing the complexity of inverse problems. The optimal choice of the parameters of reduced order models (ROMs) is crucial for the efficiency of the approach. We will consider different ways to parameterize ROMs, for both forward and inverse PDE problems, and discuss optimal sampling of the parameters.

▶ MS-Tu-E-14-1 16:00–16:30
A New Inversion Method for NMR Signal Processing. C.E. Yarman, L. Monzon, M. Reynolds, N. Heaton
Yarman, Evren Schlumberger

Abstract: We present a new, semi-analytic inversion method for NMR log measurements. Our method represents multiwait-time-measurements via short sums of exponentials. The resulting sparse T2-distribution requires fewer T2-relaxation times than present in linearized inversion methods. The T1-relaxation times, and corresponding amplitudes are estimated via convex optimization and a semi-analytic algorithm. We obtain an efficient way to represent the NMR data that can be utilized to estimate petrophysical properties and for compression in logging-while-drilling applications.

▶ MS-Tu-E-14-2 16:30–17:00
Rational Approximation of the Function $z^{-1/2}$ with A Shifted Slit on the Union of A Positive and A Negative Real Line Segment
Druskin, Vladimir Schlumberger-Doll Research
Guettel, Stefan The Univ. of Manchester
Knizhnerman, Leonid Central Geophysical Expedition

Abstract: When constructing absorbing boundary conditions for discretized hyperbolic PDEs, one needs good $[(m-1)/m]$ rational approximants to $z^{-1/2}$ on the union of a positive and a negative real line segment. These approximants are recalculated into complex end FD subgrids carrying out numerical absorption. We present a theoretically well-grounded algorithm for obtaining "almost best" approximants, our construction exploiting classical Zolotarev's and Gonchar's assertions. Our theorems are illustrated with the results of numerical experiments.

▶ MS-Tu-E-14-3 17:00–17:30
Surrogate Optimization of Rational Krylov Methods for 3D Transient Electromagnetics Modeling
Guettel, Stefan The Univ. of Manchester

Abstract: The optimization of pole parameters for rational Krylov methods is an active area of research. We present a new and simple approach to obtaining near-optimal parameters based on a surrogate problem with a diagonal matrix. Considerations from potential theory allows us to choose the eigenvalues of the surrogate such that almost no unwanted spectral deflation occurs in the optimization phase. We demonstrate the applicability of this approach by an example from geophysics.

▶ MS-Tu-E-14-4 17:30–18:00
Multi-scale Mimetic Reduced-order Models for Large Wave Problems
Zaslavsky, Mikhail Schlumberger-Doll Research
Druskin, Vladimir Schlumberger-Doll Research
Mamonov, Alexander Schlumberger

Abstract: We have developed a novel approach for discretizing spatial operator in wavefield simulations. We split the reference fine grid model into multiple subdomains. The adjacent subdomains are conjugated using Neumann-to-Dirichlet map. We construct sparse reduced-order model of NtD map for each cell via transformation to Stieltjes continued fraction. This method perfectly fits high performance computing platforms and allows to simulate wavefields in media with unlimited complexity and to achieve spectral accuracy even on regular model-independent

▶ MS-Tu-E-14-5 18:00–18:30
A Network Based Inversion Method for the Schroedinger Problem
Guevara Vasquez, Fernando Univ. of Utah, Mathematics
Mamonov, Alexander Schlumberger

Abstract: We present a method for recontructing the Schroedinger potential from Dirichlet to Neumann map measurements at the boundary of a 2D region. Our method relies on the Liouville identity relating the conductivity and Schroedinger equations, and a discrete version relating a resistor network to another resistor network with a discrete Schroedinger potential, i.e. current leaks at the nodes. These leaks are used to reconstruct the continuum Schroedinger potential. Joint with L Borcea and AV Mamonov.

MS-Tu-E-15 16:00–18:00 213B
Inverse problems in PDE and probability - Part II of II
For Part 1, see MS-Tu-D-15

Organizer: Helin, Tapio Univ. of Helsinki
Organizer: Hyvonen, Nuutti Aalto Univ.

Abstract: The aim of the minisymposium is to highlight new research results in inverse problems that involve stochastic modelling and partial differential equations. All aspects of such inversion are discussed, including mathematical analysis, computational techniques, and experimental results.

▶ MS-Tu-E-15-1 16:00–16:30
Sample-based Sparse Bayesian Inversion in Biomedical Imaging
Lucka, Felix UCL

Abstract: Solving inverse problems by Bayesian inference has become popular because the probabilistic representation of the solution allows for a rigorous quantification of its uncertainties. The talk focuses on using sparsity priors and presents several own contributions, including efficient MCMC methods for posterior sampling, new theoretical insights into the relationship between MAP and CM estimates and computational results such as the inversion of experimental CT data with TV and Besov priors. Joint work with Martin Burger.

▶MS-Tu-E-15-2 16:30–17:00

Anomaly Detection in Random Heterogeneous Media

Simon, Martin Univ. of Mainz

Abstract: In this talk, we are concerned with the analysis and numerical solution of a stochastic inverse anomaly detection problem in electrical impedance tomography (EIT). More precisely, we study the problem of detecting a parameterized perfectly conducting anomaly in an isotropic, stationary and ergodic conductivity random field whose realizations are rapidly oscillating.

▶MS-Tu-E-15-3 17:00–17:30

Inverse Scattering Methods for Electrical Impedance Tomography and the Novikov-Veselov Equation

Siltanen, Samuli Univ. of Helsinki

Abstract: Electrical Impedance Tomography is an emerging medical imaging method where a body is probed with harmless electrical currents. It leads to a nonlinear and ill-posed inverse problem that can be solved using a nonlinear Fourier transform arising from inverse scattering theory. Furthermore, the same techniques can be used for solving the Novikov-Veselov equation, a (2+1) dimensional generalisation of the KdV equation.

▶MS-Tu-E-15-4 17:30–18:00

Multilevel Markov Chain - Monte Carlo Method for Bayesian Inversion

Hoang, Viet Ha Nanyang Technological Univ.

Abstract: We develop a new Multilevel Markov Chain Monte Carlo sampling strategy for Bayesian Inversion of partial differential equations, with sampling from a multilevel discretization of the posterior and a multilevel discretization of the forward PDE. The method achieves a prescribed level of accuracy with an optimal level of complexity that is equal to that for performing only one step of the standard MCMC procedure. (Joint work with Andrew Stuart (Warwick) and Christoph Schwab (ETH, Zurich)).

MS-Tu-E-16 16:00–18:10 205A

Multi-scale complex flows - Part II of II

For Part 1, see MS-Tu-D-16

Organizer: Swierczewska-Gwiazda, Agnieszka Univ. of Warsaw

Abstract: The mini-symposium aims to present challenging problems of multiscale description of various phenomena including polymeric fluids, collective behaviour, to name a few. There are different approaches to such problems - either through kinetic equations, modelling of the microstructure by the stochastic partial differential equations or by capturing microscopic quantities in terms of averaged macroscopic ones. Our aim is to present some of these approaches and the recent studies, both from the point of view of mathematical analysis and numerical results.

▶MS-Tu-E-16-1 16:00–16:30

Analysis and Numerics of the Diffusive Peterlin Viscoelastic Model.

Lukacova, Maria Univ. of Mainz, Inst. of Matehmatics

Abstract: We present our recent results on the analysis and numerical simulations of the so-called diffusive Peterlin model for unsteady incompressible polymeric fluids. We prove global in time existence and uniqueness of a weak solution in two space dimensions. Further, we will propose a characteristc finite element method and prove its first order accuracy. This research has been done in the collaboration with S. Necasova (Prague), H. Mizerova (Mainz) and M. Tabata, H. Notsu (Tokyo).

▶MS-Tu-E-16-2 16:30–17:00

On Various Aspects of Behaviour of Polymers

Gwiazda, Piotr Univ. of Warsaw

Abstract: Contemporary approaches to the modelling of polymeric fluids have exploited multi-scale descriptions in an essential way. Mathematical models have thus been built by coupling systems describing the motion of the solvent with equations that track the evolution of the microscopic behaviour of the solute in the solution. We wish to explore how the rheological properties of the fluid are affected by the presence of chains of macromolecules.

▶MS-Tu-E-16-3 17:00–17:30

On Thermodynamically Compatible Models Capable of Describing the Response of Asphalt

Malek, Josef Charles Univ. in Prague, Faculty of Mathematics & Physics

Abstract: We develop a thermodynamically compatible model that can be identified as generalisation of the Burgers model and that seems capable of describing the nonlinear response of asphalt binders. We test the efficancy of the model by comparing its predictions against two different sets of torsion experiments. Finally, we solve computationally several time-dependent boundary value problems that have relevance to applications involving asphalt. This is a joint work with K. Tuma and K. R. Rajagopal.

▶CP-Tu-E-16-4 17:30–17:50

Structural Analysis, Regularization and Integration of Differential-Algebraic Equations

Steinbrecher, Andreas TU Berlin

Abstract: In the simulation of dynamical systems usually differential-algebraic equations (DAEs) are used. These in general are of higher index and, therefore, contain hidden constraints which inhibit a numerical treatment or complicate it extremely. Therefore, a regularization or remodeling is required which reduces the index and preserves the set of solutions. In modern simulation environments often regularization approaches based on structural information are used which add hidden constraints and introduce dummy derivatives. Such a regularization often is valid only locally since the choice of the dummy derivatives can vary in time.
In this talk we propose a combination of regularization and efficient numerical integration of DAEs. The proposed regularization also uses structural information to construct a regularized overdetermined formulation which (in contrast to the approach above) is globally valid. For the numerical integration we present the software package QUALIDAES which is suited for the direct numerical integration of the proposed regularization.

▶CP-Tu-E-16-5 17:50–18:10

On the Numerical Treatment of Dissipative Particle Dynamics and Related Systems

Shang, Xiaocheng Univ. of Edinburgh
Leimkuhler, Benedict Univ. of Edinburgh

Abstract: We review and compare numerical methods for particle-based modelling of complex fluids and polymers. The class of methods considered includes dissipative particle dynamics (DPD) as well as extended stochastic-dynamics models incorporating a generalized pairwise thermostat scheme, in particular, a stochastic pairwise Nosé-Hoover-Langevin (PNHL) method. To this end, splitting methods are developed and studied in terms of their thermodynamic accuracy, two-point correlation functions, and convergence. In terms of computational efficiency as measured by the ratio of thermodynamic accuracy to CPU time, we report significant advantages in simulation for the PNHL method compared to popular alternative schemes (up to an 80% improvement), without degradation of convergence rate. The momentum-conserving thermostat technique described here provides a consistent hydrodynamic model in the low-friction regime, but it will also be of use in both equilibrium and nonequilibrium molecular simulation applications owing to its efficiency and simple numerical implementation.

MS-Tu-E-17 16:00–18:30 205B

Reaction-diffusion-advecton systems arising from mathematical biology modeling chemotaxis - Part II of III

For Part 1, see MS-Tu-D-17
For Part 3, see MS-We-D-17

Organizer: Xiang, Tian Renmin Univ. of China

Abstract: As with all living organisms, single cells and bacteria sense and respond to the environment where they live. The primary way these organisms achieve this is through the phenomenon of chemotaxis. Chemotaxis is the oriented movement of cells and organisms along chemical gradients, as a response to gradients of the concentration of chemical substances. It plays a significant role in many biological fields, and chemotaxis models have been successfully applied to the aggregation patterns in bacteria, slime molds, skin pigmentation patterns, angiogenesis in tumor progression and wound healing and many other examples. Therefore, a huge number of works, both theoretical and experimental, have been devoted to exploring and hence understanding the mechanistic basis of chemotaxis.
In 1953, Patlak contributed the first mathematical idea to model chemotaxis. In 1970s, Keller and Segel introduced a classical and important chemotaxis model (a advection-diffusion type parabolic-parabolic quasi-linear PDE systems) to describe the aggregation process of cellular slime mold by chemical attractions. These pioneering works have initiated an intensive mathematical investigation of the (Patlak-)Keller-Segel model and chemotaxis models have become one of the best study models in mathematical biology over the last 40 years.
Despite its simple looking, the Keller-Segel model exhibits the phenomenon of cell aggregation, which is usually modeled by time-dependent solutions blowing up in finite or infinite time. Thus, the issue whether or not the solutions of the proposed chemotaxis models are globally bounded or blow-up becomes

the main concern in studying K-S type models. It is a very active research subject; up to now, there are at least 5 beautiful survey papers, Horstsmann [1,2], Hillen and Painter [3], Wang [4] and Blanchet [5], where one is provided with a broad survey on the progress of various chemotaxis models as well as with a rich selection of references. The key phenomena are: no blow-up in 1-D, except in some extreme nonlinear diffusion models, critical mass blow-up in 2-D, and generic blow-up in ≥ 3-D, a breakthrough made in Winkler [6].
Chemotaxis phenomenon has been also successfully applied to other equations, for instance, Navier-Stokes equations, see [7] for a glimpse.
Thus, in our mini-symposium, our group topics center mainly on reaction-diffusion-advecton systems modeling chemotaxis arising from mathematical biology. We bring together active researchers to share and discuss their very recent results on boundedness versus blow-up, critical mass blow-up, global existences, stability and large time behavior so as to understand more insights on the mechanism of chemotaxis. This mini-symposium will definitely stimulate more inspirations. [1] D. Horstman, From 1970 until now: the Keller-Segal model in chaemotaxis and its consequence I, Jahresber DMV, 105 (2003), 103–165. [2] D. Horstman, From 1970 until now: the Keller-Segal model in chaemotaxis and its consequence II, Jahresber DMV, 106 (2003), 51–69. [3]T. Hillen and K. J. Painter, A user's guide to PDE models for chemotaxis, J. Math. Biol., 58 (2009), 183–217. [4] Z. A. Wang, Mathematics of traveling waves in chemotaxis, Discrete Contin. Dyn. Syst. Ser. B 18 (2013), 601–641. [5] A. Blanchet, On the Parabolic-Elliptic Patlak-Keller-Segel System in Dimension 2 and Higher, preprint, arXiv:1109.1543 [6] M. Winkler, Finite-time blow-up in the higher-dimensional parabolic-parabolic Keller-Segel system, J. Math. Pures Appl. 100 (2013), 748–767. [7] R. J. Duan and Z.Y. Xiang, A note on global existence for the chemotaxis-Stokes model with nonlinear diffusion. Int. Math. Res. Not. IMRN 2014, no. 7, 1833-1852.

▶ MS-Tu-E-17-1 16:00–16:30
Global Existence and Boundedness in the Chemotaxis-fluid Systems with A Tensor-valued Sensitivity
Wang, Yulan — Xihua Univ.

Abstract: We consider the boundary-value problem in smoothly bounded domain for coupled chemotaxis-fluid systems. Here, one of the novelties is that the chemotactic sensitivity is not a scalar function but rather attains matrix values. We shall establish some new energy-type inequalities or derive a series of a priori estimates to obtain the global existence and boundedness for two chemotaxis-fluid systems with large initial data.

▶ MS-Tu-E-17-2 16:30–17:00
Asymptotic Profile of A Parabolic-Hyperbolic System with Boundary Effect Arising from Tumor Angiogenesis
Wang, Zhian — Hong Kong Polytechnic Univ.

Abstract: In this talk, we shall discuss a parabolic-hyperbolic system on the half space with boundary effect. The system is derived from a singular chemotaxis model describing the initiation of tumor angiogenesis. We show that the solution of the system subject to appropriate boundary conditions converges to a traveling wave profile as time tends to infinity if the initial data is a small perturbation around the wave.

▶ MS-Tu-E-17-3 17:00–17:30
Boundedness, Blowup and Critical Mass Phenomenon in Competing Chemotaxis
Jin, Haiyang — South China Univ. of Tech.

Abstract: In this presentation, we will consider the initial boundary problem of an attraction-repulsion Keller-Segel system. By constructing a Lyapunov functional, we establish the global existence of uniformly-in-time bounded classical solutions with large initial data if the repulsion dominates or cancels attraction. If the attraction dominates, a critical mass phenomenon is found. This is a joint work with Dr. Zhian Wang.

▶ MS-Tu-E-17-4 17:30–18:00
Blow-up and Boundedness for A Keller-Segel Chemotaxis Model
Zheng, Pan — Chongqing Univ. of Posts & Telecommunications

Abstract: This paper deals with a quasilinear parabolic-elliptic chemotaxis system with logistic source under homogeneous Neumann boundary conditions in a smooth bounded domain. Under some different suitable assumptions on the nonlinearities and logistic source, we study the global boundedness and finite-time blow-up of solutions for the problem.

▶ MS-Tu-E-17-5 18:00–18:30
Stable and Periodic Patterns of A Chemotaxis Model with Two Competing Species
Wang, Qi — Southwestern Univ. of Finance & Economics

Abstract: Chemotaxis is the oriented movement of cellular organisms along the concentration gradient of certain chemicals in environment. In this talk, we study Keller-Segel type chemotaxis model with two species subject to Lotka-Volterra competition dynamics. We investigate the stable and time-periodic spatially inhomogeneous solutions to the system as well as the pattern formation mechanisms. Numerical simulations are presented to illustrate and support our theoretical findings.

MS-Tu-E-18 16:00–18:00 209B
Nonlinear aggregation-diffusion equations - Part II of III
For Part 1, see MS-Tu-D-18
For Part 3, see MS-We-D-18

Organizer: Huang, Yanghong — Univ. of Manchester
Organizer: Carrillo, Jose A. — Imperial College London
Organizer: Yao, Yao — Univ. of Wisconsin Madison

Abstract: A large variety of stationary and dynamic patterns are the results of the competition between nonlinear diffusion and aggregation effects, including the well-known Patlak-Keller-Segel system. These systems are typically modelled from the collective behaviour of individuals, as the kinetic and/or continuum description based on mean-field type PDEs. The aim of the mini-symposium is to highlight recent advances on the interplay between the aggregation and the nonlinear diffusion, by developing tools to understand the long time asymptotics, stability of the patterns, related functional inequalities and numerical schemes.

▶ MS-Tu-E-18-1 16:00–16:30
Exact and Asymptotic Steady States of Aggregation Equations with Power-law Potentials
Huang, Yanghong — Univ. of Manchester
Carrillo, Jose A. — Imperial College London

Abstract: Despite the rich steady patterns observed in nonlocal interaction models, there are very few steady solutions with explicit closed expressions. In this talk, several exact solutions are presented for the aggregation equation with power-law potential, using explicit inverse of some singular integral operators. The asymptotic behaviours near the boundary are also discussed.

▶ MS-Tu-E-18-2 16:30–17:00
A Linearly Transformed Particle Method for the Aggregation Equation
Choi, Young-Pil — Imperial College London

Abstract: The aggregation equation appears in various context as a mathematical model for collective behavior. In this talk, uniform convergences of a linearly transformed particle method for the aggregation equation are provided. In this particle method particles are pushed along their trajectories, which is a linearization of the exact flow, on the discrete times. Moreover, the particles have their own shape which is transformed to better represent the local flow.

▶ MS-Tu-E-18-3 17:00–17:30
A Numerical Method for the Evolution of Arbitrary Sets
Nave, Jean-Christophe — McGill Univ.

Abstract: In this talk I will present a numerical method for the evolution of arbitrary sets. The approach is based on evolving the underlying flow map using the Gradient-Augmented Level Set Method (GALSM). The method is unique in the sense it retains both geometric information (diffeomorphism) and integrated quantities (e.g. densities). I will present linear and non-linear flow examples.

▶ MS-Tu-E-18-4 17:30–18:00
Ground States and Long-time Behaviour of the 2D Keller-Segel Model with Nonlinear Diffusion and Logarithmic Interaction
Volzone, Bruno — Univ. "Parthenope"
Carrillo, Jose A. — Imperial College London
Yao, Yao — Univ. of Wisconsin Madison

Abstract: In this talk we show the existence of a unique radially decreasing global minimizer of the free energy associated to the two-dimensional parabolic-elliptic Keller-Segel model with degenerate diffusion of porous medium type. This minimizer is proved of be a radially decreasing compactly supported continuous density function, characterized as the unique compactly supported stationary state of the evolution model. In addition, we will show that this profile describes the long time asymptotics of the evolution model.

MS-Tu-E-19 16:00–18:30 307B
Multirate Time Integration

Organizer: Guenther, Michael — Bergische Universität Wuppertal
Organizer: Sandu, Adrian — Virginia Tech

Abstract: Dynamical systems described by ODEs, DAEs, PDEs or, especially, coupled multiphysical systems are often equipped with multilateral behavior:

components, right-hand side or signals show a drastically different activity level, given by very different time scales. Multirate integration scheme aim at exploiting this multirate behavior by integrating the different parts with their respective step sizes, while at the same time preserving the convergence order and stability properties of the underlying schemes.
This mini symposium will present recent advances in developing numerical multirate schemes and highlight the efficient use of these scheme in industrial applications.

▶ MS-Tu-E-19-1 16:00–16:30

Multirate Time-Domain Simulation of Field/Circuit Coupled Pulse-Width-Modulation Controlled Devices

Schöps, Sebastian TU Darmstadt
Vazquez Sabariego, Ruth KU Leuven
Gyselinck, Johan Universite libre de Bruxelles

Abstract: In this contribution a tailored approach for the simulation of electrical devices with pulse-width-modulated (PWM) supply is proposed. The method is based on decomposing time into fast and slow components similarly to the multitone partial differential approach. To this end, dedicated duty-cycle dependent piecewise polynomial PWM basis functions are introduced. They allow for large switching-frequency-independent time steps and thus significant computational savings. The method is applied to a buck-converter, modeled as a field/circuit coupled system.

▶ MS-Tu-E-19-2 16:30–17:00

On Construction of Multirate Exponential Integrators.

Tokman, Mayya Univ. of California, Merced

Abstract: Exponential methods have emerged as a promising alternative to standard implicit time integrators for solving large scale stiff systems. Recently a number of classes of exponential integrators including unsplit, split and hybrid exponential propagation iterative methods of Runge-Kutta-type (EPIRK) have been proposed. In this talk we will explore how the structure of these classes of methods can be exploited to develop exponential multirate integrators.

▶ MS-Tu-E-19-3 17:00–17:30

Efficiency and Sensitivity Analysis of Observation Networks for Atmospheric Inverse Modelling with Emissions

Wu, Xueran Forschungszentrum Juelich/Univ. of Wuppertal
Elbern, Hendrik Univ. of Cologne/Forschungszentrum Juelich
Jacob, Birgit Univ. of Wuppertal

Abstract: Different parameters influence the temporal evolution of predictive geophysical models. This renders initial-value-only optimisation by data assimilation methods as insufficient. A quantitative method on validation of measurement configurations to optimize initial values and emissions is introduced. Kalman filter and smoother and their ensemble versions are combined with singular value decomposition to evaluate the potential improvement associated with specific observational networks. Further, their sensitivity to model can be identified by determining the direction of maximum perturbation.

▶ MS-Tu-E-19-4 17:30–18:00

Combination of Model Order Reduction and Multirate Time Integration

Bartel, Andreas Univ. of Wuppertal
Hachtel, Christoph Univ. of Wuppertal
Guenther, Michael Bergische Universität Wuppertal

Abstract: Multiphysical problems are often described by coupled problems with largely differing timescales. Frequently, a low dimensional subsystem is active, while the majority of unknowns is latent. Thus applying model order reduction (MOR) to the latent system is a valid idea. Here we address ODEs. Special focus is paid to the design of the coupling interface, which shall enable an efficient computation while combining multirate methods and MOR. Numerical are discussed for a thermal-electric system.

▶ MS-Tu-E-19-5 18:00–18:30

Generalized Additive Runge-Kutta Methods

Sandu, Adrian Virginia Tech
Guenther, Michael Bergische Universität Wuppertal

Abstract: This presentation discusses a general structure of the additively partitioned Runge-Kutta methods by allowing for different stage values as arguments of different components of the right hand side. An order conditions theory is devel- oped for the new family of generalized additive methods, and stability and monotonicity investigations are carried out. The new family, named GARK, introduces additional flexibility when compared to traditional partitioned Runge- Kutta methods.

MS-Tu-E-20 16:00–18:00 210B

Recent advances in large-scale matrix functions and applications

Organizer: Botchev (Bochev), Mikhail Univ. of Twente
Organizer: Guettel, Stefan The Univ. of Manchester

Abstract: Matrix functions have become an important tool in Applied Mathematics, however their computation is particularly challenging for large matrices. Significant progress has been made in this research field in the last decade or two. This includes rational Krylov techniques and their parameter selection, efficient restarting, and error control. This minisession discusses some of these advances, applications, and recent new challenges in computing the action of large-scale matrix functions.

▶ MS-Tu-E-20-1 16:00–16:30

Rational Krylov Techniques for Matrix Functions

Guettel, Stefan The Univ. of Manchester

Abstract: We discuss recent advances in rational Krylov techniques for the approximation of matrix functions. In particular, we present a new iterative method for rational least squares fitting called RKFIT. RKFIT is a generalization of the popular vector fitting method and, in our numerical experiments, an improvement in terms of stability and insensitivity to the initial guess. We also showcase some of the features of a new Rational Krylov Toolbox for MATLAB. This joint work with Mario Berljafa.

▶ MS-Tu-E-20-2 16:30–17:00

Matrix Exponential and Krylov Subspaces for Time Domain Photonic Crystal Modeling

Botchev (Bochev), Mikhail Univ. of Twente

Abstract: Time integration methods involving the matrix exponential are attractive for time domain photonic crystal modeling due to their excellent stability and accuracy properties. We demonstrate that a significant gain in efficiency, as compared to standard finite difference time domain (FDTD) methods, can be obtained with rational Krylov subspace exponential methods. Using a single Krylov basis for a large time span, restarting and fast inner linear solvers are crucial for achieving the efficiency gain.

▶ MS-Tu-E-20-3 17:00–17:30

ALR Method for the Computation of the Matrix Exponential and Solution of Large-scale Lyapunov Equation

Oseledets, Ivan Skolkovo Inst. of Sci. & Tech.

Abstract: We propose a new method for the approximate solution of the Lyapunov equation with rank-1 right-hand side, which is based on extended rational Krylov subspace approximation with adaptively computed shifts. The shift selection is obtained from the connection between the Lyapunov equation, solution of systems of linear ODEs and alternating least squares method for low-rank approximation. The numerical experiments confirm the effectiveness of our approach.

▶ MS-Tu-E-20-4 17:30–18:00

Convergence Analysis of Restarted Arnoldi Type Methods for $f(A)b$

Frommer, Andreas Bergische Universität Wuppertal
Guettel, Stefan The Univ. of Manchester

Abstract: We show that the restarted Arnoldi method to compute $f(A)b$ converges, provided that f is a Stieltjes function and A is hermitian and positive definite. We also show that the restart error function is again a Stieltjes function and that it can be evaluated using quadrature. In case that A is non-hermitian but positive real, we propose a convergent modification of the Arnoldi approach based on interpolation in harmonic Ritz values.

MS-Tu-E-21 16:00–18:00 309B

Minisymposium on discontinuous Galerkin method: recent development and applications - Part II of VIII

For Part 1, see MS-Tu-D-21
For Part 3, see MS-We-D-21
For Part 4, see MS-We-E-21
For Part 5, see MS-Th-BC-21
For Part 6, see MS-Th-D-21
For Part 7, see MS-Th-E-21
For Part 8, see MS-Fr-D-21

Organizer: Xu, Yan Univ. of Sci. & Tech. of China
Organizer: Shu, Chi-Wang Brown Univ.

Abstract: Over the last few years, discontinuous Galerkin (DG) methods have found their way into the main stream of computational sciences and are now being successfully applied in almost all areas of natural sciences and engineering. The aim of this minisymposium is to present the most recent developments in the design and theoretical analysis of DG methods, and to discuss relevant issues related to the practical implementation and applications

of these methods. Topics include: theoretical aspects and numerical analysis of discontinuous Galerkin methods, non-linear problems, and applications. Particular emphasis will be given to applications coming from fluid dynamics, solid mechanics and kinetic theory.

▶ MS-Tu-E-21-1 16:00–16:30

Multiwavelet Discontinuous Galerkin Methods and Automated Parameters for Troubled Cell Indication

Vuik, Mathea J. — Delft Univ. of Tech.
Ryan, Jennifer — Univ. of East Anglia

Abstract: This talks focuses on using a multiwavelet representation of the discontinuous Galerkin (DG) approximation for trouble cell indication. The multiwavelet representation is related to the jumps in the (derivatives of) the DG approximation. We then compare this indicator with other, more established indicators and demonstrate that it is possible to choose the parameters for troubled cell indicators automatically and appropriately.

▶ MS-Tu-E-21-2 16:30–17:00

Space-time Adaptive ADER Discontinuous Galerkin Finite Element Schemes with A Posteriori Sub-cell Finite Volume Limiting

Zanotti, Olindo — Univ. of Trento

Abstract: We present a novel high order discontinuous Galerkin finite element method on space-time adaptive Cartesian meshes (AMR) for hyperbolic conservation laws in multiple space dimensions, using a a-posteriori sub-cell ADER-WENO finite volume limiter. The discrete solution within the troubled cells is recomputed by scattering the DG polynomial at the previous time step onto a suitable number of sub-cells along each direction. Tests are shown of the new scheme over the Euler and magnetohydrodynamics equations.

▶ MS-Tu-E-21-3 17:00–17:30

An H-adaptive RKDG Method for the Vlasov-Poisson System

Zhu, Hongqiang — Nanjing Univ. of Posts & Telecommunications

Abstract: In this talk we present an h-adaptive Runge-Kutta discontinuous Galerkin (RKDG) method for the Vlasov-Poisson system. A simple adaptive strategy is designed based on the first-order moments. The one-dimensional Poisson's equation is solved using the local discontinuous Galerkin method on the one-dimensional mesh which is projected from the current two-dimensional adaptive mesh. Numerical examples are presented and the numerical results illustrate the effectiveness and the capability of the method.

▶ MS-Tu-E-21-4 17:30–18:00

Convergence of Adaptive Methods for A Low Order DG Method

Guzman, Johnny — Brown Univ.

Abstract: We prove that an adaptive method for a weakly penalized method converges. The penalty parameter only needs to be large enough to guarantee stability. This is in contrast to previous results on adaptive DG methods with strong penalty terms where the penalty terms needs to be chosen larger than was is needed for stability. This is joint work with Thirupathi Gudi.

MS-Tu-E-22 16:00–18:00 206A

Iterative Methods and Preconditioning - Part II of II

For Part 1, see MS-Tu-D-22

Organizer: Pestana, Jennifer — The Univ. of Manchester
Organizer: Szyld, Daniel — Temple Univ.

Abstract: The solution of large sparse linear systems are at the core of most problems in science and engineering. Iterative methods, in conjunction with the use of preconditioning, are among the leading techniques for their solution. Development and analysis of known and new methods and preconditioners continues to be at the forefront of research, with new applications and new outlooks for larger problems and new computer architectures.
In this minisymposium current developments are showcased, illustrating recent advances and the wide range of applications including tensor equations, matrix equations, shifted systems, PDE-constrained optimization, and nonlinear eigenvalue problems.

▶ MS-Tu-E-22-1 16:00–16:30

Constraint Preconditioning for the Coupled Stokes-Darcy System

Ladenheim, Scott — Temple Univ.

Abstract: We propose the use of a constraint (indefinite) preconditioner for the iterative solution of the linear system arising from the finite element discretization of coupled Stokes-Darcy flow. We provide spectral and field-of-value bounds for exact and inexact versions of the preconditioned system which are independent of the underlying mesh size. Numerical experiments in 2D and 3D show the effectiveness of our approach. Joint work with Prince Chidyagwai and Daniel B. Szyld.

▶ MS-Tu-E-22-2 16:30–17:00

Block Preconditioners for A C1 Finite Element Discretization of the Dirichlet Biharmonic Problem

Pestana, Jennifer — The Univ. of Manchester
Muddle, Richard — Univ. of Manchester
Heil, Matthias — Univ. of Manchester
Francoise, Tisseur — The Univ. of Manchester
Mihajlovic, Milan — The Univ. of Manchester

Abstract: Finite element discretisation of the Dirichlet biharmonic problem by Bogner-Fox-Schmit (bicubic Hermite) elements leads to a symmetric positive definite coefficient matrix. However, the condition number of this matrix grows rapidly as the mesh is refined, making preconditioning essential. We present two novel preconditioners for this problem that are purely algebraic. We characterise the spectra of the preconditioned matrices and present numerical results that demonstrate the effectiveness of the proposed strategy.

▶ MS-Tu-E-22-3 17:00–17:30

A Pseudo-block Krylov Subspace Recycling Approach for Solving Many Shifted Systems with Arbitrary Right-hand Sides

Soodhalter, Kirk — Johannes Kepler Univ.

Abstract: Krylov subspace recycling is useful for solving a sequence of slowly changing linear systems. It has been shown that recycled GMRES usually cannot be used in conjunction with shifted system techniques due to restrictions upon the residuals. Recently, a new GMRES method for shifted systems was proposed [S., 2015] eliminating this restriction. In this talk, we discuss combining this new method with subspace recycling, yielding a recycled GMRES method for shifted linear systems.

▶ MS-Tu-E-22-4 17:30–18:00

Krylov Recycling Techniques for Hybrid Regularization

De Sturler, Eric — Virginia Tech

Abstract: In hybrid regularization, we build a Krylov subspace and compute approximate solutions by regularizing the linear system projected on the Krylov subspace. However, this typically requires that we keep all Krylov basis vectors. We consider strategies to keep only directions important for the inverse problem solution.
This is joint work with Geoffrey Dillon, Julianne Chung, Misha Kilmer, and Katarzyna Swirydowicz

MS-Tu-E-23 16:00–18:10 208A

Locally Refinable Splines and its Application in Isogeometric Analysis - Part II of II

For Part 1, see MS-Tu-D-23

Organizer: Deng, Jiansong — Univ. of Sci. & Tech. of China
Organizer: Chen, Falai — Univ. of Sci. & Tech. of China

Abstract: In geometric modeling and numerical analysis, splines are popular representations of geometric shapes. With the introduction and development of isogeometric analysis, locally refinable splines have attracted much attention both in geometric modeling and analysis. The minisymposium consists of eight talks given by the leading experts in the corresponding research topics. The talks include T-splines, LR-splines, and splines over T-meshes and related topics. Also the applications in isogeometric analysis is included.

▶ MS-Tu-E-23-1 16:00–16:30

Recent Advances on Splines over T-meshes

Chen, Falai — Univ. of Sci. & Tech. of China
Deng, Jiansong — Univ. of Sci. & Tech. of China
Kang, Hongmei — Univ. of Sci. & Tech. of China

Abstract: rlIn this talk, I will overview some recent advances on splines over T-meshes, including dimension calculation, basis construction, and applications in geometric modelling and isogeometric analysis.

▶ MS-Tu-E-23-2 16:30–17:00

Geometric Continuous Splines over Complex Domains and Applications

Mourrain, Bernard — Inria

Abstract: We consider the space $S_k^r(M)$ of piecewise polynomial functions on a 2-dimensional topological complex M, C^r across edges after composition by a transition map. We give a low bound formula for its dimension, that it is reached for k big enough and describe explicit bases for G^1-splines associated to quadrangular meshes. Applications to modeling physical spaces for numerical simulation and to isogeometric analysis are presented.

▶ MS-Tu-E-23-3 17:00–17:30

Splines Suitable for Geometric Modeling and Analysis

Kang, Hongmei — Univ. of Sci. & Tech. of China

Abstract: As the advent of 3D digital acquisition technology, traditional NURB-S representations in CAGD face with new challenges. Iso-geometric analysis

(IGA) uses CAD basis functions for analysis, resulting in a direct design-to-analysis without the intermediate step of mesh generation. In this talk, we will recall some locally refinable splines which are suitable for both geometric modeling and analysis. Particularly two kinds of local reﬁnable splines are discussed – Modiﬁed T-splines and hierarchical splines on triangular partitions.

▶ CP-Tu-E-23-4 17:30–17:50

Analysis of Space-time Computation Technique with Continuous Representation in Time (ST-C)

Ueda, Yuuki Univ. of Tokyo
Saito, Norikazu The Univ. of Tokyo

Abstract: We present a theoretical study of the application of B-spline, which is used in Isogeometric Analysis and so on, into the time representation of approximate solution. Space-time computation technique with continuous representation in time (ST-C), introduced by K.Takizawa and T.E.Tezduyar, produces a temporally smooth solution by using the B-spline (NURBS) basis functions. They also showed that there are some computational advantages in ST-C because the algorithm uses a small number of temporal B-spline functions at each time step. ST-C is composed of two versions. First, Successive Projection Technique (SPT) produces a smooth solution from a solution that represent different way. Second, Direct Computation Technique (DCT) gives us the solution by computed directly. In this paper, we report the well-posedness, stability and approximation properties of the ST-C methods. Our approach is based on approximation properties of NURBS spaces, which are established by many researchers, such as Y.Bazilevs et al.

▶ CP-Tu-E-23-5 17:50–18:10

Local Grid Refinement in Space and Time Using Summation-by-parts Schemes

Lundquist, Tomas Linköping Univ., Linköping, Sweden
Nordstrom, Jan Linkoping Univ.

Abstract: In this talk we will present a summation-by-parts approach to local grid refinement in space and time. The computational domain is divided into blocks with different mesh sizes, and interpolation operators are applied between them. New interpolation schemes with minimal bandwidth and added dissipation will be developed for this purpose. A high order of accuracy is maintained using this technique, and both conservation and unconditional stability can be proven using the energy method.

MS-Tu-E-24 16:00–19:00 211
Recent Advances in Numerical Approximation of Singular Solutions - Part I of III

For Part 2, see MS-We-D-24
For Part 3, see MS-We-E-24

Organizer: Li, Hengguang Wayne State Univ.
Organizer: Nistor, Victor Pennsylvania State Univ. & U. Lorraine
Organizer: Ovall, Jeffrey Portland State Univ.

Abstract: In this mini-symposium, we will mainly discuss new developments and open questions concerning the approximation of singular solutions of partial differential equations. The scope of the mini-symposium includes but is not limited to: a-priori estimates of the equation, sharp numerical error analysis, novel discretizations, and effective numerical solvers. We hope to bring together both recognized experts and junior researchers with common interest but diverse backgrounds and knowledge, thereby bringing in a wide range of expertise for extensive discussions and communications.

▶ MS-Tu-E-24-1 16:00–16:30

Approximation of Elliptic Equations with BMO Coefficients

Salgado, Abner Univ. of Tennessee

Abstract: We study solution techniques for elliptic equations in divergence form, where the coefficients are only of bounded mean oscillation (BMO). For $|p-2| < \varepsilon$ and a right hand side in W_p^{-1} we show convergence of a finite element scheme, where ε depends on the oscillation of the coefficients.

▶ MS-Tu-E-24-2 16:30–17:00

A Framework for Robust Estimation of Error in Eigenvalue Computations for Non-self-adjoint Operators

Ovall, Jeffrey Portland State Univ.

Abstract: Eigenvalue problems for differential operators arise in a variety of important applications, and can pose non-trivial computational challenges beyond those typical for source problems. We propose an approach for estimating error in eigenvalue and eigenvector computations for non-self-adjoint operators which makes use of recent work concerning Kato's Square Root Conjecture, and is robust with respect to multiple or tightly clustered eigenvalues. We provide experiments that corroborate our theoretical claims for an hp-finite element discretization.

▶ MS-Tu-E-24-3 17:00–17:30

Graded Mesh Approximation in Weighted Sobolev Spaces and Elliptic Equations in 2D

Adler, James Tufts Univ.
Nistor, Victor Pennsylvania State Univ. & U. Lorraine

Abstract: We consider approximation properties of some general finite-element spaces using graded meshes and weighted Sobolev spaces. They are obtained from conformally invariant families of finite elements, leading to higher regularity. We prove that for suitable grading of meshes, one obtains usual optimal approximation results and provide a construction that does not lead to long, "skinny" triangles. Error estimates and quasi-optimal rates of convergence are obtained for finite-element approximations of solutions to strongly-elliptic interface/boundary value problems.

▶ MS-Tu-E-24-4 17:30–18:00

Analysis and Simulation of Plasma Equilibrium in A Corner Domain

Labrunie, Simon Univ. of Lorraine / CNRS / ANR CHROME

Abstract: We present various asymptotic studies on the Boltzmann-Poisson equation, which models the electrostatic equilibrium of a plasma, in a polygon with a reentrant corner. They rely on the properties of non-standard types of solutions : boundary blow-up solutions, or solutions in unbounded sectorial domains. We discuss the numerical implementation of the solution and present several test cases.

▶ MS-Tu-E-24-5 18:00–18:30

Maximum-norm A Posteriori Error Control for Singularly Perturbed Elliptic Reaction-diffusion Equations

Demlow, Alan Texas A&M Univ.

Abstract: In this talk we will present residual-type a posteriori error estimates in the maximum norm for singularly perturbed elliptic reaction-diffusion equations. Our estimates are robust with respect to the singular perturbation parameter and also include estimation of consistency defects due to quadrature errors. This is joint work with N. Kopteva (Limerick, Ireland).

▶ MS-Tu-E-24-6 18:30–19:00

Adaptively Weighted Finite Element Methods for PDE Problems with Boundary Singularities

Westphal, Chad Wabash College

Abstract: The overall effectiveness of finite element methods may be limited by solutions that lack smoothness on a relatively small subset of the domain. By enhancing norms and and/or inner products in the variational framework with weight functions chosen according to a coarse-scale approximation, it is possible to recover near-optimal convergence rates. In this talk we give an overview of the general approach, both in the least-squares and Galerkin settings, and illustrate with numerical examples.

MS-Tu-E-25 16:00–18:30 210A
Numerical Methods for Stochastic PDE and Uncertainty Quantification - Part I of IV

For Part 2, see MS-We-D-25
For Part 3, see MS-We-E-25
For Part 4, see MS-Th-BC-25

Organizer: ZHOU, TAO AMSS, the Chinese Acad. of Sci.
Organizer: Yu, Xijun Inst. of Applied Physics & Computational Mathematics
Organizer: Xiu, Dongbin Univ. of Utah

Abstract: Efficient solution strategy for stochastic partial differential equations (SPDE) has been a classical topic, as many physical phenomena are inherently random. The topic has received an increasing amount of attention in recent years, driven by the need for uncertainty quantification (UQ). In UQ, even deterministic systems need to be modeled as random because of the uncertainty in the system inputs. Stochastic problems become more challenging to solve, as they often reside in high dimensional random space. The purpose of this mini-symposium is to gather researchers from mathematics and computer science and engineering to interchange the latest advances in simulation techniques for SPDE and UQ. The focus will be on efficient algorithms for practical systems, particularly those arising from multidisciplinary problems.

▶ MS-Tu-E-25-1 16:00–16:30

A Stochastic Study of the Global Instability of Plane Shear Flow

Yu, Haijun Acadamy of Mathematics & Sys. Sci., Chinese Acad. of Sci.
E, Weinan Peking Univ. & Princeton Univ.

Abstract: The instability of laminar flow is one of the most important issues

in fluid dynamics and is not fully understood. We use a stochastic approach to study the global instability of plane shear flow by solving the stochastic impressible Navier-Stokes equations for a very long time. A critical Reynolds is determined based on numerical results for the solution transitions between a localized travelling wave solution and the steady state solution.

▶ MS-Tu-E-25-2 16:30–17:00

Analysis of the Ensemble Kalman Filter for Inverse Problems

Schillings, Claudia Univ. of Warwick
Stuart, Andrew Univ. of Warwick

Abstract: The ideas from the Ensemble Kalman Filter introduced by Evensen in 1994 can be adapted to inverse problems by introducing artifical dynamics. In this talk, we will discuss an analysis of the EnKF based on the continuous time scaling limits, which allows to derive estimates on the long-time behavior of the EnKF and, hence, provides insights into the convergence properties of the algorithm. Results from various numerical experiments supporting the theoretical findings will be presented.

▶ MS-Tu-E-25-3 17:00–17:30

Modelling and Simulation of Radio Frequency Applications with Uncertain Parameters

Pulch, Roland Univ. of Greifswald

Abstract: In radio frequency applications, signals often represent high-frequency oscillations, whose amplitude as well as frequency change slowly in time. Thus a transient simulation of the differential algebraic equations, which describe the underlying electronic circuit, becomes costly. A multidimensional signal model allows for decoupling the slow and the fast time scale. Consequently, we obtain a system of multirate partial differential algebraic equations (MPDAEs). A local frequency function appears as degrees of freedom in this model. Due to miniaturisation, the industrial production of the electronic circuits may involve imperfections, which cause uncertainties in physical parameters. We model these uncertainties by using random variables instead of deterministic parameters. Now the stochastic model inherits degrees of freedom due to the local frequency function. We solve the random-dependent MPDAEs numerically, where the computation of moments or failure probabilities is required, for example. On the one hand, sampling methods are feasible. On the other hand, techniques based on the polynomial chaos result in stochastic Galerkin methods or stochastic collocation schemes. We present results of numerical simulations for a test example.

▶ MS-Tu-E-25-4 17:30–18:00

Uncertainty Quantification in Composite Materials Manufacturing

Tretyakov, Michael Univ. of Nottingham

Abstract: There are a number of sources of uncertainty which affect manufacturing of composite materials. In the talk resin transfer moulding (RTM) process is considered taking into account random variability of permeability of dry reinforcement. RTM is described via a moving boundary problem in random porous media. Results of numerical study of this model will be presented.

▶ MS-Tu-E-25-5 18:00–18:30

Stochastic Variational Inequalities with Polynomial Chaos

Ghanem, Roger Univ. of Southern California

Abstract: We will describe the development of stochastic variational inequalities for problems with interfaces, con- tact, and phase transformation that exhibit variability in material properties. We build on the product space nature of the polynomial chaos decomposition to extend the standard variational inequality constructions to functional spaces adapted to the stochastic case. We describe mathematical and computational challenges and demonstrate the formalism on a wide range of practical problems.

MS-Tu-E-26 16:00–18:00 110

Recent Advances in the Solution of Least Squares Problems 1

Organizer: Hayami, Ken National Inst. of Informatics

Abstract: Least squares problems appear in many important applications in science and engineering. Recently, there have been many developments in the solution of least squares problems of various kinds. Examples are fast and robust solvers for large scale least squares problems combining Krylov subspace methods with efficient preconditioners such as stationary inner iterations or balanced incomplete factorization. There are also advances in other kinds of least squares problems, such as nonnegative constrained least squares problems, nonlinear least squares problems, total least squares problems and integer least squares problems etc. This mini-symposium will address on recent advances in such areas.

▶ MS-Tu-E-26-1 16:00–16:30

Application of Inner-iteration Preconditioning to General Least Squares Problems

Morikuni, Keiichi Univ. of Tsukuba
Hayami, Ken National Inst. of Informatics

Abstract: We apply inner-iteration preconditioning to the left- and right-preconditioned generalized minimal residual (GMRES) method (AB- and BA-GMRES) for solving general least squares problems, whose solutions are the minimum-norm solutions of standard least squares problems (pseudo-inverse solutions). We use a two-step procedure, whose first step is to solve a least squares problem and second step is to solve a linear system of equations. Numerical experiments show that the proposed method is more efficient than previous methods.

▶ MS-Tu-E-26-2 16:30–17:00

Preconditioners for Least Squares Problems

Mas, Jose Universitat Politecnica de Valencia
Marin, Jose Universitat Politecnica de Valencia
Hayami, Ken National Inst. of Informatics

Abstract: New preconditioners for least squares problems based on incomplete LU factorizations are presented. Two approaches are considered: computing an incomplete LU factorization of a suitable submatrix of the coefficient matrix, or to compute a pseudoinverse from an incomplete LU factorization and use it as preconditioner. Numerical experiments on a set of matrices will be discussed and analyzed. In addition several reorderings of the coefficient matrix are previously applied to the coefficient matrix.

▶ MS-Tu-E-26-3 17:00–17:30

Jacobian-Free Three-Level Trust Region Method for Nonlinear Least Squares Problems

Xu, Wei Tongji Univ.
Hayami, Ken National Inst. of Informatics
Zheng, Ning The Graduate Univ. for Advanced Studies

Abstract: Nonlinear least squares (NLS) problems arise in many applications. Common solvers require to compute and store the corresponding Jacobian matrix explicitly. In this paper, we propose an effective Jacobian free method especially for large NLS problems because of the novel combination of using automatic differentiation with the preconditioning ideas that do not require forming the Jacobian matrix. Our method does not rely on the sparsity. Thus, it can be applied to solve large NLS problems.

▶ MS-Tu-E-26-4 17:30–18:00

Block Gram-Schmidt Algorithms

Barlow, Jesse The Pennsylvania State Univ.

Abstract: This talk will discuss some recent advances in block Gram-Schmidt for QR factorization. Two applications will be of interest. The first is the QR factorization of matrices arising out of solving large scale linear systems by Krylov space methods and block Krylov space methods. Here we present a context for tall-skinny QR factorization in computing these factorizations. The second is block downdating, the problem of removing several rows from an already completed QR factorizations.

MS-Tu-E-27 16:00–18:00 407

Decoupling methods for multi-physics and multi-scale problems - Part I of VIII

For Part 2, see MS-We-D-27
For Part 3, see MS-We-E-27
For Part 4, see MS-Th-BC-27
For Part 5, see MS-Th-D-27
For Part 6, see MS-Th-E-27
For Part 7, see MS-Fr-D-27
For Part 8, see MS-Fr-E-27

Organizer: He, Xiaoming Missouri Univ. of Sci. & Tech.
Organizer: Xu, Xuejun Inst. of Computational Mathematics, AMSS, CAS

Abstract: The inherent multi-physics and multi-scale features of many real world problems accentuate the importance to develop efficient and stable numerical methods for the relevant PDEs, especially the decoupling methods. Although great efforts have been made for solving these problems, many practical and analytical challenges remain to be solved. This mini-symposium intends to create a forum for junior and senior researchers from different fields to discuss recent advances on the decoupling methods for multi-physics and multi-scale problems with their applications.

▶ MS-Tu-E-27-1 16:00–16:30

On A New Robin-type Nonoverlapping Domain Decomposition Preconditioner

Xu, Xuejun Inst. of Computational Mathematics, AMSS, CAS

Abstract: In this talk, we shall present a new Robin-type nonoverlapping domain decomposition preconditioner. The unknown variables to be solved in this preconditioned algebraic system are the Robin transmission condition on the interface, which are different from the well-known DD methods like substructuring nonoverlapping DD method and FETI method. By choosing suitable parameter on each subdomain boundary and using the tool of energy estimate, for the second-order elliptic problem, we prove that the condition number of the preconditioned system is $C(1+\log(H/h))^2$, where H is the coarse mesh size and h is the fine mesh size. Numerical results shall be given to illustrate the efficiency of our DD preconditioner. This talk is based on a joint work with Yongxiang Liu.

▶ MS-Tu-E-27-2 16:30–17:00

Direct Numerical Simulation of Charged Particles in Complex Flows

Ruede, Ulrich FA Univ. Erlangen

Abstract: Massive parallelism enables the fully resolved simulation of flows with large ensembles of suspended rigid particles that are represented as individual geometric objects. Our approach uses a Lagrangian approach based on rigid multi body dynamics and an Eulerian description of the flow with the Lattice Boltzmann method. Additionally we model electrostatic forces on the particles using a finite volume discretization for the electric field. All effects are coupled and result in a six-way interaction.

▶ MS-Tu-E-27-3 17:00–17:30

Efficient Multi-stage Preconditioners for Highly Heterogeneous Reservoir Simulations on Parallel Distributed Systems

Chen, Zhangxin Xi'an Jiaotong Univ. & Univ. of Calgary

Abstract: Large-scale reservoir simulation has been a big challenge due to the difficulty of solving linear systems resulted from nonlinear Newton iterations. For black oil simulation, for example, more than 90% of running time is spent on the solution of linear systems. The problem is getting worse when developing parallel reservoir simulators using parallel distributed systems with tens of hundreds of CPUs. Efficient linear solvers and preconditioners are critical to the development of parallel reservoir simulators.
This presentation will address our recent work on developing parallel physics-based preconditioners for highly heterogeneous reservoir simulations. A family of new Constrained Pressure Residual (CPR)-like preconditioners and advanced matrix pre-processing methods are developed, including two new three-stage preconditioners and three four-stage preconditioners. A pressure system is solved by an algebraic multi-grid method, a saturation system is solved by a restricted additive Schwarz method (domain decomposition method), and the entire linear system is also solved by the restricted additive Schwarz method. To overcome a convective issue in reservoir simulation, a parallel potential-based matrix reordering method is employed to stabilize our preconditioners. Matrix decoupling methods, such as the alternative block factorization (ABF) strategy and the quasi-IMPES (implicit pressure explicit saturation) strategy, are also applied. With the restricted additive Schwarz and algebraic multi-grid methods, our preconditioners have good scalability for parallel computers.
Our preconditioners have been applied to oil-water and black oil benchmark simulations. For the SPE 10 project, which is a big challenge for a linear solver because of highly heterogeneous permeability and porosity, our preconditioners with Krylov subspace solvers are stable and efficient. When using 128 CPUs, the number of iterations of our linear solvers is less than 20, and the SPE 10 project is finished in 4.5 minutes. When applying our method to a refined SPE 1 project from black oil simulation with over 80 million of grid cells, the number of iterations of our linear solvers is fewer than 3 using 1,024 CPU cores. Benchmarks with 4,096 CPU cores on IBM Blue Gene/Q are also performed and linear scalability is obtained. Our numerical experiments show that our preconditioners and linear solvers are stable with a large number of CPU cores and are efficient for highly heterogeneous simulations.

▶ MS-Tu-E-27-4 17:30–18:00

Strength Failure Models in An Eulerian Context

Grove, John Los Alamos National Laboratory

Abstract: We will describe an anisotropic failure model for ductile material failure. The model is based on the polar decomposition of the stress tensor. When a stress component exceeds a specified failure tolerance the stress tensor is modified to remove this component in the direction of the corresponding eigenvector. We will discuss the implementation of this method in an Eulerian hydrodynamics code and thermodynamic issues associated with the model.

MS-Tu-E-28 16:00–18:30 109

FLOW, HEAT AND MASS TRANSFER IN FLUID MECHANICS - Part I of II

For Part 2, see MS-We-D-28

Organizer: P A, Dinesh M S Ramaiah Inst. of Tech., Bangalore

Abstract: The objective of this mini symposium is to develop a mathematical model and to investigate analytically or numerically and systematically the study of flow problems; free, forced and mixed convection heat and mass transfer arises in fluid mechanics. Study of such type of problems in fluid mechanics has received enormous attention of many researchers in industrial applications, scientific and engineering fields. The subject is multidisciplinary and completely encircles the main views of applied mathematics to areas like soil physics, hydrogeology, petroleum industry, filtration of solids from liquids, chemical engineering, biological systems, oil reservoir modelling, food processing, casting and welding, manufacturing processes, the dispersion of pollutants into environment, storage of nuclear waste, power plant stream lines, bio mechanical, polymerization, fluid mechanics, filters, chemical, mechanical, paper and cloth industry, geophysics, chemistry etc.
The following are the abstracts proposed for the mini symposia:
A numerical solution for the free convective, unsteady, laminar convective heat and mass transfer in a MHD viscoelastic fluid along a semi-infinite vertical plate with Soret and Dufour effects is presented. The Walters-B liquid model is employed to simulate medical creams and other rheological liquids encountered in biotechnology and chemical engineering. This rheological model introduces supplementary terms into the momentum conservation equation. The dimensionless unsteady, coupled, and non-linear partial differential conservation equations for the boundary layer regime are solved by an efficient, accurate and unconditionally stable finite difference scheme of the Crank-Nicolson type.
The aim of this study is to present chemical reaction and thermophoretic effects on MHD mixed convective incompressible flow, viscous and electrically conducting fluid over a radiate isothermal inclined plate embedded in a porous medium in the presence of heat source/sink.
We analyzed the effects of thermal radiation, viscous dissipation and magneticfield on boundary layer flow of a nanofluid past a nonlinear permeable stretching/shrinking sheet.
In this problem the flow of a Viscoelastic fluid due to a linearly and quadraticaly stretching sheet and heat transfer characteristics using variable thermal conductivity is studied in the presence of a non uniform heat source/sink. The thermal conductivity is assumed to vary as a liner function of temperature. The similarity transformation is used to convert the governing partial differential equations of flow and heat transfer into a ordinary differential equations. Shooting method is used to obtain the numerical solution for the resulting boundary value problem. The effects of Chandrashekar Number, Prandltl Number, Non-Uniform heat source/sink parameters and Variable Thermal Conductivity parameter on the dynamics are shown graphically in several plots.
In this paper, a multi grid analysis of the effect of surface roughness in hydrodynamic lubrication of a porous journal bearing with a heterogeneous slip/no-slip surface is studied. In the traditional lubrication theory, it has been assumed that all the bearing surfaces are smooth but it is unrealistic study for the bearing with small film thickness.
This study reports a numerical investigation of the convective flow and heat transfer in a square porous cavity with partially active thermal walls. Five different heating and cooling zones are considered along the vertical walls

▶ MS-Tu-E-28-1 16:00–16:30

DOUBLE DIFFUSIVE MIXED CONVECTION IN A COUPLE STRESS FLUIDS WITH VARIABLE FLUID PROPERTIES

Narasappa, Nalinakshi Atria Inst. of Tech.
P A, Dinesh M S Ramaiah Inst. of Tech., Bangalore
D V, Chandrashekhar Vivekananda Inst. of Tech.

Abstract: An analytical and numerical approach is been made to investigate the double diffusive mixed convection flow of a couple stress fluid over a vertical heated plate. The effect of couple stress parameter and other physical parameters are presented. It is observed that maximum velocity moves far away from the plate with the increase of couple stress parameter which is due to the rotational field of the velocity generated in couple stress fluid.

▶ MS-Tu-E-28-2 16:30–17:00

Numerical Study for Stokes Flow Past A Cylinder in Porous Media

D V, Jayalakshmammma Vemana Inst. of Tech.
P A, Dinesh M S Ramaiah Inst. of Tech., Bangalore
D V, Chandrashekhar Vivekananda Inst. of Tech.

Abstract: A numerical study of Brinkman flow is considered for a steady, incompressible, viscous fluid past an impermeable cylinder embedded in a sparsely packed porous media, by assuming uniform velocity far away from the surface of the cylinder. The similarity transformation method is employed, the resulting ordinary differential equation is solved numerically by using shooting technique. The effects of non-dimensional parameters, on both the tangential and normal components of velocity are investigated and are illustrated graph-

ically.

▶MS-Tu-E-28-3 17:00–17:30

Flow and Heat Transfer in A Viscous Fluid over A Stretching Sheet with Variable Thermal Conductivity and Non Uniform Heat Source

P A, Dinesh — M S Ramaiah Inst. of Tech., Bangalore
S T, DINESH KUMAR — GOVERNMENT Sci. COLLEGE

Abstract: In this problem the flow of a Viscoelastic fluid due to a linearly and quadraticaly stretching sheet and heat transfer characteristics using variable thermal conductivity is studied in the presence of a non uniform heat source/sink. Shooting method is used to obtain the numerical solution for the resulting boundary value problem. The effects of Chandrashekar Number, Prandltl Number, and Variable Thermal Conductivity parameter on the dynamics are shown graphically in several plots.

▶MS-Tu-E-28-4 17:30–18:00

Multi Grid Based Analysis of Surface Roughness Effect in A Short Porous Journal Bearing with A Heterogeneous Slip/No-Slip Surface

G K, Kalavathi — Malnad College of Engineering Hassan

Abstract: In this paper, a multi grid analysis of the effect of surface roughness in hydrodynamic lubrication of a porous journal bearing with a heterogeneous slip/no-slip surface is studied. By considering surface roughness structure, the modified Reynolds equations are mathematically formulated accounting for the heterogeneous surface on which slip occurs in certain region and is absent in others. The Christensen stochastic theory is used to study the surface roughness effect.

▶MS-Tu-E-28-5 18:00–18:30

NUMERICAL STUDY OF SQUEEZE FILM LUBRICATION BETWEEN PARALLEL PLATES IN THE PRESENCE OF MAGNETIC FIELD

Patil, Shalini M — JSSATE
P A, Dinesh — M S Ramaiah Inst. of Tech., Bangalore
C.V, VINAY — J S S Acad. of Technical Education

Abstract: Theoretical and Numerical study of squeeze film lubrication between two rectangular parallel plates in the presence of uniform magnetic field is carried out. Using BJ slip conditions and Christensen Stochastic theory the Modified Reynolds Equation (MRE) is derived. Finite difference based multigrid method is adopted to solve the MRE. The investigations reveal that the squeeze film characterstics like pressure distribution and load carrying capacity increases for increasing roughness parameter and Hartmann number.

MS-Tu-E-29 16:00–18:00 305

High Order Numerical Methods for PDEs - Hybrid Methods - Part I of III

For Part 2, see MS-We-D-29
For Part 3, see MS-We-E-29

Organizer: Jung, Jae-Hun — SUNY at Buffalo
Organizer: Don, Wai Sun — Ocean Univ. of China/Brown Univ.
Organizer: Ling, Leevan — Hong Kong Baptist Univ.
Organizer: Yoon, Jungho — Ewha W. Univ.

Abstract: In this mini-symposium, we gather together researchers in the areas of high order numerical approximation methods for PDEs and Images and their applications. The mini-symposium will present recent progress in high-order methods including ENO/WENO methods, spectral methods, discontinuous Galerkin methods, and radial basis function methods. Particularly we are interested in the recent development of the hybrid methods that combine the different high order methods in a single frame. The proposed mini-symposium will gain a significant attention since it will provide a valuable opportunity for researchers from different areas to investigate the idea of hybridization of their methods.

▶MS-Tu-E-29-1 16:00–16:30

First Order System Least Squares Pseudo-spectral Method for Stokes-Darcy Equation

Hessari, Peyman — Ulsan National Inst. of Sci. & Technologu

Abstract: We investigate the first order system least squares pseudo-spectral method for coupled Stokes-Darcy equations. Least squares functional is defined by summing up the L^2_w-norm of residuals of the first order system for coupled Stokes-Darcy equations and that of Beavers-Joseph-Saffman interface conditions. Continuous and discrete homogeneous functionals are shown to be equivalent to appropriate norms. The spectral convergence is derived and numerical experiments are also given.

▶MS-Tu-E-29-2 16:30–17:00

Scalable Algorithms for Large Scale Quantum-mechanical Density Matrix Calculations for A Nanoparticle System Interacting with Multi-state Multiple Quantum Dots

MIN, MISUN — Argonne National Laboratory

Abstract: We study a cavity quantum electrodynamics model for the optical response of a metal nano particle system interacting with multi-state multiple quantum dots. We consider the evolution of the quantum-mechanical density operator defined by the statistical emsemble of several quantum states, involving sparse complex density matrix. We explore efficient timestepping and data communication algorithms for large scale Hamiltonian for multiple quantum dots and surface plasmon systems that can be useful in quantum computing.

▶MS-Tu-E-29-3 17:00–17:30

Superconvergence Properties of Discontinuous Galerkin Methods Based on Upwind-biased Fluxes for Linear Hyperbolic Equations.

Frean, Daniel — Univ. of East Anglia

Abstract: Traditionally, superconvergence properties of discontinuous Galerkin (DG) methods have been studied using purely-upwind fluxes. In this talk, we analyze DG methods using upwind-biased fluxes through pointwise spatial discretization error estimates and the smoothness-increasing accuracy-conserving (SIAC) filtered solution. This is done under the assumptions of periodic boundary conditions and a uniform mesh for solving linear hyperbolic equations with smooth solutions. We further illustrate the discussion with numerical experiments. This is joint work with Jennifer Ryan.

▶MS-Tu-E-29-4 17:30–18:00

Superconvergence of Discontinuous Galerkin Method for Linear Hyperbolic Equations

Yang, Yang — Michigan Technological Univ.

Abstract: We apply the discontinuous Galerkin method to hyperbolic equations in two space dimensions. We prove that, under suitable initial discretization, the scheme is k+2th order accurate at the downwind-biased Radau points, and 2k+1th order superconvergence at the downwind point, where k is the polynomial degree used in the finite element space. Numerical experiments will be given to demonstrate that the rate of convergence is optimal.

MS-Tu-E-30 16:00–18:00 VIP2-2

Numerical Analysis of Stochastic Differential Equations - Part II of II

For Part 1, see MS-Tu-D-30

Organizer: Neuenkirch, Andreas — Univ. of Mannheim
Organizer: Jentzen, Arnulf — ETH Zurich

Abstract: This session is devoted to the numerical analysis of all kinds of stochastic differential equations (SDEs) and related approximation problems. Among the studied equations, there will be SDEs with irregular coefficients, backward SDEs (BSDEs), stochastic partial differential equations (SPDEs) and SDEs with other driving noises than Brownian motion. The goal of this session is to present recent developments in the area of computational SDEs. Particular focus will be given to the interplay of the different topics in this area and to the identification of new research questions.

▶MS-Tu-E-30-1 16:00–16:30

Mild Stochastic Calculus and Weak Convergence Rates for Stochastic Partial Differential Equations

Jentzen, Arnulf — ETH Zurich

Abstract: In this talk we present a certain class of stochastic processes, which we suggest to call mild Ito processes, and a new - somehow mild - Ito type formula for such processes. Examples of mild Ito processes are mild solutions of stochastic partial differential equations (SPDEs) and their numerical approximation processes. We illustrate the use of the mild Ito formula by several applications. More details on this topic can be found at [http://www.sam.math.ethz.ch/sam_projects/jentzen/numerical.php].

▶MS-Tu-E-30-2 16:30–17:00

Adaptive Importance Sampling in Least-squares Monte-Carlo Algorithms for Backward Stochastic Differential Equations

Turkedjiev, Plamen — Ecole Polytechnique

Abstract: We design an importance sampling scheme for backward stochastic differential equations (BSDEs) that minimizes the conditional variance occurring in least-squares Monte-Carlo (LSMC) algorithms. The Radon-Nikodym derivative depends on the solution of BSDE, and therefore it is computed within the Dynamic Programming Equation (DPE). To allow robust error estimates w.r.t. the unknown change of measure, we properly randomize the initial position of the forward process. We introduce novel methods to analyze the error: firstly, we establish norm stability results due to the random initialization; secondly, we develop refined concentration-of-measure techniques to highlight the variance of reduction. Our theoretical results are supported by numerical experiments.

▶ MS-Tu-E-30-3 17:00–17:30

Exponential Integrator Schemes for Semi-linear Stochastic Wave Equations

Wang, Xiaojie — Central South Univ.

Abstract: In this talk exponential integrator schemes are introduced for the temporal discretization of semi-linear stochastic wave equations (SWEs) driven by both additive and multiplicative noises. Strong and weak convergence results of the proposed methods are presented. Both theoretical and numerical results show that the exponential schemes have higher convergence rate than the backward Euler–Maruyama scheme and the Crank-Nicolson-Maruyama scheme.

▶ MS-Tu-E-30-4 17:30–18:00

Random Ordinary Differential Equations and Their Numerical Approximation

Kloeden, Peter — Huazhong Univ. of Sci. & Tech.

Abstract: Classical numerical schemes such as Runge-Kutta schemes can be used for RODEs but do not achieve their usual high order since the vector field does not inherit enough smoothness in time from the driving process. It will be shown how, nevertheless, Taylor expansions of the solutions of RODES can be obtained when the stochastic process has Hoelder continuous sample paths and then used to derive pathwise convergent numerical schemes of arbitrarily high order.

MS-Tu-E-31 16:00–18:00 405

Improving convergence of (quasi-)Monte Carlo in financial engineering applications

Organizer: Baldeaux, Jan — Danske Bank

Organizer: Reisinger, Christoph — Oxford Univ.

Abstract: This mini-symposium shows how to improve the convergence of (quasi-)Monte Carlo algorithms by tailoring them to the problem under consideration.

The first talk motivates the use of Monte Carlo methods but also of discrete Markov processes to tackle problems arising in the financial industry. In subsequent talks, it is shown how Monte Carlo methods can be improved by combining multilevel simulation with control variates and how quasi-Monte Carlo samples can be successfully applied to discrete Markov processes. The final talk demonstrates how the variance of option price estimators can be reduced significantly if the expectation with respect to some of the risk-factors is evaluated semi-analytically.

▶ MS-Tu-E-31-1 16:00–16:30

Variance Reduced Monte Carlo Method Path Simulation

Nagapetyan, Tigran — Weierstrass Inst. for Applied Analysis & Stochastics

Abstract: In this talk we present a specially designed control variates for estimating smooth terminal functionals of discretized paths, arising from SDE path approximation. Our control variates decrease the variance of the functional down to the order of discretization step in certain power, which allows us to improve significantly the computational cost / error relation for both Multilevel and Singlelevel Monte Carlo (SMC) methods. Our results are illustrated with several numerical examples arising from financial applications.

▶ MS-Tu-E-31-2 16:30–17:00

CVA Calculations in Consistent Models

Baldeaux, Jan — Danske Bank

Abstract: Asset prices are usually modeled via SDEs. Implementing such a model, different discrete approximations are performed: 1) a forward PDE is discretised for calibration 2) a backward PDE is discretised to price American options 3) an MC scheme is discretised to price path-dependent products. These schemes need not be consistent, i.e. return the same price when pricing the same product. In this talk we show how to ensure that the three discretised schemes are consistent.

▶ MS-Tu-E-31-3 17:00–17:30

Simulation of SDEs with Discontinuous Drift

Leobacher, Gunther — Johannes Kepler Univ. Linz

Abstract: We present an algorithm for the numerical treatment of stochastic differential equations (SDEs) with discontinuous drift. This kind of SDEs appears naturally in stochastic optimal control problems from mathematical finance. The algorithm is shown to have strong order convergence rate 1/2. Furthermore, the algorithm is shown, under mild additional assumptions, to be equivalent to a multidimensional integration problem of a function with bounded variation, making it useful for QMC. Numerical examples illustrate the theoretical findings.

▶ MS-Tu-E-31-4 17:30–18:00

Variance Reduction via Simulation of Analytic Conditional Expectations

Reisinger, Christoph — Oxford Univ.

Abstract: We consider financial derivatives in models where the underlying stock price process has further stochastic parameters, for instance stochastic volatilities and stochastic interest rates. We demonstrate how the variance of estimators can be reduced significantly if the expectation with respect to some of the risk-factors is evaluated semi-analytically. We give a convergence proof of the approximation scheme and numerical experiments.

MS-Tu-E-32 16:00–18:00 307A

Structured-mesh methods for interface problems. - Part I of VIII

For Part 2, see MS-We-D-32
For Part 3, see MS-We-E-32
For Part 4, see MS-Th-BC-32
For Part 5, see MS-Th-D-32
For Part 6, see MS-Th-E-32
For Part 7, see MS-Fr-D-32
For Part 8, see MS-Fr-E-32

Organizer: Chen, Huanzhen — College of Mathematical Sci. Shandong Normal Univ.

Organizer: He, Xiaoming — Missouri Univ. of Sci. & Tech.

Organizer: KWAK, Do Young — Korea Advanced Inst. of Sci. & Tech.

Organizer: Zhang, Xu — Purdue Univ.

Abstract: In many real world applications it is more convenient or efficient to utilize structured meshes for solving different types of interface problems. Since the structured meshes may not fit the non-trivial interfaces, special methods need to be developed to deal with the difficulties arising from the interface problems in order to solve them on these meshes. Therefore, great efforts have been made for solving interface problems and tracing the moving interfaces based on structured meshes in the past decades. This mini-symposium intends to create a forum for researchers from different fields to discuss recent advances on the structured-mesh numerical methods for interface problems and their applications.

▶ MS-Tu-E-32-1 16:00–16:30

A P_1-immersed FEM for Heterogeneous Elasticity Problems

KWAK, Do Young — Korea Advanced Inst. of Sci. & Tech.

Abstract: We develop a new finite element method using uniform meshes for solving planar heterogeneous elasticity problems. This method is based on the 'broken P_1-nonconforming finite element' for elliptic interface problems. We modify the basis functions so that they satisfy the interior traction condition along the interface. We prove optimal H^1, L^2 and divergence norm error estimates under a mild assumption on the regularity of the solution. Numerical experiments are included.

▶ MS-Tu-E-32-2 16:30–17:00

Simulation of Parachute FSI Using the Front Tracking Method

Li, Xiaolin — SUNY at Stony Brook

Abstract: We use the front tracking method on a spring system to model the dynamic evolution of parachute canopy and risers. The present model is shown to be numerically convergent and conforms with the material's Young modulus and Poisson ratio. The system is coupled with the Navier-Stokes equation using the impulse method. Porosity, parachutist effect and turbulence models are included. Complex validation simulations conclude the effort via drag force comparisons and breathing period with experiments.

▶ MS-Tu-E-32-3 17:00–17:30

A Multigrid Algorithm for A Mixed Elliptic Hyperbolic PDE

Meir, Amnon J. — Auburn Univ.

Abstract: Partial differential equations of mixed type appear in mathematical models of various phenomena, for example, transonic flows. Numerical simulation of such problems is often difficult, mainly due to the fact that different discretizations and numerical algorithms are suitable for the different equation types arising in different parts of the domain. Here we present an efficient multigrid algorithm for handling mixed-type problems that are elliptic on one side of an interface and hyperbolic on the other.

▶ MS-Tu-E-32-4 17:30–18:00

Local Discontinuous Galerkin Method for Parabolic Interface Problems

Yu, Xijun — Inst. of Applied Physics & Computational Mathematics

Abstract: In this talk, we give the so-called minimal dissipation local discontinuous Galerkin method for solving the parabolic interface problems. The interfaces are of arbitrary shape but are smooth. We prove that the proposed method is L2 stable and the error estimate of linear Galerkin methods in the energy norm is of order O(h2) for 1D and O(h—logh—1/2) for 2D respectively. Numerical experiments are given to verify the efficiency and accuracy of the

method.

MS-Tu-E-33 16:00–18:00 406
Particle Method Based Applications and their Parallel Optimizations towards Exascale.

Organizer: Guo, Xiaohu Sci. & Tech. Facilities Council
Organizer: Cui, Tao ICMSEC, AMSS, CAS

Abstract: A large number of industrial physical problems can be modeled using particle-based methods. Particle descriptions can be used for the simulation of continuum systems as in the case of discrete fluid or solid elements in smooth particle hydrodynamics (SPH) and vorticity-carrying fluid elements in vortex methods (VM); or for inherently discrete systems as in gravitational particles for astrophysics, dissipative particle dynamics (DPD) for mesoscale polymer descriptions, atomistic molecular dynamics (MD) simulations, and charged particles in plasma physics(PIC). The dynamics of particle methods are governed by the interactions of the N computational particles resulting in an N-body problem with a computational cost that scales nominally as O(N2). For short-ranged particle interactions, the computational cost scales linearly with the number of particles. Therefore, the parallel implementations of these methods are critical for application purpose. In recent published DOE exascale math report, particles based methods have been identified as "well-suited for exascale computing". The reason is that particles based methods provide extremely fine-grained parallelism and each particle can compute independently and allow the exploitation of asynchrony. Particles model can effectively use single precision accuracy due to the associated statistical noise. And their statistical nature also makes the application software resilient to both soft and hard faults. Methods in this category include Monte Carlo, smoothed particle hydrodynamics, and particle-in-cell techniques. Efficient parallel particle method based application libraries typically require the following efficient kernel implementation: domain decomposition, dynamic load balancing, optimized data mapping (structured and unstructured communication), parallel file I/O, nearest neighbor lists searching routines for building trees, particle-to-mesh, and mesh-to-particle interpolation, sparse linear solver for incompressible problems. The present proposal aims to identify the common efficient implementation of the above kernels and their high performance optimizations among above different applications for the future exascale systems. In the mean time, the following implementation factors will be considered: Exploiting the symmetry of the particle interactions requires sending back of ghost contributions to the proper real particle The simultaneous presence of particles and meshes prohibits a single optimal way of parallelization Complex-shaped computational domains and strong particle inhomogeneities require spatially adaptive domain decompositions Particle motion may invalidate the existing domain decomposition causing rising load imbalance, and com plicate the implementation of multi-stage integration schemes Inter-particle relations constrain decompositions and data assignment Efficient implementations on many core architectures.

▶MS-Tu-E-33-1 16:00–16:30
Highly Scalable Parallel Toolkit for Solving A Complex, Highly Nonlinear and Distorted Flow Using Incompressbile Smoothed Particle Hydrodynamics
Guo, Xiaohu Sci. & Tech. Facilities Council
Cui, Tao ICMSEC, AMSS, CAS

Abstract: A large number of industrial physical problems can be simulated using particle-based methods. In this talk, we will present a toolkit for solving a complex, highly nonlinear and distorted flow using Incompressible Smoothed Particle Hydrodynamics in very large scale. This toolkit is implemented cache friendly and specially designed to preserve the data locality. With unstructured communication mechanism in parallel, this toolkit can also be used with the other type of particle methods, such as PIC.

▶MS-Tu-E-33-2 16:30–17:00
Feature-scale Simulations of Particulate Slurry Flows in Chemical Mechanical Polishing by SPH
Shao, Sihong Peking Univ.
Yan, Changhao Fudan Univ.
Cai, Wei Univ. of North Carolina at Charlotte

Abstract: In this talk, the mechanisms of material removal in chemical mechanical polishing in the very large scale integration (VLSI) process are investigated by the smoothed particle hydrodynamics (SPH) method. The feature-scale behaviors of slurry flow, rough pad, wafer defects, moving solid boundaries, slurry-abrasive interactions and abrasive collisions are modeled and simulated. The preliminary results provide microscopic insights on the experimental data of the relation between the removal rate and abrasive concentration.

▶MS-Tu-E-33-3 17:00–17:30
Incompressible Smoothed Particle Hydrodynamics
Lind, Steven Univ. of Manchester

Abstract: This paper summaries recent work by the authors in developing a robust and highly accurate Incompressible Smoothed Particle Hydrodynamics (ISPH) method for general fluid flows. ISPH uses a projection method to enforce incompressibility and a particle redistribution (or shifting) procedure for numerical stability. Internal, free-surface, and two phase flows (Newtonian and non-Newtonian) can be accurately modelled for a wide range of parameters. Industrial applications within offshore/coastal engineering and manufacturing are presented.

▶MS-Tu-E-33-4 17:30–18:00
Variational Symplectic Algorithm for Kinetic Plasma Simulation
Xiao, Jianyuan Univ. of Sci. & Tech. of China

Abstract: In this work, we show how to construct a variational multi-symplectic particle-in-cell (PIC) algorithm with smoothing functions for the Vlasov-Maxwell system. The conservation of discrete symplectic structure make this algorithm specifically suitable for simulating long-term dynamics of plasmas. The algorithm has been implemented in a 6D large scale PIC code, Numerical examples are given to demonstrate the good conservation properties of this algorithm.

MS-Tu-E-34 16:00–18:00 112
Mathematics and Algorithms in Quantum Chemistry - Part II of III
For Part 1, see MS-Tu-D-34
For Part 3, see MS-We-D-34

Organizer: Melgaard, Michael Univ. of Sussex
Organizer: Shao, Sihong Peking Univ.

Abstract: Ab initio models of electronic structures has had an immense impact in the physics and chemistry communities, as well as the materials science community, due to the capacity for carrying out realistic computations. The mathematical formulation and the efficient numerical simulation of such models is a notoriously difficult problem for several reasons, e.g., high dimensional configurations spaces, multi-particle interactions, multiple scales, nonlinear effects, and/or degeneracies of eigenspaces. Further developments in this area require the integration of physical modeling, mathematical analysis, and algorithm development in order to obtain reliable computational tools. The mini-symposium aims to bring together quantum chemists, applied and computational mathematicians, physicists and materials scientists all of whom are working in quantum chemistry to exchange ideas and to share their recent progress on the frontiers of theory and numerical methods as well as applications in material science. The mini-symposium will particularly focus on three topics: Time-dependent problems and excited states; Wave function methods; Relativistic effects.

▶MS-Tu-E-34-1 16:00–16:30
Recent Developments of Adaptive Local Basis Functions for Electronic Structure Calculations
Lin, Lin Univ. of California at Berkeley

Abstract: The discontinuous Galerkin density functional theory (DGDFT) based on adaptive local basis functions can adaptively and systematically incorporates reduce the dimension of the discretized Kohn-Sham equation. Recently, we validate the accuracy of the force calculation with single point calculation, molecular dynamics, and vibrational calculations. Together with the PEXSI technique, the DGDFT method is highly parallelizable to more than 100k processors.

▶MS-Tu-E-34-2 16:30–17:00
Relativistic Wave Functions: Basic Structures, Coalescence Conditions and Explicit Representation
Shao, Sihong Peking Univ.

Abstract: We first show relativistic many-body Hamiltonians and wave functions can be expressed systematically with Tracy-Singh products for partitioned matrices, and then derive the electron-electron coalescence conditions for the wave functions of the Dirac-Coulomb, Dirac-Coulomb-Gaunt, and Dirac-Coulomb-Breit Hamiltonians by making use of the internal symmetries of the reduced two-electron systems. These findings enrich our understandings of relativistic wave functions and may be useful to develop relativistic explicitly correlated wave function methods.

▶MS-Tu-E-34-3 17:00–17:30
Hierarchical Tensors and Tensor Networks for Many Particle Quantum Systems
Schneider, Reinhold Inst. for Mathematics

Abstract: In tensor product approximation, Hierarchical Tucker tensor format (Hackbusch) and Tensor Trains (TT) (Tyrtyshnikov) have been introduced

recently offering stable and robust approximation by a low order cost . If $\mathcal{V} = \bigotimes_{i=1}^{d} \mathbb{C}^2$, these formats are equivalent to tree tensor networks states and matrix product states (MPS) originally introduced for the treatment of quantum spin systems. Considering the electronic Schrödinger equation, we use an occupation number labeling of Slater determinants, and show that the discrete Fock space becomes isometric to d-fold tensor product of a a two-dimensional Hilbert space. %We use hierarchical tensor representations, which are equivalent to tree tensor networks, in particularly in the form of matrix product states. For the computation of an approximate ground solution this problem can be casted into an optimization problem constrained by the restriction to tensors of prescribed multi-linear ranks $\mathbf{r}$. Dirac Frenkel variational principle developed in a similar fashion as for Multi-Configurational Hartree (-Fock) by observing the differential geometric structure of the novel tensor formats. This provides a variational formulation of the QC (Quantum Chemistry) DMRG (Density Renormalization Group) algorithm We propose a dynamical low rank approximation, corresponding to the Dirac-Frenkel variational principle, for solving a constraint optimization problem. The approach can be applied to ground state calculations as well as to dynamical problems. Convergence of (Riemannian) gradient algorithms can be shown. A simple optimization methods is provided by alternating direction methods, which reveals the DMRG (density matrix renormalization group) algorithm. This approach has been applied applied by G.C. Chan et al. and O. Legeza et al. to analyse the dissociation of diatomic molecules and to transition metal complexes, supporting that the presented approach has a certain potential to treat some strongly correlated electronic systems.

▶ MS-Tu-E-34-4 17:30–18:00

A Parallel Orbital-Updating Approach for Electronic Structure Calculations

Xiaoying, Dai — Acad. of Mathematics & Sys. Sci., Chinese Acad. of Sci.)

Abstract: In this talk, we will talk about an orbital iteration based parallel approach for electronic structure calculations. With this new approach, the solution of the single-particle equation is reduced to some solutions of independent linear algebraic systems and a small scale algebraic problem. It is demonstrated by our numerical experiments that this new approach is quite efficient for electronic structure calculations. This presentation is based on some joint works with X. Gong, A. Zhou, andJ.Zhu.

MS-Tu-E-35 16:00–18:00 408

Numerical Algorithms for Stochastic Model and Uncertainty Quantification in High-Dimensional Complex Systems - Part II of II

For Part 1, see MS-Tu-D-35

Organizer: Wang, Peng — Beihang Univ.
Organizer: Lin, Guang — Purdue Univ.

Abstract: Uncertainty persists in most natural and engineering systems, from material discovery to reactive transport in porous media. Quantifying the uncertainty associated with the parameters in complex systems is critical, which can help us to verify our modern simulation codes and assess confidence levels. Our aim is to use accurate computational simulations to predict the behaviour of complex systems. For large number of random dimensions, advanced stochastic approximation techniques are necessary to minimize the complexity of mathematical models. This minisymposium will explore recent advances in numerical algorithms and applications for stochastic model, uncertainty quantification, and model reduction in large-scale high-dimensional complex systems.

▶ MS-Tu-E-35-1 16:00–16:30

Uncertainty Quantification and Parameter Inference for Mesoscopic Modeling

Huan, Lei — Pacific Northwest Natl Laboratory
Yang, Xiu — Pacific Northwest Natl Laboratory
Bin, Zheng — Pacific Northwest National Laboratory
Karniadakis, George — Brown Univ.
Baker, Nathan — Pacific Northwest Natl Laboratory

Abstract: We propose a method to quantify uncertainty for physical systems with high dimensional stochastic space using generalize polynomial chaos expansion. We demonstrate that sparse grid method suffers instability problem for such systems. Alternatively, we re-define a set of variables within active subspace to increase the sparsity of gPC expansion, yielding more accurate surrogate model recovered by compressive sensing method. Our method is demonstrated in soft matter systems, which enables us to identify possible parameter degeneracies.

▶ MS-Tu-E-35-2 16:30–17:00

STOCHASTIC HOMOGENIZATION OF ELLIPTIC EQUATIONS AND OPTIMAL CONTROL PROBLEMS

Ming, Ju — Beijing Computational Sci. Research Center

Abstract: We consider an optimal control problem governed by elliptic equations with rapidly oscillating random coefficients. Using the stochastic homogenization method in the frame of H-convergence, we derive an optimal problem in which the state equations are associated with the H-limit of the coefficients. Numerical experiments are performed to validate our results.

▶ CP-Tu-E-35-3 17:00–17:20

Film Blowing Modeling to Enhance Film Properties Prediction

Koren, Barry — Eindhoven Univ. of Tech.
Leonova, Tatiana — Eindhoven Univ. of Tech.
Van Eijndhoven, Stef — Eindhoven Univ. of Tech.

Abstract: Polyethylene films are widely used for packaging. Last decades, polyethylene films have become stronger and thinner. Further film properties improvement is a relevant research goal. Sixty percent of all polyethylene films are produced by film-blowing processes. A mathematical model of polymer melt rheology during film blowing is presented, to enhance film properties prediction. The model incorporates the kinematics and dynamics of the process. In the kinematics part, the polymer melt is assumed to be purely viscous. It is modeled by a non-isothermal Newtonian model, resulting in a system of nonlinear first-order differential equations with appropriate boundary conditions. Bifurcation properties of the model are analyzed. In the dynamics part two constitutive models are explored: the multi-mode Maxwell model and the Phan-Thien-Tanner model. The complete model predicts film stresses, which are further related to other film properties through a data model.

▶ CP-Tu-E-35-4 17:20–17:40

Bayesian Inference Using Probability Measures over Numerical PDEs Solutions

Conrad, Patrick — Univ. of Warwick
Girolami, Mark — Univ. of Warwick
Stuart, Andrew — Univ. of Warwick

Abstract: Many inference problems include PDE-based forward models, but discretization error is an important source of statistical bias. We successfully address this problem by constructing a probability measure over functions consistent with the PDE solution that provably contracts to a Dirac measure on the unique solution. The measure straightforwardly derives from finite element and meshless functional approximations and can be naturally used to make statistical inference, frequentist or Bayesian, insensitive to discretization error.

▶ CP-Tu-E-35-5 17:40–18:00

Fuzzy Reliability Analysis of A Multi-robot System Considering Data Uncertainty

Kumar, Naveen — National Inst. of Tech. Kurukshetra
Komal, Komal — H.N.B. Garhwal Univ., Srinagar(Garhwal), Uttarakhand

Abstract: This paper presents an approach to analyze the fuzzy reliability of a multi-robotic system consisting of two robots working independently with a conveyer unit utilizing uncertain available data collected from various sources. In this approach, quantification of involved uncertainties is done through data fuzzification using triangular fuzzy numbers with known spreads as suggested by system experts. Three different types of techniques namely traditional lambda-tau method, Fuzzy lambda-tau (FLT) and Genetic Algorithms based lambda-tau(GABLT) have been applied for analyzing multi-robotic system fuzzy reliability. Traditional lambda-tau method applies system fault tree to model the system, lambda-tau expressions to formulate system failure/repair rates' mathematical expressions and uses crisp data for analyzing system reliability. On the other hand, FLT uses system fault tree, fuzzy data, α -cut set, lambda-tau expressions, and fuzzy arithmetic operations for analyzing system fuzzy reliability. This is observed that FLT gives wide ranges of prediction for any fuzzy reliability index due to the use of α -cut set based fuzzy arithmetic operations applied in the calculations. To overcome this problem, present study utilizes GABLT technique in which system fault tree, fuzzy data, α -cut set, lambda-tau expressions, nonlinear programming approach and genetic algorithm is used to analyze system fuzzy reliability. Sensitivity analysis has also been done to analyze the impact on system mean time between failures (MTBF) by varying other reliability parameters. Based on results some influential suggestions are given for improving robotic system performance.

MS-Tu-E-36 16:00–18:30 409
Mori-Zwanzig formulation and applications - Part I of II
For Part 2, see MS-We-D-36
Organizer: Stinis, Panos — Pacific Northwest National Laboratory
Organizer: E, Weinan — Peking Univ. & Princeton Univ.

Abstract: The Mori-Zwanzig formalism allows reducing the number of variables in large systems of coupled equations. For differential equations, the reduced equations model the effect of the unresolved variables, leading to a Markovian, memory and fluctuating terms. This formalism can be a starting point for multiscale and meso-scale modeling, based on first principles calculations. We will investigate recent mathematical developments as well as applications to materials, fluid mechanics, soft matter, biology and uncertainty quantification.

▶MS-Tu-E-36-1 16:00–16:30
Mesh Refinement for Uncertainty Quantification
Stinis, Panos — Pacific Northwest National Laboratory
Li, Jing — Pacific Northwest National Lab

Abstract: We present mesh refinement methods for uncertainty quantification which are inspired by model reduction. The methods do not require the explicit knowledge of the reduced model which can be very expensive to obtain. In addition, they allow a unified framework which can treat mesh refinement both in probability and physical space.

▶MS-Tu-E-36-2 16:30–17:00
Parametrization of Multiscale Systems: Mori-Zwanzig and Ruelle Approaches
Lucarini, Valerio — Univ. of Hamburg

Abstract: We study how to parametrize the effect of the Y variables Y on the X variables of a dynamical system, when the X-Y coupling is weak. Using the Ruelle response theory, one can construct a surrogate dynamics such that the expectation values of any observable agrees to what prescribed by the full dynamics. The same surrogate dynamics is obtained by expanding the Mori-Zwanzig projection operator. The parametrization includes deterministic, stochastic, and memory terms.

▶MS-Tu-E-36-3 17:00–17:30
Bottom-up Construction of Dissipative Particle Dynamics Model Using the Mori-Zwanzig Formulation
Li, Zhen — Brown Univ.
Bian, Xin — Brown Univ.
Caswell, Bruce — Brown Univ.
Karniadakis, George — Brown Univ.

Abstract: The coarse-grained force field governing the dissipative particle dynamics (DPD) system is constructed directly from a microscopic dynamics by using Mori-Zwanzig (MZ) formulation. The bottom-up coarse-graining procedure is demonstrated by reproducing a molecular dynamics (MD) system of polymer melts. Quantitative comparisons between the coarse-grained system and its underlying microscopic system indicate that both static and dynamic properties of the MD system can be accurately reproduced by the MZ-guided DPD model without any iteratively optimized parameter.

▶MS-Tu-E-36-4 17:30–18:00
Empirical Approaches to the Mori-Zwanzig Formalism
Chorin, Alexandre — Univ. of California, Berkeley
Lin, Kevin — Univ. of Arizona
Lu, Fei — Univ. of California, Berkeley & Lawrence Berkeley National Lab

Abstract: The Mori-Zwanzig (MZ) formalism shows when we project a dynamical system onto a subset of its degrees of freedom, the resulting process generally exhibits memory. How to represent the memory is a major question in model reduction and data-driven modeling. We discuss some practical issues in evaluating memory terms from data, and propose a class of simple, effective methods to resolve them. We compare our work to earlier proposals and present sample applications.

▶MS-Tu-E-36-5 18:00–18:30
The Mori-Zwanzig Formalism for the Reduction of Molecular Dynamics Models for Biological Systems and Crystalline Solids
Li, Xiantao — The Pennsylvania State Univ.

Abstract: This talk will present methods to address some of the most important issues in the Mori-Zwanzig models for molecular dynamics models. This includes: (1) the computation of the memory; (2) sampling the random noise so that the fluctuation-dissipation theorem is satisfied; (3) adaptive selections of the coarse-grain variables. We present methods that treat all these problems under a unified framework.

MS-Tu-E-37 16:00–18:00 301B
Quantum Control Theory and Its Applications
Organizer: Qi, Bo — AMSS, Chinese Acad. of Sci.
Organizer: Luo, Shunlong — AMSS, Chinese Acad. of Sci.

Abstract: Quantum systems are notoriously different from classical systems, and can outperform classical systems in many important tasks, such as factorization of large numbers, secure communication, ultra-high sensitive measurement. Thus, developing quantum technology has significant importance to national defence and information technology. In this minisymposium, we focus on the theory of quantum control and its applications. We present how to control quantum systems by quantum feedback control, pulse shaping, sampling-based learning control as well as how to efficiently deal with the inevitable quantum measurement backaction effect. We will compare the similarities and differences in controlling quantum systems and classical systems.

▶MS-Tu-E-37-1 16:00–16:30
Estimating and Compensating Quantum Measurement-Induced Backaction
Cui, Wei — South China Univ. of Tech.

Abstract: Measuring a quantum state usually introduces disturbance to the state itself, known as measurement-induced backaction. We developed an extended quantum state observer to estimate the quantum state and backaction. An active disturbance rejection control (ADRC) approach was further proposed for compensating the backaction. This technique allows one to reduce the effects of measurement-induced backaction and to greatly enhance the efficiency of quantum measurement.

▶MS-Tu-E-37-2 16:30–17:00
Quantum Control by Pulse Shaping: Theory and Experiment
Shuang, Feng — Inst. of Intelligent Machines, Chinese Acad. of Sci.

Abstract: Quantum dynamics control has been an attractive field due to its potential applications, and complex controls often hinder our understanding of the underlying mechanisms. Hamiltonian encoding-observable decoding (HE-OD) method is a powerful tool to reveal the control mechanism and steer quantum dynamics. Theories and experiments about the pathway dynamics control of atomic Rubidium will be introduced , including the HE-OD theories and implementation, the features of the pathway dynamics of Rb, and different shaping strategies.

▶MS-Tu-E-37-3 17:00–17:30
Sampling-based Learning Control of Quantum Ensembles
Chen, Chunlin — Nanjing Univ.

Abstract: Compensation for parameter dispersion is a significant challenge for control of quantum ensembles. In this talk, we present the systematic methodology of sampling-based learning control (SLC) for simultaneously steering the members of inhomogeneous quantum ensembles to desired states, and apply the SLC method to several typical quantum ensemble control problems such as control of inhomogeneous quantum ensembles and quantum ensemble classification.

▶MS-Tu-E-37-4 17:30–18:00
Real-time Information, Uncertainty and Quantum Feedback Control
Qi, Bo — AMSS, Chinese Acad. of Sci.

Abstract: In this talk, we compare two types of quantum feedback control, coherent feedback control (CFC) and measurement-based feedback control (MFC)，by focusing on the real-time information used in the feedback loop and the capability in dealing with parameter uncertainty. An equivalent relationship is established between quantum CFC and non-selective quantum MFC. Using several examples of quantum feedback control, we show that quantum MFC can theoretically achieve better performance than quantum CFC.

MS-Tu-E-38 16:00–18:00 302A
Distance Problems for Dynamical Systems
Organizer: Voigt, Matthias — Technische Universität Berlin

Abstract: In engineering practice, many dynamical processes can be modeled by differential or differential-algebraic equations. These systems usually have important properties such as stability that are essential for the simulation. Unfortunately, the governed systems are usually subject to uncertainties in the data or to modeling errors. Therefore, it is not only of importance to know whether a dynamical system has a certain property, but also to assess its robustness with respect to perturbations. This minisymposium will address particular robustness measures and their efficient computation or estimation.

▶MS-Tu-E-38-1 16:00–16:30
Fast Approximation of the Stability Radius and the H_∞ Norm for Large-Scale Linear Dynamical Systems with Output Feedback
Mitchell, Tim — New York Univ.

Guglielmi, Nicola Univ. of L'Aquila
Overton, Michael New York Univ.
Gurbuzbalaban, Mert Massachusetts Inst. of Tech.

Abstract: We present a new superlinearly converging algorithm intended for directly approximating the H-infinity norm of large-scale dynamical systems. Under reasonable assumptions, our hybrid expansion-contraction technique guarantees convergence to stationary points of the optimization problem defining the H-infinity norm and in practice, typically converges quadratically to local or global maximizers. Compared to an earlier, idealized algorithm which could sometimes break down, our new method is provably more robust and also significantly faster.

▶MS-Tu-E-38-2 16:30–17:00

Approximating the Real Structured Stability Radius with Frobenius-bounded Perturbations via Spectral Value Sets

Guglielmi, Nicola Univ. of L'Aquila
Gurbuzbalaban, Mert Massachusetts Inst. of Tech.
Mitchell, Tim New York Univ.
Overton, Michael New York Univ.

Abstract: We propose a fast method to approximate the real structured stability radius of a linear dynamical system with output feedback when real perturbations bounded with respect to the Frobenius norm are considered. Our work builds on a number of algorithms that have been proposed in recent years for approximating the complex or real pseudospectral radius or the complex stability radius (the reciprocal of the $H\infty$norm) for large sparse matrices.

▶MS-Tu-E-38-3 17:00–17:30

Large-Scale Optimization of Eigenvalues

Mengi, Emre Koc Univ.

Abstract: We consider the optimization of a prescribed eigenvalue of a large Hermitian matrix valued function, and suggest the orthogonal projection of the matrix valued function onto a small subspace. The subspace is gradually expanded with the additions of eigenvectors at the optimal points of small problems. This subspace projection idea converges quadratically w.r.t. the dimension of the subspace in practice and theory. We conclude with applications to large problems in control theory and structural design.

▶MS-Tu-E-38-4 17:30–18:00

ROBUST STABILITY FOR HIGHER ORDER IMPLICIT DIFFERENCE EQUATIONS UNDER RESTRICTED PERTURBATIONS

Mehrmann, Volker TU Berlin
Duc Thuan, Do School of Applied Mathematics & Informatics, Hanoi Univ. of Sci. & Tech.

Abstract: In this talk, the robust stability analysis for linear implicit m-th order difference equations is discussed. We allow the leading coefficient coefficient to be singular, i.e., we include the situation that the system does not generate an explicit recursion. A spectral condition for the characterization of asymptotic stability is presented and computable formulas are derived for the real and complex stability radii in the case that the coefficient matrices are subjected to structured perturbations.

MS-Tu-E-39	16:00–18:30	302B
Pharmacometrics: Bridging Mathematics to Pharmaceutical Sciences		

Organizer: Nekka, Fahima Universite de Montreal
Organizer: Li, Jun Universite de Montreal
Organizer: Wu, Xiaotian Univ. of Montreal

Abstract: In the drug development arena, the rapid accumulation of new quantitative methodologies and tools pushed the emergence of systemic and mechanistic studies of pharmacology that drive the drug R&D. Particularly, tools based on modeling and simulation (M&S) gained a large popularity in the milieu considering the increasing number of success stories involving M&S. The efficient use of these tools heavily relies on advanced mathematical methodologies and their appropriateness to the problem at hand. This minisymposium will exemplify this field with mathematical applications to concrete pharmaceutical problems. Mathematical analysis and closed forms of newly reported pharmacokinetics phenomena, identification of drug disposition characteristics in clinical conditions, knowledge translation from in vitro to in vivo conditions for drug design, as well as signal transduction modeling in hematopoietic diseases are some of the examples that will be highlighted.

▶MS-Tu-E-39-1 16:00–16:30

Gabpm: Modeling Ambulatory Blood Pressure Data in R

Yan, Xiaoyan Affiliated Hospital of Shandong Univ. of Traditional Chinese Medicine
Wei, Xijin Affiliated Hospital of Shandong Univ. of Traditional Chinese Medicine
Sun, Xiaoyong Shandong Agricultural Univ.

Abstract: Ambulatory blood pressure measurement (ABPM) is superior to the traditional single blood pressure (BP) measurements. In this talk, we discussed an R package: Gabpm based on the previous work to model and visualize the ABPM data as well as report the modeling results. This tool will gain insight into the digital profiles of patients' BP and can extend to analyze the temporal BP data collected through the wearable devices available in the market.

▶MS-Tu-E-39-2 16:30–17:00

Steady-State Volume of Distribution (Vdss) : Mathematical Formulation and Update

Wu, Xiaotian Univ. of Montreal
Li, Jun Universite de Montreal
Nekka, Fahima Universite de Montreal

Abstract: Vdss is one of the main PK parameters used to determine the drug amount in the body. Its estimation is generally based on noncompartment analysis, underlying thus a linear kinetics. In the context of Michaelis-Menten elimination, exhibited by hormone drugs for example, Vdss has not been studied. In the current work, we elucidate the impact of the structure of the PK model on Vdss estimation and show the discrepancy with previous noncompartmental formulation.

▶MS-Tu-E-39-3 17:00–17:30

Pharmacokinetic Study of Hormone Drugs Exhibiting Simultaneous Linear and Saturated Eliminations

Li, Jun Universite de Montreal
Wu, Xiaotian Univ. of Montreal
Nekka, Fahima Universite de Montreal

Abstract: Hormone drugs generally exhibit simultaneous linear and saturated eliminations and present mathematical challenges for pharmamericians. In the current talk, by introducing a new family of functions that generalizes the Lambert W function, I will provide the closed form solutions of these models and discuss the elimination half-time and its dose-dependency. Moreover, I will shed lights on the interplay of both dominant pathways in terms of model parameters and drug concentration.

▶MS-Tu-E-39-4 17:30–18:00

Pharmacometrics: the Science of Drug-related Variability and Nonlinearity

Nekka, Fahima Universite de Montreal
Li, Jun Universite de Montreal

Abstract: The search for more efficient therapeutics and concerns about their rational use for target populations and diseases raise important challenges. However drug discovery has achieved a stagnating status, strongly suggesting that the empirical culture of this field is gradually fading to give more ground to alternative quantitative approaches. In this talk, I will discuss the probabilistic pharmacometrics framework that we developed to account for drug-related variability and nonlinearity and their therapeutic impact and its added-value.

▶MS-Tu-E-39-5 18:00–18:30

Nonlinear Compartmental Model with Michaelis-Menten Elimination Kinetics

Tang, Sanyi Shaanxi Normal Univerity

Abstract: In this talk, we first present how to obtain the analytical solutions of one compartment models with Michaelis-Menten elimination kinetics for three different inputs (single intravenous dose, multiple-dose bolus injection and constant). All analytical solutions obtained can be described by the well defined Lambert W function which can be easily implemented in most mathematical softwares such as Matlab and Maple. Some analytical techniques have been developed to address the approximation problems of solutions.

MS-Tu-E-40	16:00–18:30	303A
Fluid structure interaction problems		

Organizer: Zhao, Longhua Case Western Reserve Univ.

Abstract: Fluids are the natural environment of almost every organism and fluid structure interaction problems are ubiquitous in many area of biology and geology. As fluid dynamics plays an important role in propulsion and transport, many important fluids and material exhibit nonlinearities and other complex properties. The aim of this mini-symposium is to present examples of such behavior and the techniques use to address these problems.
Note: The number of speaks is five. If this minisymposium is fitted in the conference schedule, the organizer will present the work. If it couldn't, opportunities will been given to the invited speakers.

▶MS-Tu-E-40-1 16:00–16:30

Analytical Results on the Role of Flexibility in Flapping Propulsion
Moore, Nick — Florida State Univ.

Abstract: We use small-amplitude asymptotics to model a flexible wing flapping in an inviscid fluid. Remarkably, the model allows for a class of exact solutions that describe the emergent wing kinematics. These solutions allow us to examine how flexibility modifies propulsive performance and in particular the role of resonance.

▶ MS-Tu-E-40-2 — 16:30–17:00
Fluid Dynamics for Flow  driven by Nodal Cilia
Zhao, Longhua — Case Western Reserve Univ.

Abstract: Nodal cilia play an important role in the left-right symmetry breaking at the early stage of the mammal embryos. This study is about the flow driven by nodal cilia sweeping out cones above a no-slip plane in low Reynolds number regime. We build a mathematical model to investigate the fluid properties and compared with table-top experimental data. Stereoscopic Lagrangian tracking show quantified agreement with theoretical prediction with our model.

▶ MS-Tu-E-40-3 — 17:00–17:30
Sensing Flow Directions by A Hydrodynamic Antenna for Swimming Fish
Zhang, Jun — Courant Inst., New York Univ.

Abstract: The lateral line of fish detects hydrodynamic pressure gradients and is thought to be important in swimming behaviors such as rheotaxis and prey tracking. Here, we explore the hypothesis that this sensory system is concentrated at locations where changes in pressure are greatest during motion through water. Our data from our experiments seem to support the notion that the lateral-line of a fish functions like a hydrodynamic antenna. [Collaborators: L. Ristroph and J. Liao]

▶ MS-Tu-E-40-4 — 17:30–18:00
The Internal Torque Patterns of An Undulatory Swimmer in Resistive Environments
Ding, Yang — Beijing Computational Sci. Research Center

Abstract: Undulatory swimmers such as C. elegans need to overcome the torque generated by resistive forces from environments. We found that the pattern of the torque is also a traveling wave, until it breaks into two traveling waves when the wavelength of the body bending become less than half of the body length. Combined with body elasticity, we found that the same torque pattern can generate different wavelengths observed on C. elegans in different environments.

▶ MS-Tu-E-40-5 — 18:00–18:30
Bodies and Buoyant Jets in Strong Stratification
McLaughlin, Richard — Univ. of North Carolina

Abstract: We present theoretical, computational, and experimental studies of the motion of bodies and buoyant fluids moving through a stratified background density field focusing on the vertical transport. Interesting critical phenomena are observed in which bodies and buoyant fluids may either escape or be trapped as parameters (such as the propagation distance) are varied. An exact solution is derived for the Morton-Taylor-Turner (MTT) closure hierarchy which is proven to be the optimal mixer in this context.

MS-Tu-E-41 — 16:00–18:10 — 303B
Numerical Linear Algebra Techniques in Massive Data Analysis
Organizer: Gu, Ming — Univ. of California Berkeley

Abstract: Effective and efficient treatment of massive data sets has become increasing important in this age of information explosion. Most machine learning and data analysis algorithms for massive data sets require huge amounts of computational time. In this minisymposium, we discuss effective algorithms for analyzing massive data sets by exploiting efficient numerical linear algebra techniques.
This minisymposium is sponsored by the SIAG.

▶ MS-Tu-E-41-1 — 16:00–16:30
Efficient Algorithms for Solving Kadison-Singer Problems
Gu, Ming — Univ. of California Berkeley

Abstract: The Kadison-Singer Problems are a large class of related problems in a dozen areas of research in pure mathematics, applied mathematics and Engineering. Recent work of Marcus, Spielman and Srivastava shows the existence of the solutions to these problems. In this talk, we present efficient algorithms for solving these problems, including algorithms for computing the Weaver and Feichtinger partitions.

▶ MS-Tu-E-41-2 — 16:30–17:00
A Dynamic Approach to Sparse Recovery
Yao, Yuan — Peking Univ.

Abstract: We propose a dynamic approach to sparse recovery under noisy linear measurements, which solve a dilemma in statistics discovered by Fan and Li in 2001: LASSO is biased and to remove the bias while keeping sparse recovery, nonconvex regularization is necessary. However, we will show that a simple dynamics, based on gradient flow in dual space, will generate unbiased and sign-consistent solution without boiling to nonconvex optimization.

▶ MS-Tu-E-41-3 — 17:00–17:30
Fast Randomized Iteration for Matrix Inversion, Eigenproblems, and Exponentiation
Lim, Lek-Heng — Univ. of Chicago
Weare, Jonathan — Univ. of Chicago

Abstract: We introduce randomized iterative algorithms inspired by the diffusion Monte Carlo algorithm for some common tasks in numerical linear algebra. These algorithms work in either linear or constant cost per iteration. Traditional iterative methods in numerical linear algebra were created in part to deal with instances where a matrix (of size $O(n^2)$) is too big to store. Our O(1) iterative methods address instances where even a vector (of size O(n)) is too big to store.

▶ CP-Tu-E-41-4 — 17:30–17:50
Simultaneous Reduction of Large Sparse Matrix Pencils
Sidje, Roger — Univ. of Alabama

Abstract: There are algorithms to simultaneously reduce a pair of symmetric matrices to tridiagonal-tridiagonal form with a congruent transformation, but these algorithms are impractical for large sparse matrices because they successively update the matrices and so destroy their sparsity. We consider pairs that are either symmetric or nonsymmetric in this work. We describe a new Krylov subspace projection method to reduce a symmetric pair to tridiagonal-triadiagonal form with a three-term recurrence that can be interrupted midstream in a Lanczos-like manner. We generalize to reduce a nonsymmetric pair to Hessenberg-Hessenberg form in an Arnoldi-like manner. While the new methods also involve shift-and-invert operations as previous algorithms do, the sparse context means that this step can itself be handled with other specialized methods meant for sparse linear systems. Applications of this work include areas such as the generalized eigenvalue problem where partial simultaneous projection methods can be applied to the matrix pencil.

▶ CP-Tu-E-41-5 — 17:50–18:10
The Low-rank Basis Problem for A Matrix Subspace
Uschmajew, Andre — Univ. of Bonn
Nakatsukasa, Yuji — Univ. of Tokyo
Soma, Tasuku — Univ. of Tokyo

Abstract: Given a matrix subspace, there are relevant reasons to ask for a basis of lowest rank. A greedy algorithm will provably find it, but the subproblems are NP-hard. We propose an algorithm with two phases: first, basis ranks are estimated using soft singular value thresholding. Second, a basis is constructed using hard thresholding and subspace projection. Alternatively, when the basis consists of rank-one matrices, one may find it using tensor decomposition.

MS-Tu-E-42 — 16:00–18:00 — 301A
Nonlinear waves in systems with dissipation and gain - Part II of II
For Part 1, see MS-Tu-D-42
Organizer: Yan, Zhenya — Chinese Acad. of Sci.
Organizer: Konotop, Vladimir — Univ. of Lisbon

Abstract: In a few recent years there was growing interest in propagation of nonlinear waves in media with gain and losses. These are systems with the parity-time (PT) symmetry, with localized gain or dissipation, with imbalances gain and dissipation but still allowing for linear real spectra, etc. Physically the respective models are relevant to optics, plasmonics, Bose-Einstein condensates, atomic gasses, mechanical systems, electric circuits, etc. This Minisymposia aims to joint researches working in the related areas ranging from experimental and theoretical physics to mathematics.

▶ MS-Tu-E-42-1 — 16:00–16:30
Storage and Retrieval of Optical Solitons in Cold Atomic Gases
Huang, Guoxiang — East China Normal Univ.

Abstract: In recent years, much attention has been paid to the study of slow-light and light memory in various physical systems. In this talk, I shall report our recent research results on the storage and retrieval of slow-light solitons and vortices in cold atomic gases.

▶ MS-Tu-E-42-2 — 16:30–17:00
Tunable nonlinear parity – time-symmetric defect modes with an atomic cell

Hang, Chao East China Normal Univ.

Abstract: We propose a scheme of creating a tunable highly nonlinear defect in a one-dimensional photonic crystal. The defect consists of an atomic cell filled in with two isotopes of three-level atoms. The probe-field refractive index of the defect can be made parity - time (PT) symmetric, which is achieved by proper combination of a control field and of Stark shifts induced by a far-off-resonance field. In the PT -symmetric system, families of stable nonlinear defect modes can be formed by the probe field.

▶ MS-Tu-E-42-3 17:00–17:30

Nonlinear Modes in PT-symmetric and Asymmetric Complex Potentials

Zezyulin, Dmitry Univ. of Lisbon

Abstract: There are several fundamental differences in properties of conservative and dissipative nonlinear systems. One of them is related to the structure of stationary modes. In conservative systems, stationary modes constitute one- (or several-) parametric families, while in the presence of gain and dissipation stationary solutions typically represent isolated fixed points. In the context of the nonlinear Schroedinger equation with an additional external potential, this dichotomy is related to the type of the potential. If the latter is real-valued, then the model is conservative and supports the continuous families. On the other hand, a complex potential involves dissipation and gain and the nonlinear modes appear as isolated points. Recently, this issue attracted special attention in the context of nonlinear extensions of parity-time-(PT-) symmetric systems. It was established that the PT-symmetric potentials, although being complex, still can possess continuous families of localized modes resembling in this way conservative systems.
It our work, we show that there exists another general class of complex asymmetric (generally speaking, non-PT symmetric) potentials of the form $w^2(x) - iw_x(x)$, where $w(x)$ is a real function, which allows for the existence of one-parametric continuous families of stationary nonlinear modes. Existence of the continuous families in the problem is explained by a "hidden" symmetry, which is expressed in the form of a conserved quantity of the nonlinear dynamical system describing profiles of the nonlinear modes. This remarkable behavior holds for a fairly general choice of functions $w(x)$. As an illustrative example, we introduce a complex asymmetric double-hump potential and demonstrate that it supports continuous families of nonlinear modes.

▶ CP-Tu-E-42-4 17:30–17:50

Asymptotics for the Defocusing Integrable Discrete Nonlinear Schrödinger Equation

Yamane, Hideshi Kwansei Gakuin Univ.

Abstract: We study the integrable discretization of the defocusing nonlinear Schrödinger equation, namely the Ablowitz-Ladik model. The asymptotic behavior of the solution is investigated by using the nonlinear steepest descent method of Deift-Zhou. We consider three regions. In the first, where 2t¿—n— and t tends to infinity, the leading part is the sum of two terms which shows the behavior of decaying oscillation. In the second, near 2t=—n—, the leading part is a single term with slower decay and simpler oscillation. In the third, where 2t¡—n— and —n— tends to infinity, the solution decays faster than any negative power of n.

MS-Tu-E-43 16:00–18:30 VIP4-1

New models for capacity planning and scheduling

Organizer: Leus, Roel KU Leuven
Organizer: Xie, Jinxing Tsinghua Univ

Abstract: Scheduling theory has received a wide coverage in the literature on operations research and discrete optimization over the last five decades or so, but the literature seems to have reached a “sink” equilibrium with respect to the standard assumptions and parameters to be included in the models. In this symposium we aim to present recent new scheduling models that extend the classic ones, and where the extensions have a direct link with practical operations scheduling in a variety of industries.

▶ MS-Tu-E-43-1 16:00–16:30

Approximate Dynamic Programming Approach for Solving the Stochastic Resource-Constrained Project Scheduling Problems

Li, Haitao Univ. of Missouri - St. Louis

Abstract: In this talk, I present a new approximate dynamic programming (ADP) approach to solve a category of resource-constrained project scheduling problems. To enhance performance of the basic rollout policy offered by priority-rule based heuristic, we employ constraint programming (CP) to handle each sub-problem in the ADP algorithm. We further devise a hybrid framework that integrates both the look-back and look-ahead approximation architectures, to simultaneously achieve both the quality of a rollout (look-ahead) policy, and the

▶ MS-Tu-E-43-2 16:30–17:00

An Exact Algorithm for Parallel Machine Scheduling with Conflicts

Leus, Roel KU Leuven
Kowalczyk, Daniel KU Leuven

Abstract: We consider an extension of classic parallel machine scheduling, where an undirected conflict graph is part of the input. Each node in the graph represents a job and an edge implies that its two jobs cannot be scheduled on the same machine. The goal is to find an assignment of the jobs to the machines such that the maximum completion time is minimized. We present an exact algorithm based on branch and price.

▶ MS-Tu-E-43-3 17:00–17:30

MILP Formulations for Order Splitting on A Multi-slot Machine in the Printing Industry

Trautmann, Norbert Univ. of Bern
Baumann, Philipp Univ. of California, Berkeley
Forrer, Salome Univ. of Bern

Abstract: We study the imprinting of customer-specific designs on napkin pouches. Given customer orders are to be split among several slots of printing plates such that the total costs are minimized subject to several constraints. We present two alternative mixed-binary linear programming formulations which eliminate symmetric solutions explicitly or implicitly, respectively, from the search space. The implicit formulation performs significantly better in terms of average integrality gap and number of instances solved to feasibility.

▶ MS-Tu-E-43-4 17:30–18:00

Using Combinatorial Optimization for Large-scale Data Mining

Baumann, Philipp Univ. of California, Berkeley
Hochbaum, Dorit S. Univ. of California, Berkeley

Abstract: Combinatorial machine learning algorithms represent the data set in form of a graph. The size of the graph grows quadratically in the size of the data set which poses a challenge in terms of scalability. We address this challenge with a novel method called sparse computation that generates a very sparse graph without losing relevant information. Our empirical results show that sparse computation significantly reduces running times, while having a minimal effect on accuracy.

▶ MS-Tu-E-43-5 18:00–18:30

Flexible Personnel Scheduling Using Branch and Price

Brunner, Jens Univ. of Augsburg

Abstract: The talk presents a general approach for flexible personnel scheduling which might be applied to flexible shift or days off scheduling. Main objective is to minimize total workforce size subject to demand coverage. When performing scheduling the minimum and maximum number of consecutive periods on as well as off is limited. Furthermore, total number of working periods in the planning horizon is bounded. Computational experiments show the benefits of having flexibility in the scheduling process.

MS-Tu-E-44 16:00–18:00 VIP2-1

Mathematics of Information and Low Dimensional Models - Part I of III

For Part 2, see MS-We-D-44
For Part 3, see MS-We-E-44

Organizer: Blanchard, Jeffrey Grinnell College

Abstract: This min-symposium considers a variety of ill-posed inverse problems associated with information theory, signal processing, and image processing. By exploiting low dimensional structure, such as in compressed sensing and low rank matrix completion, tractable algorithms permit construction of accurate approximate solutions and low dimensional representations. The mini-symposium will include state-of-the-art work on algorithms, theoretical analysis, and relationships with high dimensional geometry from researchers at all stages of their careers.
Notes to ICIAM Committee: - Jared Tanner (Oxford) is a co-organizer of this symposium but does not have a pin. - This symposium is sponsored by the SIAM SIAG on Linear Algebra.

▶ MS-Tu-E-44-1 16:00–16:30

Self-calibration and Biconvex Compressive Sensing

Ling, Shuyang UC Davis

Abstract: Compressive sensing is an ingenious strategy to sample sparse signals. Meanwhile, self-calibration is to equip a hardware device with a smart algorithm that can compensate automatically for the lack of calibration. We show how several self-calibration problems can be treated efficiently as a biconvex compressive sensing problem y = DAx with unknown sparse x and diagonal matrix D. We describe how 'SparseLift' solves this underdetermined system exactly and efficiently via linear programming with theoretic guarantees.

▶ MS-Tu-E-44-2 16:30–17:00

Conjugate Gradient Iterative Hard Thresholding

Blanchard, Jeffrey — Grinnell College

Abstract: Conjugate Gradient Iterative Hard Thresholding is a greedy algorithm for solving the compressed sensing and matrix completion problems combining the advantages of the low per iteration complexity of Normalized Iterative Hard Thresholding and the effectiveness of projection based algorithms such as Hard Thresholding Pursuit and Compressive Sampling Matching Pursuit. This talk will also introduce the compressed sensing and matrix completion problems as examples of low dimensional models.

▶ MS-Tu-E-44-3 17:00–17:30

Recovery of Low Rank Tensors

Holger, Rauhut — RWTH Aachen Univ.
Stojanac, Zeljka — RWTH Aachen Univ.

Abstract: We consider extensions of low rank matrix recovery and matrix completion to the recovery of higher order tensors of low rank from incomplete information. While convex optimization and greedy approaches come along with nice theory in the matrix case, one faces several theoretical and numerical difficulties for higher order tensors. We discuss several recent approaches for low rank tensor recovery (with respect to different notions of rank) and present the so-far available results.

▶ MS-Tu-E-44-4 17:30–18:00

Phase Retrieval via Kaczmarz Methods

Wei, Ke — Hong Kong Univ. of Sci. & Tech.

Abstract: We study the Kaczmarz methods for solving a system of quadratic equations, i.e., the generalized phase retrieval problem. The methods extend the Kaczmarz methods for solving systems of linear equations by integrating a phase selection heuristic in each iteration and overall have the same per iteration computational complexity. Empirical performance comparisons establish the computational advantages of the Kaczmarz methods over other state-of-the-art phase retrieval algorithms.

MS-Tu-E-45 16:00–18:00 213A

Triangular decomposition of polynomial systems: solvers and applications - Part IV of IV

For Part 1, see MS-Mo-D-45
For Part 2, see MS-Mo-E-45
For Part 3, see MS-Tu-D-45

Organizer: Moreno Maza, Marc — The Univ. of Western Ontario
Organizer: Chen, Changbo — Chinese Acad. of Sci.

Abstract: The Characteristic Set Method of Wen Tsun Wu has freed Ritt's decomposition from polynomial factorization, opening the door to a variety of discoveries in polynomial system solving. In the past three decades the work of Wu has been extended to more powerful decomposition algorithms and applied to different types of polynomial systems or decompositions: differential systems, difference systems, real parametric systems, primary decomposition, cylindrical algebraic decomposition. Today, triangular decomposition algorithms provide back-engines for computer algebra system front-end solvers, such as Maple's solve command and have been applied in various areas both in the academia and in the industry.

In this proposed workshop, we hope to gather researchers who have applied and extended the works Joseph Fels Ritt and Wen Tsun Wu. Our goals are, first, to disseminate the techniques and software tools which have been developed by this vibrant community and, second, to stimulate further developments and applications of polynomial system decomposition by means of characteristic sets.

At the International Congress on Mathematical Software (ICMS 2014), a satellite conference of the International Congress on Mathematics, in Seoul (South Korea), a session on the same topics as the proposed one had gathered 9 talks, see `http://www.csd.uwo.ca/~moreno/ICMS_Triangular_Decomposition_Session.html`

About another 30 researchers had expressed interest in participating to this session but were not able to do so at that time the year or in that location. Moreover, three other sessions of ICMS 2014 had talks on this subject of polynomial system decomposition by means of characteristic sets.

In a sum, the proposed workshop for ICIAM 2015 is expected to be well attended and to generate rich interactions. At the same time, the available software such as the RegularChains library (see http://www.regularchains.org) will support software demonstration of the applications of the Characteristic Set Method.

▶ MS-Tu-E-45-1 16:00–16:30

On Computational Formula of Isogenies of Elliptic Curves

Kazuhiro, Yokoyama — Rikkyo Univ.
Noro, Masayuki — Rikkyo Univ.

Abstract: We consider a computational problem to make an exact formula of isogenies between elliptic curves to examine the effectiveness of several modular methods for computing Groebner bases (triangular sets) and ideal decompositions. This problem is reduced to finding the isolated divisor of a polynomial ideal derived from direct computation of each isogeny, and we report how several modular techniques are efficiently applied with help of mathematical properties of isogenies.

▶ MS-Tu-E-45-2 16:30–17:00

An Application of Quantifier Elimination to Automatic Parallelization of Computer Programs

Moreno Maza, Marc — The Univ. of Western Ontario
Chen, Changbo — Chinese Acad. of Sci.

Abstract: In automatic parallelization of computer programs, the so-called polyhedron model is a powerful geometrical tool for analyzing the relation between iterations of nested loops. To be practically efficient, one should avoid a too fine-grained parallelization. It is also desirable for the generated code to depend on parameters such as number of processors, cache sizes, etc. These extensions of the polyhedron model lead to the manipulation of system of non-linear polynomial equations and the use of techniques like quantifier elimination (QE),

In this talk, we show that our recent algorithm for computing cylindrical algebraic decomposition (C. Chen and M. Moreno Maza, 2012) provides a good support for the QE problems arising in automatic parallelization. In addition, the combination of the metafork compilation framework (www.metafork.org) and the RegularChains library (www.regularchains.org) offers a suitable implementation environment

▶ MS-Tu-E-45-3 17:00–17:30

From Lexicographic Groebner Bases to Triangular Sets

Dahan, Xavier — Ochanomizu women's Univ.

Abstract: A lexicographic Groebner basis G having a finite number of simple solutions has at least n polynomials (n is the number of variables). When it has more than n polynomials, it is well-known that it is possible to decompose it into triangular sets. Lazard in the 90s sketched two algorithms "Lextriangular", and Moller fully proved another one to achieve this decomposition. New results on the structure of lexicographic Groebner bases suggests a simple recursive algorithm

▶ MS-Tu-E-45-4 17:30–18:00

Algebraic Attack and Algebraic Immunity of Boolean Functions

Lin, Dongdai — Inst. of Information Engineering, Chinese Acad. of Sci.

Abstract: Algebraic attack was an active research topic of cryptology in the last decade. In this talk, we will first review the history of algebraic attacks, and then the various types of algebraic attacks and their principles including classical algebraic attacks, fast algebraic attacks and probabilistic algebraic attacks, summarize the recent research achievements in the study of immunity of Boolean functions and their constructions.

MS-Tu-E-46 16:00–18:00 306B

Theoretical and Computational Aspects of Geometric Shape Analysis - Part II of II

For Part 1, see MS-Tu-D-46

Organizer: Narayan, Akil — Univ. of Massachusetts Dartmouth
Organizer: Micheli, Mario — Univ. of San Francisco
Organizer: Kushnarev, Sergey — Singapore Univ. of Tech. & Design

Abstract: The analysis, classification, and processing of geometric shapes is a timely and increasingly important problem in engineering, computer science, and mathematics. Modern strategies for shape analysis span several disciplines: statistical cliquing, differential geometry, data processing, and numerical optimization. The aim of this minisymposium is to present state-of-the-art methods for geometric shape analysis, and to discuss open problems, applications, and future directions for research of interest to the imaging science community. This minisymposium brings together researchers from diverse backgrounds to foster collaboration between the fields of computer vision, image processing, and mathematical shape analysis.

▶ MS-Tu-E-46-1 16:00–16:30

PCA on Manifolds: Application to Spaces of Landmarks

Kushnarev, Sergey — Singapore Univ. of Tech. & Design

Abstract: Principal Component Analysis (PCA) is a widely used tool for analyzing high-dimensional data. In many shape applications data lies on manifold, and PCA cannot be applied in this non-linear space. The traditional approach is to linearize data via tangent space representation, but this linearization fails to account for curvature of the underlying manifold. In this talk I will demonstrate how to take into account curvature of the manifold and better capture variance of the data.

▶MS-Tu-E-46-2 16:30–17:00

Centroid Algorithms and Statistical Shape Analysis of Large Database in the LDDMM Framework.

Glaunes, Joan Alexis MAP5, Universite Paris Descartes

Abstract: This talk will discuss several techniques for the estimation of a template shape and the subsequent statistical shape analysis of a population in the diffeomorphic framework. This has important applications in computational anatomy, to study the shape variability of human organs. It is also closely related to recent computation methods for means on Riemannian manifolds. We will present the Iterative Centroid algorithm, and its use in two specific projects, in brain morphometry and spatial audio.

▶MS-Tu-E-46-3 17:00–17:30

Shape Analysis via Extremal Teichmuller Maps

LUI, Lok Ming Ronald The Chinese Univ. of Hong Kong

Abstract: This work presents a shape analysis model using extremal Teichmuller maps (T-Map). Given two corresponding domains with/without labeled landmarks, an extremal T-Map between them can be computed. The extremal T-map gives rise to a metric called the Teichmuller metric, which can be used to measure shape distance. In this talk, we will describe how the extremal T-Map can be computed and how the Teichmuller metric can be used for shape analysis.

▶MS-Tu-E-46-4 17:30–18:00

Fshape Spaces : Mathematical Construction and Applications to Computational Anatomy.

Charon, Nicolas Johns Hopkins Univ.

Abstract: This talk will present the recent mathematical construction of functional shape, which are the combination of a geometrical object (typically a submanifold) with an additional functional data supported on it. We will show how the extension of metamorphosis allows to equip fshape spaces with a Riemannian metric which can be complemented by inter-orbit dissimilarity terms based on the idea of varifolds. This leads eventually to a variational formulation of atlas estimation problems in computational anatomy.

MS-Tu-E-47 16:00–18:00 108

Flow patterns in high-Reynolds numbers - Part II of II

For Part 1, see MS-Tu-D-47

Organizer: Okamoto, Hisashi Kyoto Univ.

Abstract: Recent increase of computer power enables us to have good understanding and prediction of fluid flows if the Reynolds number is not very large. However, flows display singular phenomena if the Reynolds number is very large. Here we need, in addition to computer power, a good combination of mathematical analysis and accurate numerical methods. In this minisymposium we present singular or strange characters of fluid flows at high Reynolds numbers. For instance, we report on our recent discovery of large scale structures which appear only in 2D high Reynolds number flows and called unimodal patterns. Streamlines of the unimodal solutions are topologically simple, but under its apparent simplicity there lie internal layers, which results from the singular perturbation nature of the Navier-Stokes equations. We propose an asymptotic analysis which agrees with the numerical data. Also some of us review applications to geophysics. In particular solutions of the 2D Navier-Stokes equations or Euler equations are computed on a sphere or a spheroid. They are compared with atmospheric data. We show that what is called a zonal flow, which is observed in fluid motion in planetary scale, can be reproduced in our computations.

▶MS-Tu-E-47-1 16:00–16:30

Large-scale Structure in Forced Two-dimensional Turbulence on A Rotating Sphere

Obuse, Kiori Okayama Univ.
Takehiro, Shin-ichi Research Inst. for Mathematical Sci., Kyoto Univ.
Yamada, Michio Kyoto Univ.

Abstract: We discuss the formation and the time development of large-scale structures in forced two-dimensional turbulence on a rotating sphere. A multiple zonal-band structure emerges at an early stage of time integration, then enters quasi-steady state, showing little energy increase with nearly steady spectral component distribution of the flow. It is followed by a sudden merger/disappearance of the jets, and a zonal-band structure with only a few jets is realized as an asymptotic state.

▶MS-Tu-E-47-2 16:30–17:00

Extremes of Flow Quantities in 2D and 3D Turbulence

Takehiro, Shin-ichi Research Inst. for Mathematical Sci., Kyoto Univ.
Yamada, Michio Kyoto Univ.

Abstract: Statistical property of extrema of physical variables in fluid phenomena is interesting from both theoretical and practical points of view. The theory of extremum statistics has been established mainly for identical independent random events, where the asymptotic extremum distributions are classified into three groups. In this paper, we summarize difficulties in application of the extremum distributions to fluid phenomena, and then discuss an extremum statistics in two- and three- dimensional fluids.

▶MS-Tu-E-47-3 17:00–17:30

Instability and Singular Behavior of Surface Tension in Vortex Sheets

Sohn, Sung-Ik Gangneung-Wonju National Univ.

Abstract: Fluid interfaces with surface tension often exhibits singular behaviors; for example, capillary waves and ripples in the Hele-Shaw flow and water waves. In this talk, we present the unstable motion of vortex sheets with surface tension, mainly on the flow of small surface tension. The linear stability analysis shows dependence of stability on the mode of perturbation and the Weber number. Computational results for the evolution of vortex sheets are presented for various regimes of the Weber number. It is found, for the first time, that for a high Weber number, capillary waves are produced on circular vortex sheets, as well as pinching and self-intersection. The reason of the appearance of capillary waves will be discussed. For an intermediate Weber number, the sheet demonstrates competition between the inertial force and capillary force, while for a low Weber number, it is marginally unstable.

▶MS-Tu-E-47-4 17:30–18:00

Numerical Exact Solutions Representing Developed Turbulence

SASAKI, EIICHI Osaka Univ.

Abstract: Fully developed turbulence has universal statistical properties which have attracted many researchers' interests. We will present numerical invariant solutions which reproduce the statistical properties of turbulence. We will also characterize vortex dynamics in terms of the invariant solutions.

MS-Tu-E-48 16:00–18:00 212B

Regularization of Inverse Problems in Imaging Sciences: Theoretical and Numerical Aspects - Part II of II

For Part 1, see MS-Tu-D-48

Organizer: Fadili, Jalal CNRS & ENSICaen
Organizer: Peyre, Gabriel CNRS & Universite Paris-Dauphine
Organizer: Zhang, Xiaoqun Shanghai Jiao Tong Univ.

Abstract: Inverse problems have become a central theme in various fields of sciences and engineering such as imaging sciences. This field draws from various mathematical disciplines including linear algebra, differential geometry, harmonic analysis, functional analysis, mathematical physics, numerical analysis, optimization, PDE’s, stochastic and statistical methods. The fields of application encompass medical and astronomical imaging, radar, optics, etc. The goal of the mini-symposium is to present recent theoretical, numerical and applicative advances in these fields. It will focus on ill-posed inverse problems, variational regularization theory, recovery guarantees, and numerical algorithms to solve the corresponding optimization problems.

▶MS-Tu-E-48-1 16:00–16:30

Methods for Parameter Adaptation in Image Restoration

Grasmair, Markus NTNU

Abstract: In this talk, we will give a short overview of methods for the local adaptation of regularisation parameters in variational methods for image restoration. In particular, we will concentrate on total variation based approaches, where the parameter choice is based on a local statistical analysis of the residual.

▶MS-Tu-E-48-2 16:30–17:00

Parallel-ℓ_0, A Fully Parallel Algorithm for Combinatorial Compressed Sensing

Tanner, Jared Univ. of Oxford

Abstract: We consider the problem of solving for the sparsest solution of large underdetermined linear system of equations where the matrix is the adjacency matrix of an expander graph corresponding with at most d neighbours per node. We present a new combinatorial compressed sensing algorithm with provable recovery guarantees, fully parallel with computational runtime less than traditional compressed sensing algorithms, and able to recover sparse signals beyond l1-regularization. This work is joint with Rodrigo Mendoza-Smith.

▶MS-Tu-E-48-3 17:00–17:30

On Sparse Regularization and Deterministic Sampling in Inverse Problems

Adcock, Ben — Simon Fraser Univ.

Abstract: Tomography problems typically yield deterministic sampling patterns that are highly structured. Recent developments demonstrate how regularization techniques such as TV and l1 work very well with such sampling patterns, however (maybe surprisingly) only on certain structured signals. Given that the sampling patterns are deterministic (as opposed to random), there is no theory explaining this phenomenon. We will discuss how to solve this problem.

▶ MS-Tu-E-48-4 — 17:30–18:00

Sparse Image Modeling and Blind De-convolution

Hui, Ji — National Univ. of Singapore

Abstract: One challenging image recovery problem is the so-called blind de-convolution problem, which aims at recovering the clear image from one blurred observation without knowing how it is blurred. In this talk, I will present several mathematical models and techniques that provide a strong foundation for resolving this challenging problem.

MS-Tu-E-49 — 16:00–18:10 — 107

Rare Events in Complex Physical Systems - Part IV of IV

For Part 1, see MS-Mo-D-49
For Part 2, see MS-Mo-E-49
For Part 3, see MS-Tu-D-49

Organizer: Cameron, Maria — Univ. of Maryland
Organizer: Li, Tiejun — Peking Univ.
Organizer: Lu, Jianfeng — Duke Univ.
Organizer: Weare, Jonathan — Univ. of Chicago
Organizer: Zhou, Xiang — City Univ. of Hong Kong

Abstract: Many problems arising from chemistry, physics and materials science involve rare but significant exit events and/or transition events between stable states. The transitions happen on a time scale much longer than the intrinsic time scale of the dynamical system. Examples of such events are conformational changes of biomolecules, chemical reactions, etc. The purpose of this minisymposium is to bring together experts working in theory, numerical algorithms and application issues, such as analysis of models for metastable systems, free energy calculation, importance sampling, accelerated dynamics, and sampling of transition pathways.

▶ MS-Tu-E-49-1 — 16:00–16:30

Geometric Methods for the Approximation of High-dimensional Dynamical Systems

Maggioni, Mauro — Duke Univ.

Abstract: We discuss a geometry-based statistical learning framework for performing model reduction and modeling of stochastic high-dimensional dynamical systems: we construct robust estimators for the number of effective degrees of freedom of the system, global dimension reduction techniques, and fast parallel learning techniques for model reduction, with guarantees on large-time accuracy.

▶ MS-Tu-E-49-2 — 16:30–17:00

Rare Event Sampling for Systems Far from Equilibrium

Dinner, Aaron — The Univ. of Chicago

Abstract: I will describe recent extensions and applications of nonequilibrium umbrella sampling. In particular, I will show how it, and related enhanced sampling methods, can be used to accelerate convergence of arbitrary time correlation functions.

▶ MS-Tu-E-49-3 — 17:00–17:30

Parallel MD Simulations for Enhanced Conformational Sampling of Biological Systems

Sugita, Yuji — RIKEN

Abstract: Many important chemical and biological phenomena are slow processes on time-scales from microsec to msec or much longer. The limitation of all-atom MD simulations in general purpose computers suggests the importance of enhanced conformational sampling methods. Here, we discuss the practical usages of parallel MD simulation methods developed in our group for overcoming the energy barriers between metastable states in the rugged free-energy landscapes.

▶ CP-Tu-E-49-4 — 17:30–17:50

Lattice Differential Equation analysis of Schloegl’s second model for particle creation and annihilation

Wang, Chi-Jen — Georgia Inst. of Tech.

Abstract: Schloegl’s stochastic models for autocatalysis on a lattice of dimension d⩾2 involves: (i) spontaneous annihilation of particles at lattice sites; and (ii) autocatalytic creation of particles at vacant sites. We analyze the dynamics of interfaces between populated and empty regions via discrete reaction-diffusion equations (dRDE’s) obtained from approximations to the exact master equations. These dRDE can display artificial propagation failure (APF) absent due to fluctuations. Higher-dimension analysis avoiding APF captures behavior in the stochastic model.

▶ CP-Tu-E-49-5 — 17:50–18:10

On the Meaning of Vertex Couplings in Quantum Graphs

Exner, Pavel — Czech Acad. of Sci.

Abstract: Quantum graphs are a useful model in microelectronics and other areas. In this talk we report a solution [1] to a longstanding open problem showing that any self-adjoint coupling in the graph vertices allowed by probability current conservation can by approximated by a suitable family of scaled Schrödinger operators on a “fat graph”, in other words, a network of tubes whose widths shrink to zero.
[1] P. Exner, O. Post, Commun. Math. Phys. 322 (2013), 207-227

MS-Tu-E-50 — 16:00–18:00 — 207

Nonlinear Subdivision Schemes and Applications - Part II of II

For Part 1, see MS-Tu-D-50

Organizer: Donat, Rosa — Universitat de Valencia
Organizer: LIANDRAT, Jacques — Centrale Marseille/I2M

Abstract: Subdivision schemes and their associated multiscale algorithms have led, over the past 20 years, to important breakthroughs in scientific computing including computer-aided geometric design, signal analysis, harmonic analysis and numerical analysis. Non-linearities appear rapidly in data dependent approaches or in connection to nonlinear constraints of the framework. Applications of, and mathematical approaches to, non-linear subdivision schemes are wide and diverse.
The goal of the minisymposium is to gather mathematicians covering the different approaches, in order to discuss the challenges in applications and establish links with ongoing work.

▶ MS-Tu-E-50-1 — 16:00–16:30

A 2D Nonlinear Algorithm for Monotone Interpolation

Arandiga, Francesc — Univ. of Valencia

Abstract: In this talk we present an algorithm for monotonic interpolation to monotone data on a rectangular mesh by piecewise bicubic functions. Carlton and Fritsch develop conditions on the Hermite derivatives that are sufficient for such a function to be monotonic. Here we obtain nonlinear approximations to the first partial and first mixed partial derivatives at the mesh points. We prove that we get a monotone piecewise bicubic interpolant and analize the order of this nonlinear interpolant. We also present some numerical experiments were we compare the results we obtain our algorithm with the obtained using linear techniques.

▶ MS-Tu-E-50-2 — 16:30–17:00

Generalized Gradients, Generalized Jacobians and Stability of Nonlinear Subdivision Schemes

Donat, Rosa — Universitat de Valencia

Abstract: Subdivision schemes that are defined by a certain type of piecewise smooth nonlinear rules can be analized using the theory of generalized gradients. We shall revisit de general theory and demonstrate its aplicacbility and limitations on two new classes of subdivision schemes based on the use on nonlinear (weighted) averages.

▶ MS-Tu-E-50-3 — 17:00–17:30

Behavior Preserving Extension of Univariate and Bivariate Functions

Levin, David — Tel-Aviv Universiuty

Abstract: Given function values on a domain, possibly with noise, we examine the possibility of extending the function to a larger domain. In addition to smoothness at the boundary, the extension should also inherit behavioral trends of the function, such as growth and decay or even oscillations. The approach is based upon the framework of linear models, univariate, or bivariate, with constant coefficients or varying coefficients.

▶ MS-Tu-E-50-4 — 17:30–18:00

Subdivision Methods for Manifold-Valued Data: Act Locally and Think Globally

Yu, Thomas — Drexel Univ.

Abstract: Fueled by the intertwining interests in approximation theory, data compression, statistical estimation, and computer-aided geometric design, linear subdivision algorithms have been studied extensively since the 80's. Modern technologies such as diffusion tensor imagining, motion capturing, or reduced order modeling in scientific computing motivate the study of approximation theory for manifold-valued data and, more specifically, the use of

subdivision schemes as a constructive approximation method for such nonlinear data.
Like many successful methods, subdivision schemes "act locally but think globally". On top of being multiscale in nature, they are very effective in handling the nontrivial topologies of manifolds. In this talk we review the applications, algorithms and theory of subdivision methods applied to manifold-valued data.

MS-Tu-E-51 16:00–18:00 209A
Blood flow and Blood Vessel Systems
Organizer: Hu, Dan Inst. of Natural Sci., Shanghai Jiao Tong Univ.

Abstract: The interaction between blood flow and blood vessel systems are important in many life processes and in the pathogenesis of many cardiovascular diseases. Modeling studies of these life processes, such as the blood flow regulation, the blood vessel adaptation, and the blood wave propagation, have provided deep understandings of relevant experimental observations. In this mini-symposium, we will report our recent works on the modeling these important life processes and the application of these models in explaining experimental phenomena. The adaptation of blood vessels in response to the stimulus induced by the wall shear stress of the blood flow is applied successfully in predicting the vessel pruning in embryo zebra fish. The one-dimensional model of blood pulse wave is used in explaining the correlation between pulse phases and diseases, such as the wiry pulse and hypertention. The model of arteriole smooth muscle cells based on Ca2+ signaling predicts spontaneous vasomotion and the auto regulation of blood flow in arterioles. This mini-symposium will not only provide a platform for us to present the recent discoveries in modeling and experimental studies of the interaction between blood flow and blood vessel systems, but also provide a platform to discuss the future collaborations towards an integrated and deep understanding on the functional mechanism of the cardiovascular systems and the pathogenesis mechanism of a few important cardiovascular diseases.

▶MS-Tu-E-51-1 16:00–16:30
Haemodynamics-Driven Developmental Pruning of Brain Vasculature in Zebrafish
Chen, Qi Max Planck Inst. for Molecular Biomedicine

Abstract: The developing vasculature in zebrafish midbrain undergoes extensive vessel pruning, which is driven by changes in blood flow and leads to gradual reduction in the vasculature complexity with development. The occurrence position of vessel pruning could be largely predicted by haemodynamics-based numerical simulation of vasculature refinement. This model, which based on adaptation and optimization of biological transport networks, also indicates low and variable blood flow in pruned segment, which is consistent with experimental observation.

▶MS-Tu-E-51-2 16:30–17:00
The Formation of the Pulse Phase in Human Body
Du, Tao Department of Mathematics & Inst. of Natural Sci., Shanghai Jiao Tong Univ.

Abstract: Blood pulse phase is a result of blood pulse wave propagation and reflection in arterial tree, which contains information of our body. This work is to explain the formation of the blood pulse phase based on the wave propagation in single vessel and reflection at bifurcation in arterial tree, and use this result to explain why some abnormal pulse phases appear in human body, such as wiry pulse in hypertension and slippery pulse in pregnancy.

▶MS-Tu-E-51-3 17:00–17:30
Adaptation and Initiation of Blood Vessel Systems
Hu, Dan Inst. of Natural Sci., Shanghai Jiao Tong Univ.

Abstract: For animals, a visible part of energy is costed on driven the blood flow. An efficient strucutre of the blood vessel systems is crucial for animals. At the same time, animals are constantly adapting their blood vessel systems to meet the tissue demands for blood flow to supply nutrient and oxygen. In this talk, we show that efficient structure of the vessel systems is achieved with the adaptation and initiation process.

▶MS-Tu-E-51-4 17:30–18:00
Modeling Blood Flow in the Kidney
Layton, Anita Duke Univ.

Abstract: To maintain normal kidney function, autoregulatory mechanisms closely regulate renal blood flow. One such autoregulatory mechanism is the myogenic response, wherein a rise in intravascular pressure elicits a reflex constriction that increases vascular resistance. Another mechanism is the tubuloglomerular feedback, which is a negative feedback response that balances glomerular filtration with tubular transport. We use a mathematical model of renal hemodynamics control to investigate the interactions of these mechanisms under physiological and pathophysiological conditions.

MS-Tu-E-52 16:00–18:10 212A
Stochastic Dynamics in Cellular-Scale Biology - Part II of II
For Part 1, see MS-Tu-D-52
Organizer: Kramer, Peter Rensselaer Polytechnic Inst.

Abstract: Many physical processes involving cells and associated entities such as viruses involve inherent irregularities due to thermal fluctuations or other noisy aspects of protein function, arising from the small scales, flexible structures, and/or reliance on diffusive transport of small numbers of biomolecules. The quantitative study of such systems generally relies on stochastic models which integrate the uncertain noisy aspect in a physically, or sometimes phenomenologically, motivated manner. The speakers in this minisymposium will illustrate how stochastic models can be deployed and analyzed to obtain insights on a broad variety of cellular processes.

▶MS-Tu-E-52-1 16:00–16:30
Dissipative Particle Dynamics Simulations of Polymer Networks
Matzavinos, Anastasios Brown Univ.

Abstract: In this talk, we present a dissipative particle dynamics approach to simulating the meso-scale dynamics of polymer networks. Our simulations explicitly include mechanical interactions with other meso-scale structures (e.g., lipid membranes) and cytoplasmic flows. We compare the results of our approach to those of Brownian dynamics simulations. We also discuss ongoing work on stochastic homogenization, bridging the gap between the mesoscopic simulations and macroscopic descriptions of bulk mechanical properties.

▶MS-Tu-E-52-2 16:30–17:00
Kinetic Theories for Age-structured Populations
Chou, Tom UCLA

Abstract: We derive a new kinetic theory for age-structured populations undergoing a semi-markov birth-death process. A high-dimensional transport equation is derived for the probability density for any number of individuals with specified age ranges. Different structural forms required for different processes such as birth-death, branching, and sexual reproduction are highlighted. Our equations form a series analogous to that of the BBGKY hierarchy. We show how low-moment closure leads to the classic deterministic McKendrick equation.

▶MS-Tu-E-52-3 17:00–17:30
Spontaneous Neural Activity in the Morris-Lecar Model with Ion Channel Noise
Newby, Jay Mathematical BioSci. Inst.

Abstract: Noise induced excitability is studied in types I and II Morris - Lecar neurons. Ion channels open and close randomly, creating current fluctuations that can induce spontaneous firing of action potentials. Both noise sources are assumed to be weak so that spontaneous action potentials occur on a longer timescale than ion channel fluctuations. Asymptotic approximations of the stationary density function and most probable are developed to understand the role of channel noise in spontaneous excitability.

▶CP-Tu-E-52-4 17:30–17:50
Solving the Chemical Master Equation by A Krylov-based Finite State Projection and the Stochastic Simulation Algorithm
Sidje, Roger Univ. of Alabama

Abstract: Solving the chemical master equation (CME) allows us to model and simulate the stochastic behavior of biochemical reactions that take place within a biological cell. The mathematical framework is a continuous time Markov chain with a discrete state space that describes the composition of molecules inside the cell. Computing the transient probability distribution of this Markov chain allows us to track the composition over time, and this has important practical applications. However, solving the CME is challenging because the state space is very large or even countably infinite. Truncation and approximation techniques such as the finite state projection and inexact Krylov subspace techniques lead to reduce-sized problems that capture enough of the cell dynamics. But these problems can still be quite large. We show how striking improvements can be further achieved by combining these reduction techniques with the stochastic simulation algorithm (SSA). This work is supported by NSF grant DMS-1320849.

▶CP-Tu-E-52-5 17:50–18:10
Exploring the Structural Controllability Properties of the Gene Regulatory Network for Arabidopsis Thaliana Flower Morphogenesis
Chairez-Veloz, Jose Eduardo PhD student, DCA-Cinvestav-IPN
Martinez-Garcia, Juan Carlos DCA-Cinvestav-IPN
Alvarez-Buylla, Elena R. Departamento de Genomica Funcional, Instituto de Ecologia, UNAM

Davila-Velderrain, Jose — PhD student, Departamento de Ecologia Funcional, Instituto de Ecologia, UNAM

Abstract: The gene regulatory network driving A. thaliana flower morphogenesis (GRN) constitutes a model-of-choice for the study of morphogenesis. Described in Boolean terms, this network has 10 attractors, four of them related to the structural configuration and the dynamical behavior of the inflorescence meristem; the other attractors are related to the phenotypic traits of the primordial cells shaping sepals, petals, stamens and carpels. The stochastic exploration of the network has shown that stochastic noise suffices to drive the system throughout the state trajectory corresponding to the temporal pattern giving rise to the construction of the flower. Our aim is to explore the controllability properties of the GRN, focusing our attention on the elucidation of the role of specific genes. We characterize the developmental trajectories related to the direct manipulation of specific nodes. For this, we apply the semi-tensor product, as well as the standard controllability theoretical framework for discrete-time systems.

MS-Tu-E-53 16:00–18:00 311B

Stochastic control perspectives in mathematical finance

Organizer: Ludkovski, Mike — UC Santa Barbara
Organizer: Leung, Tim — Columbia Univ.
Organizer: Zhu, Chao — Univ. of Wisconsin-Milwaukee
Organizer: Song, Qingshuo — City Univ. of Hong Kong

Abstract: The stochastic control theory is a field that probability and partial differential equation are intimately intertwined. With the rapid development of the mathematical finance in the last two decades, the stochastic control theory has gained significant interests both from theoretical researchers and practitioners. In particular, many problems driven by financial applications can be formulated into some interesting non-standard control problems, further raise new challenges in this field. This mini-symposium is devoted to the recent advances in the stochastic control theory motivated by the financial applications.

▶ MS-Tu-E-53-1 16:00–16:30

Continuity of the Value Functions of Stochastic Control Problems in A Bounded Domain

Zhu, Chao — Univ. of Wisconsin-Milwaukee
Song, Qingshuo — City Univ. of Hong Kong

Abstract: We determine a weaker sufficient condition than that of Theorem 5.2.1 in Fleming and Soner (2006) for the continuity of the value functions of stochastic exit time control problems.

▶ MS-Tu-E-53-2 16:30–17:00

Stackelberg Game with Regime Switching

Yan, Zhongfeng — jinan Univ.

Abstract: This work is devoted to irreversible investment problems in duopoly games with regime switching. The problem is formulated as a stopping time game in presence of Stackelberg leader-follower competition, in which both players determine their respective optimal market entry time. By extending the variational inequality approach, we obtain regime-dependent optimal policies for both players. In addition, numerical examples are reported to demonstrate the properties of the solution.

▶ MS-Tu-E-53-3 17:00–17:30

Consumption in Incomplete Markets

WANG, Gu — Univ. of Michigan at Ann Arbor

Abstract: An agent maximizes isoelastic utility from consumption with infinite horizon in an incomplete market, in which state variables are driven by diffusions. We provide (i) a general verification theorem, which links the solution of the HJB equation to the optimal consumption and investment policies; (ii) approximate policies in closed form, which admit an upper bound of utility loss, and become optimal if the market is complete, or utility is logarithmic. Joint work with Paolo Guasoni.

▶ MS-Tu-E-53-4 17:30–18:00

A Dynamic Approach for Some Time Inconsistent Problems

Zhang, Jianfeng — Univ. of Southern California

Abstract: We study precommitted strategy of time inconsistent problems, and we note that many such problems in the literature can be transformed into an optimization of a multiple dimensional controlled Backward SDE. We shall introduce a type of "forward utility" so that the problem, which is time inconsistent under the original fixed utility, becomes time consistent under our forward utility. We next characterize our forward utility as a solution to certain McKean-Vlasov type of equations.

MS-Tu-E-54 16:00–18:30 VIP1-2

Computational Methods in Finance

Organizer: Goncu, Ahmet — Xian Jiaotong Liverpool Univ.

Abstract: Introduction Applied and computational mathematics, in particular numerical PDEs, Monte Carlo methods, and numerical optimization, play a crucial role in solving problems from financial engineering. The talks in this minisymposia cover recent developments in computational methods used in financial problems, with an emphasis on Monte Carlo methods. Some covered topics are uncertainty and robustness of financial models, stratification and importance sampling in credit risk computations, and statistical arbitrage and Monte Carlo simulation.
Planned Speakers Our initial list of talks in this minisymposia consists of five planned talks.
We believe that our proposed session will attract scholars from applied and financial mathematics, and make an important contribution to ICIAM 2015's anticipated success.

▶ MS-Tu-E-54-1 16:00–16:30

Existence of Statistical Arbitrage Portfolios in the Black-Scholes Framework

Akyildirim, Erdinc — akdeniz Univ.

Abstract: In this study we consider diﬀerent statistical arbitrage strategies and prove the existence of statistical arbitrage portfolios in the Black-Scholes framework. We show that if there exists at least one stock in an economy with a Sharpe ratio larger than half of the volatility of the stock, a statistical arbitrage trading strategy can be designed. We derive analytical formulas for the expected value and probability of loss of our statistical arbitrage portfolios.

▶ MS-Tu-E-54-2 16:30–17:00

Efficient Simulations for A Bernoulli Mixture Model of Portfolio Credit Risk

Sak, Halis — Xi'an Jiatong Liverpool Univ.

Abstract: We consider the problem of calculating tail loss probability and conditional excess for the Bernoulli mixture model of credit risk. This is an important problem as all credit risk models proposed in literature can be represented as Bernoulli mixture models. The algorithm we propose is a combination of stratification, importance sampling based on cross-entropy, and inner replications using the geometric shortcut method. We evaluate the efficiency of our general method on specific credit risk models.

▶ MS-Tu-E-54-3 17:00–17:30

Statistical Arbitrage Portfolios in the Black-Scholes Framework

Goncu, Ahmet — Xian Jiaotong Liverpool Univ.

Abstract: In this study we consider different statistical arbitrage strategies and prove the existence of statistical arbitrage portfolios in the Black-Scholes framework. Statistical arbitrage profits can be generated if there exists at least one asset in the economy that satisfies the statistical arbitrage condition derived. We derive analytical formulas for the expected value and probability of loss of our statistical arbitrage portfolios. Furthermore, extensive Monte Carlo simulations are conducted to verify our theoretical results.

▶ MS-Tu-E-54-4 17:30–18:00

Sensitivity and Robustness of Financial Models

Okten, Giray — Florida State Univ.
Mandel, David — Florida State Univ.

Abstract: We wil discuss sensitivity and robustness of a mathematical model, in particular, models used in financial mathematics. In the literature, different models are usually compared by the model error, however, the sensitivity of a given model with respect to its input parameters is also very important for a modeler. Using Sobol' sensitivity indices, we will introduce a notion for robustness, and compare different models with respect to their robustness.

▶ MS-Tu-E-54-5 18:00–18:30

Disappointment Aversion Preferences in Continuous Time

Pantelous, Athanasios — Univ. of Liverpool
Karagiannis, Nikolaos — Univ. of Liverpool

Abstract: In this paper, the portfolio choice problem for the Gul (1991)'s disappointment averse investors in continuous time framework is developed and considered. Assuming a complete market and general geometric Brownian motions for asset prices, and given the wealth W of an investor and a standard utility function u, we define explicitly the certainty equivalent μ_W by the following relation

$$u(\mu_W) = E[u(W)]$$

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MS-Tu-E-55 16:00–18:00 106

High-performance computing in computational biomechanics

Organizer: Pavarino, Luca F. Univ. of Milan

Organizer: Cai, Xiao-Chuan Univ. of Colorado at Boulder

Abstract: Computational biomechanics is the study of biology at the organ and tissue level using computer simulation technologies based on mathematical and numerical models. With the rapid development of HPC over the past decades, the possibilities of utilizing these simulation technologies in real life medical practices have dramatically increased. The mathematical modeling of many biological systems, such as blood flows, arteries, and heart deformation take the form of partial differential equations. The focus of this minisymposium is on efficient numerical methods and high performance software for solving partial differential equations arising in the study of biofluid dynamics and biostructural mechanics.

▶ MS-Tu-E-55-1 16:00–16:30

BDDC Preconditioners for Cardiac Electromechanics

Scacchi, Simone Univ. of Milan
Pavarino, Luca F. Univ. of Milan
Zampini, Stefano KAUST

Abstract: We present a BDDC solver for the cardiac electro-mechanical coupling, a model describing the electrical excitation of the myocardium and its subsequent contraction. The model is constituted by a parabolic partial differential equation, coupled with the non-linear elasticity system. Our solver consists of solving the non-linear system deriving from the discretization of the finite elasticity equations with a Newton-Krylov-BDDC method. 3D parallel tests on a BlueGene/Q cluster show the scalability and quasi-optimality of the proposed method.

▶ MS-Tu-E-55-2 16:30–17:00

Massively Parallel Approach to Modeling Cardiac Electromechanics at High Spatiotemporal Resolution

Plank, Gernot Medical Univ. of Graz, Inst. of Biophysics
Augustin, Christoph Medical Univ. of Graz

Abstract: We demonstrate the feasibility of high resolution models of bidirectionally coupled cardiac electro-mechanics which resolve cardiac anatomy at a para-cellular resolution. A novel algebraic multigrid method is presented, adapted for non-linear mechanics, which is shown to be strongly scalable up to 8k cores when using a human whole heart four chamber geometry model. Benchmark results demonstrate that a single heart beat can be simulated in about 1 hour minutes at full anatomical and biophysical detail.

▶ MS-Tu-E-55-3 17:00–17:30

A Highly Scalable Algorithm for Simulating Blood Flows in Compliant Arteries

Kong, Fande Department of Computer Sci., Univ. of Colorado Boulder
Cai, Xiao-Chuan Univ. of Colorado Boulder

Abstract: Simulating blood flows in compliant arteries in 3D is a challenging multi-physics problem. The difficulties are due to the high nonlinearity of coupled equations. To overcome the difficulties, we study an inexact Newton-Krylov algorithm with a multilevel Schwarz preconditioner to solve the monolithically coupled fluid-structure system. We show that the proposed algorithm is scalable in terms of the iteration count and the total compute time on a supercomputer with a large number of processors.

▶ MS-Tu-E-55-4 17:30–18:00

Parallel Domain Decomposition-based Numerical Simulation of Blood Flows in Branching Arteries Using A Non-Newtonian Model

Hwang, Feng-Nan National Central Univ.

Abstract: We develop parallel domain decomposition based algorithms used for numerical simulation of blood flows in arteries based on a non-Newtonian viscosity model and provides a comparative study with the numerical results obtained by using Newtonian case. The high nonlinearity and complex geometry make the problem more challenging and parallel computing necessary. Numerical investigation on how the wall shear stress, the streamlines, and pressure distribution depend on different physiological conditions and arterial geometries will be reported.

MS-Tu-E-56 16:00–18:00 403

Modeling, Applications, Numerical Methods, and Mathematical Analysis of Fractional Partial Differential Equations II - Part I of IV

For Part 2, see MS-We-D-56
For Part 3, see MS-We-E-56
For Part 4, see MS-Th-BC-56

Organizer: Karniadakis, George Brown Univ.

Organizer: Wang, Hong Univ. of South Carolina

Abstract: Fractional Partial Differential Equations (FPDEs) are emerging as a new powerful tool for modeling many difficult complex systems, i.e., systems with overlapping microscopic and macroscopic scales or systems with long-range time memory and long-range spatial interactions. They offer a new way of accessing the mesoscale using the continuum formulation and hence extending the continuum description for multiscale modeling of viscoelastic materials, control of autonomous vehicles, transitional and turbulent flows, wave propagation in porous media, electric transmission lines, and speech signals. FPDEs raise modeling, computational, mathematical, and numerical difficulties that have not been encountered in the context of integer-order partial differential equations. The aim of this minisymposium is to cover the recent development in mathematical and numerical analysis, computational algorithms, and applications in the context of FPDEs and related nonlocal problems.

▶ MS-Tu-E-56-1 16:00–16:30

Fractional Dynamics, Non-ergodicity, and Ageing

Metzler, Ralf Univ. of Potsdam & Tampere Univ. of Tech.

Abstract: Starting from a brief review of fractional relaxation and diffusion models, I will discuss the physical background of fractional dynamics and its implications for physical observables such as the mean squared displacement. A main point is the pronounced disparity between time and ensemble averages of physical observables and the inherent ageing of these processes. Both free and confined processes will be discussed and connections to experimental results drawn.
Reference: PhysicalChemistryChemicalPhysics 16, 24128 (2014)

▶ MS-Tu-E-56-2 16:30–17:00

Lagrangian Approximations and Hydrologic Applications of Fractional-order Advection-Dispersion Equations

Zhang, Yong Univ. of Alabama

Abstract: This talk introduces numerical methods and applications for fractional-order advection-dispersion equations (fADEs). A general Lagrangian solver is developed to approximate various fADEs using a three-step fractional adjoint method. This leads to a fully Lagrangian scheme which is a continuous time random walk with Lévy motion in space or time, providing discrete stochastic approximations for the fADEs. We will also show practical applications of the models in capturing hydrological dynamics observed in geological media.

▶ MS-Tu-E-56-3 17:00–17:30

Understanding Partial Bed-load Transport: Experiments and Stochastic Model Analysis

Sun, HongGuang Hohai Univ.

Abstract: The complex dynamics of partial bed-load transport in a series of well-controlled laboratory experiments are explored systematically and simulated by a stochastic model in this study. Flume experiments show that the leading front of bed-load moves anomalously, where the transient transport rate of the accelerating front varies with the observation time scale. A fractional derivative model is finally applied to characterize the overall behavior of partial bed-load transport.

▶ MS-Tu-E-56-4 17:30–18:00

Efficient Solution of Fractional-derivative Two-point Boundary Problems by Reformulation as Integral Equations

Stynes, Martin Beijing Computational Sci. Research Center

Abstract: Consider fractional-derivative two-point boundary value problems where the leading term in the differential operator is either a Riemann-Liouville or a Caputo derivative of order $2-\delta$ with $0<\delta<1$. Each class of problem is reformulated in terms of weakly singular Volterra integral equations. Existence and uniqueness of the solution is proved and an efficient collocation method that uses piecewise polynomials of arbitrary order on a graded mesh is analysed. This is joint work with Natalia Kopteva.

MS-Tu-E-57 16:00–18:00 402A

Advances in Numerical Methods for Porous Media Flow - Part II of IV

For Part 1, see MS-Tu-D-57
For Part 3, see MS-We-D-57
For Part 4, see MS-We-E-57

Organizer: Wang, Hong — Univ. of South Carolina
Organizer: Sun, Shuyu — King Abdullah Univ. of Sci. & Tech.
Organizer: Rui, Hongxing — Department of Mathematics, Shandong Univ.

Abstract: Porous media flow has wide applications in many areas, including environmental, energy, biological and engineering applications. They lead to strongly coupled transport processes also with nonlinear chemical reactions, which are computationally challenging, for it demands high accuracy and local mass conservation. Porous media manifest dramatically differently at different spatial and temporal scales. Heterogeneity, anisotropy, and discontinuity of medium properties require special treatment. The aim of this minisymposium is to bring together researchers in the aforementioned field to highlight the current developments, to exchange the latest research ideas, and to promote further collaborations in the community.

▶ MS-Tu-E-57-1 16:00–16:30

Multi-scale Approaches to Model CO2 Injection and Migration

Guo, Bo — Princeton Univ.
Celia, Michael — Princeton Univ.
Bandilla, Karl — Princeton Univ.

Abstract: Geological sequestration of CO2 requires modeling tools to simulate injection and migration of both CO2 and displaced brine. While strong buoyancy leads to development of vertical equilibrium models, for some systems the vertical equilibrium assumption is inappropriate. In those cases, new vertically integrated models can be developed that maintain computational efficiencies while relaxing the vertical equilibrium assumption. Algorithms of this type fit naturally into a multi-scale framework, and provide new modeling options for CO2 sequestration.

▶ MS-Tu-E-57-2 16:30–17:00

Parallel Adaptive Simulation of Processes from Science and Engineering

Wittum, Gabriel — G-CSC, Goethe Univ.

Abstract: We discuss strategies allowing for the solution of large, complex model systems. Crucial issues for such strategies are reliability, efficiency, robustness, usability, and versatility. The main strategy is using parallel adaptive mutligrid methods. This is implemented in the simulation system UG4 ("Unstructured Grids"). In the second part we show the performance and efficiency of this strategy in various applications. In particular large scale parallel computations of haline groundwater flow is discussed in more detail.

▶ MS-Tu-E-57-3 17:00–17:30

A Comprehensive Alkali-Surfactant-Polymer Chemical Flooding Mathematical Model and Its Application

Chen, Guo — Daqing Oil Field

Abstract: In order to simulate the alkali-surfactant-polymer (ASP) flooding, a comprehensive ASP flooding mathematical model is constructed, with governing equation consisting of oil-gas-water mass continuity equation, chemical convection-diffusion mass conservation equation and chemical equilibrium reaction equation, making it not only have capability to simulate complicated physicochemical phenomena, but also is suitable to characterize complex reservoir behavior. A sequential solution scheme is constituted to solve the complex equations, achieving fast computation for the complicated mathematical model.

▶ MS-Tu-E-57-4 17:30–18:00

An Eulerian-Lagrangian WENO Finite Difference Scheme for Advection Problems

Huang, Chieh-Sen — National Sun Yat-sen Univ.

Abstract: We develop a locally conservative Eulerian-Lagrangian finite difference scheme with the weighted essentially non-oscillatory property (EL-WENO) in one-space dimension. This method has the advantages of both WENO and Eulerian-Lagrangian schemes. It is formally high-order accurate in space (we present the third and fifth order version) and essentially non-oscillatory. Moreover, it is free of a CFL time step stability restriction and has small time truncation error. A flux correction term is used to make the scheme feasible. A Strang splitting algorithm is presented for higher-dimensional problems. We show formally that it maintains the designed order accuracy. It is also locally mass conservative. Numerical results are provided to illustrate the performance of the scheme and verify its formal accuracy.

MS-Tu-E-58 16:00–18:30 401

Numerical Methods for Multi-physics Problems - Part I of III

For Part 2, see MS-We-D-58
For Part 3, see MS-We-E-58

Organizer: Bazilevs, Yuri — Univ. of California, San Diego
Organizer: Xu, Jinchao — PKU,and The Pennsylvania State Univ.
Organizer: Zhang, Shuo — Inst. of Computational Mathematics, Chinese Acad. of Sci.

Abstract: Most systems targeted by mathematical modeling in modern science and engineering are multi-physical and multi-scale. These models involve complex coupled nonlinear systems of PDEs built from different physical processes at different scales. Developing robust, efficient, and practical numerical algorithms that can tackle these complex models is one central task of modern computational sciences and also a challenging one. This minisymposium will gather together experts from around the world in the related fields in industrial and applied mathematics to exchange ideas regarding the development of robust and efficient numerical schemes that preserve the key physics of these models, and to study the development of fast and efficient linear and nonlinear solvers that are scalable and optimal.

▶ MS-Tu-E-58-1 16:00–16:30

Combining Multiple Physics – Efficiency Versus Flexibility?

Mehl, Miriam — Univ. of Stuttgart

Abstract: Multi-physics applications involving several types of systems such as fluid and structural dynamics, acoustics, thermodynamics, chemical reactions, ... are an important field in numerical simulation in engineering, medicine, and other sciences. We present several numerical approaches allowing for a stable and efficient modular simulation of the respective scenarios, discuss advantages and disadvantages of these methods and compare them to monolithic approaches in terms of efficiency and applicability.

▶ MS-Tu-E-58-2 16:30–17:00

Reduced Order Models for Multi-physics Systems, Adaptivity Vs Model Reduction.

Conrads, Christoph — TU Berlin
Miedlar, Agnieszka — EPF Lausanne
Mehrmann, Volker — TU Berlin

Abstract: The control and optimization of multi-physics problems requires the construction of reduced models. There are two major approaches, either one starts with a fine grid model and approximates it with a reduced order model that can be handled by control and optimization methods or one readily adapts the discretization to the control and optimization problem. We will discuss both approaches and their advantages and disadvantages on the basis of the treatment of disk brake squeal.

▶ MS-Tu-E-58-3 17:00–17:30

Several User-friendly Discretizations and Solvers for Multi-phase Problems

Xu, Jinchao — PKU,and The Pennsylvania State Univ.
Zhang, Shuo — Inst. of Computational Mathematics, Chinese Acad. of Sci.

Abstract: In this talk, we will report some works on designing optimal finite element methods and efficient solvers for multi-phase problems. In particular, we will focus on dealing with the effect of discontinuous parameter in certain basic physics systems, and present the mechanisms how the optimality of the discretizations and the solver which are easy to implement is obtained based on some local operations near the interface where the discontinuity happens.

▶ MS-Tu-E-58-4 17:30–18:00

Hilbert Space Interpolation as A Tool for Analyzing Mixed Methods for Fourth-order Boundary Value Problems

Zulehner, Walter — Johannes Kepler Univ. Linz

Abstract: We consider mixed variational methods for fourth-order boundary value problems. Typical examples are plate bending problems and the linearized Cahn-Hilliard equation (after discretization in time). It will be shown how to derive well-posed mixed variational formulations for such problems with the help of interpolation theory of Hilbert spaces. An analogous analysis for associated mixed finite element methods lead to efficient preconditioners for the linear systems of equations resulting from the discretization.

▶ MS-Tu-E-58-5 18:00–18:30

A Lower Order Mixed Element Method for Linear Elasticity

Gong, Shihua — Peking Univ.

Abstract: Recently, Hu and Zhang proposed a family of high order mixed finite elements for linear elasticity on simplicial mesh of any space dimension. In this talk, we consider some lower order mixed finite elements method with symmetric stress approximation. The optimal convergence rate can be proved

both for the stress and displacement. We also proposed an efficient implement technique for our method to reduce the dimension of the linear system.

MS-Tu-E-59 16:00–18:00 402B
Modeling, Simulation and Analysis of Interface and Defect Problems in Solids - Part II of III

For Part 1, see MS-Tu-D-59
For Part 3, see MS-We-D-59

Organizer: Xiang, Yang — Hong Kong Univ. of Sci. & Tech.

Abstract: Interfaces or defects in crystalline materials, such as vacancies, dislocations, cracks, grain boundaries, and surfaces, play important roles in the mechanical, electronic, and plastic properties of these materials. The complexity of modeling microstructures of these defects and their evolution at various length and time scales presents new challenges for mathematical modeling and analysis. Multiphysics models are required to accurately describe the complicated interactions among various defects involved in the equilibrium and dynamics processes. The speakers in this minisymposium will discuss recent advances in the modeling approaches and new findings obtained in analysis and simulations.

▶MS-Tu-E-59-1 16:00–16:30
Computing Transition Rates of Rare Events in Dislocation Dynamics
Jin, Congming — Zhejiang Sci-Tech Univ.
Xiang, Yang — Hong Kong Univ. of Sci. & Tech.

Abstract: We present a numerical method to compute the transition rates including the entropy effect, of the thermally activated events in dislocation dynamics on the atomistic scale, based on the transition state theory and the string method. We also present atomistic simulation on dislocation cross-slip in aluminum, with focus on the dependence of the transition paths and energy barriers on dislocation length and position. A new mechanism with combination of the classical mechanisms has been identified.

▶MS-Tu-E-59-2 16:30–17:00
Emergence of Step Flow from Atomistic Scheme of Epitaxial Growth in 1+1 Dimensions
Lu, Jianfeng — Duke Univ.

Abstract: The Burton-Cabrera-Frank (BCF) model for the flow of line defects (steps) on crystal surfaces has offered useful insights into nanostructure evolution. This model has rested on phenomenological grounds. In this talk, we will discuss some recent progress in scaling arguments for the emergence of the BCF theory for non-interacting steps from a stochastic atomistic scheme of a kinetic restricted solid-on-solid model in one spatial dimension. (joint work with Jian-Guo Liu and Dionisios Margetis)

▶MS-Tu-E-59-3 17:00–17:30
Discrete and Continuum Models for the Long-range Elastic Effects of Stepped Epitaxial Surfaces
Xiang, Yang — Hong Kong Univ. of Sci. & Tech.

Abstract: We present analysis results on the step bunching properties on epitaxial surfaces under elastic interactions, using both discrete and continuum models.

▶MS-Tu-E-59-4 17:30–18:00
Dislocations and Twist Grain Boundaries in Van Der Waals Bilayers
Dai, Shuyang — Univ. of Pennsylvania

Abstract: Bilayer materials, assembled by two layers of 2D crystal with weak Van der Waals interactions, revealing unusual properties. We present a continuum model for dislocations in bilayer structure, incorporating elastic energy for each layer and the disregistry between layers, it account for both the in-plane and out-of-plane deformations. We show that the buckling of the bilayer structure is crucial to relax the in-plane strains. The obtained structures agree well with the atomistic simulations.

IM-Tu-E-60 16:00–18:00 310
Industrial Mathematics Around the World - Part IV of VIII
Problems from the Finance Industry

For Part 1, see IM-Mo-D-60
For Part 2, see IM-Mo-E-60
For Part 3, see IM-Tu-D-60
For Part 5, see IM-We-D-60
For Part 6, see IM-We-E-60
For Part 7, see IM-Th-BC-60
For Part 8, see IM-Th-D-60

Organizer: Cai, Zhijie — Fudan Univ.
Organizer: Chen, Gui-Qiang G. — Univ. of Oxford
Organizer: Huang, Huaxiong — York Univ.
Organizer: LU, Liqiang — Fudan Univ.
Organizer: Ockendon, Hilary — Univ. of Oxford
Organizer: Ockendon, John — Univ. of Oxford
Organizer: Peng, Shige — Shandong Univ.
Organizer: Tan, Yongji — Fudan Univ.
Organizer: Wake, Graeme — Massey Univ.,
Organizer: Zhu, Yichao — The Hong Kong Univ. of Sci. & Tech.
Organizer: CHENG, JIN — Fudan Univ.

Abstract: The aim of this section is to boost the use of mathematics as an industrial resource in China and around the world. It will highlight (i) the global experience in industrial mathematics and (ii) the new mathematical ideas that these activities have created as well as the exploitation of existing technologies to new applications. Participants will come from both academia and industry and, for this purpose, the section is proposed to consist of eight minisymposia. Four of them will overview the identification and solution of industrially-driven mathematical problems and the mechanisms that have evolved to deal with them in different regions: China, other Asia-Pacific countries, Europe and North America. Three of the remaining minisymposia will focus on the problems coming from different industrial sectors: financial industry, petroleum industry and industrial areas in which wave propagation is important. The last minisymposium will involve an open discussion on how the global mathematics community can best respond to the increasing demand from industry for applied and computational mathematics; the agenda will include both the mechanisms for academic / industrial collaboration and the areas where it will be most fruitful.

▶MS-Tu-E-60-1 16:00–16:30
Empirical Testing of Nonlinear Brownian Motion and It's Distributions for GVaR
Peng, Shige — Shandong Univ.

Abstract: We report our recent progress of using G-normal distribution VaR (G-VaR). Our comparison with VaR and Garch-VaR shows the robustness and adaptedness of this new algorithm based on the central limit theorem under uncertainty of distributions. We also present two successful study groups, in Weihai and Shanghai, China, focused on quantitative financial risk to solve problems from practical finance of data modeling.

▶MS-Tu-E-60-2 16:30–17:00
Risk Concentration, Margin Contribution and Capital Allocation for the Credit Risk in the Trading Book
Fu, Jingxue — Beijing Univ.

Abstract: In the aftermath of the worldwide credit crisis of the years 2007 and 2008 and recognizing the fact that banks hold substantial positions in structured and potentially illiquid credit instruments in their trading book, the Basel Committee proposed incremental risk charge (IRC) to complement the existing market risk capital requirements. IRC represent an estimate of the default and migration risk of unsecuritized credit products over a one-year horizon at a 99.9% percent confidence level. Based on a set of assumptions, we set up a multi-factor default-mode Merton model to describe the financial well-being of all the credit assets and their dependent structure. Under this framework, we get both analytic and numerical results of total IRC and allocation ratio. In our work, we come out with several different solutions to handle the negative allocation ratio problem. Our work also includes some discussion about risk measure.

▶IM-Tu-E-60-3 17:00–17:30
Credit Contingent Interest Rate Swap Pricing: What Happens After the Default?
Huang, Haohan — Royal Bank of Canada
Huang, Huaxiong — York Univ.
Zhu, Hongmei — York Univ.

Abstract: This pricing problem of credit contingent interest rate swap is assumed to be equivalent to the estimation of CVA for interest rate swaps. In

most practices, it is implicitly assumed the default probability of the replacement contract is negligible. We go a step further to consider the effect of a second default and then the full problem and examine the conditions under which the cost due to more defaults is significant using PDE technique.

▶ MS-Tu-E-60-4 17:30–18:00

Application of G Expectation in the Futures Margin–G-VaR

Yang, Shuzhen Shandong Univ.

Abstract: In the market, we need to set the futures margin based on the penetration rate of margin. In the industry, the futures margin is calculated by H-VaR, the basic idea is that the future is to reproduce the history. When calculating the margin by H-VaR, will with higher penetration rate and cause a great loss, which is because the tail data quantity is too little. G- expectation is a kind of nonlinear expectation theory, admit the parameters uncertainty in the model, including the uncertainty of the mean and volatility. In this study, by the G-expectation，we use G-VaR to calculate the futures margin.

CP-Tu-E-61	16:00–18:00	101
Information, Communication, Signals		

Chair: PATIDAR, Vinod Sir Padampat Singhania Univ.

Abstract:

▶ CP-Tu-E-61-1 16:00–16:20

A Simple Yet Efficient and Robust Image Encryption Algorithm Based on Quasigroup and Chaos

PATIDAR, Vinod Sir Padampat Singhania Univ.

Abstract: The proposed image cipher is a block cipher and based on the Shanon’s substitution-diffusion architecture. We use a quasigroup of order 256 and chaotic standard map for the substitution and permutation of image pixels respectively. The secret key of the image cipher comprises of initial conditions & parameter of chaotic standard map and a quasigroup of order 256. The encryption in the proposed image cipher has minimum (maximum) two (sixteen) rounds and each round has a substitution and permutation module. The substitution is done column-wise and row-wise starting from the first and last pixel respectively through the left and right quasigroup binary operations on a 256 order quasigroup (which is part of the secret key). However the permutation is performed row-by-row as well as column-by-column through the pseudo random number sequences generated through the chaotic standard map. To illustrate the exceelent security features, security analysis results will also be presented.

▶ CP-Tu-E-61-2 16:20–16:40

Weighted L1-minimization for Sparse Recovery with Sparse Matrices

Bah, Bubacarr Univ. of Texas at Austin

Ward, Rachel Univ. of Texas at Austin

Abstract: Since the introduction of compressed sensing, there has been growing interest in the use of weighted l1-minimization for sparse recovery but most of the prior work was using dense (subgaussian and bounded orthonormal systems) sensing matrices. Sparse matrices has better computational advantages over their dense counterparts. This work derives the first sparse recovery guarantees for weighted l1-minimization with sparse measurement matrices. We used the weighted null space property and weighted 1-norm restricted isometry property (RIP1) to derive these guarantees. Consequently, we show that these sparse matrices that are adjacency matrices of expander graphs satisfy the weighted RIP1. In addition we show that, using these matrices, weighted l1-minimization with properly designed weights achieves reduced sampling rates. This result has potential applications in many science and engineering problems where ill-posed inverse problems are solved using sparse recovery approaches.

▶ CP-Tu-E-61-3 16:40–17:00

The Nonuniform Linear Canonical Transform and Its Applications

Li, Bing-Zhao Beijing Inst. of Tech.

Abstract: As the generalization of the classical Fourier transform and the fractional Fourier transform, the linear canonical transform received much interests in recent years. A novel kind of nonuniform linear canonical transform is investigated in detail in this paper. Firstly, based on the properties of periodic nonuniform sampling model, the new definition of discrete linear canonical transform is proposed, and then the relationship between the discrete linear canonical transform spectrum with the continuous linear canonical transform are derived, and finally, the application of the derived relationship in the reconstruction of the linear canonical transform spectrum is also investigated, the simulations are also carried out to verify the correctness of the derived results.

▶ CP-Tu-E-61-4 17:00–17:20

Resource Criticality Analysis in Optical Network Planning

Wu, Jing Univ. of Ottawa

Yu, Richard Carleton Univ.

Abstract: Existing optical network planning algorithms do not explicitly measure the impact of changes of network resources on the design objective. We propose a measurement based on the Lagrangian relaxation framework, using the optimized values of Lagrange multipliers as a direct measurement of resource criticality. Such a quantitative measurement can be naturally obtained along with the optimization process to compute the optimal solution (or a near-optimal solution) to the static Routing and Wavelength Assignment (RWA) problems.

▶ CP-Tu-E-61-5 17:20–17:40

Geometric Methods for the Study of Electrical Networks

Durand, Philippe CNAM

Maurice, Olivier GERAC

Reineix, Alain XLIM

Abstract: The methods developed by Gabriel Kron, for the tensor approach of networks (TAN), offers a great source of applications for the geometrical and topological study of electrical networks. The language of tensorial analysis is well adapted to the description of networks. Tools about discrete combinatorial topology are well adapted specifically to the study of graphs,, for example, the Euler caracteristic Poincaré, the simplest invariant in topology is connected to a formula obtained by Kron connecting the nodes of the graphs, edges, mesh currents and node pairs. Extensions using tools of algebraic topology are possible in larger dimension. We thus find the node law and the law of mesh The addition of differential geometry is used to connect discrete data obtained from circuit and continuous phenomena for example, transmission problems via antenna.

▶ CP-Tu-E-61-6 17:40–18:00

An Optimization Model for Electricity Networks Using Random Variables

Ezzati, Ghasem Federation Univ. Australia

Abstract: Many optimization models have been introduced for electricity networks where total cost is minimized. Deterministic variables are often used in these models and reliability issues are at most considered using some indices. However, no optimization model is available taking into account random variables. In this paper, a random variable is assumed for electricity networks optimization model in order to define a safety condition for networks reliability. A performance function is then introduced based on this random variable so that network failure probability can be calculated. The optimization model will then be formulated for electricity networks based on the obtained failure probability. This model minimizes total cost while keeping the failure probability below than a predetermined accepted level. It’s predictable that a lower predetermined accepted level for network failure probability leads to a higher total cost.

CP-Tu-E-62	16:00–18:40	102
Life Science and Medicine		

Chair: Santos, Fernando Inst. of BioSci. IBB Unesp

Abstract:

▶ CP-Tu-E-62-1 16:00–16:20

Numerical Study of Dengue Disease Problem Using Discrete Patches

Santos, Fernando Inst. of BioSci. IBB Unesp

Abstract: Dengue is a subject of intense research and it has been a major public health problem worldwide, especially in tropical and subtropical countries such as Brazil, where its incidence has increased in recent years. Spatial models are commonly used in the diffusion approach, where the space is considered as a continuous variable. In diffusion models, the many factors that affect the movement are difficult to incorporate. Thus, in areas where resources are located in patches or discrete locations, mosquito dispersal is more conveniently modeled, in which the population is divided into discrete patches. In this work we develop a discrete model to analyze the spread of Dengue numerically. In the process of mathematical modeling we take into account the populations Dengue mosquitoes, humans and the circulation of a single serotype.

▶ CP-Tu-E-62-2 16:20–16:40

Optimal Control Model of Wolbachia Transinfection Targeting Vector Population

Vasilieva, Olga Universidad del Valle

Cardona, Daiver Universidad Autonoma de Occidente

Campo, Doris Elena universidad del valle

Abstract: Wolbachia is a vertically transmitted bacterial symbiont capable to reduce the virus transmission in insect hosts. Recently, Wolbachia-based biological control has been proposed for suppressing the transmissibility of vector-borne diseases. In this presentation, we propose a mathematical model for Wolbachia transinfection targeting the wild population of Aedes aegypti mosquitoes, the principal vector of dengue. The model is formulated in term of optimal control, where the control variable stands for the rate of release of Wolbachia-infected mosquitoes. The purpose of control is to maximize the density of Wolbachia-infected mosquitoes while minimizing the overall number of dengue-infected people together with the total interventions costs. Our approach allows to identify the model parameters (linked to the biological features of Wolbachia) which affect the mosquito's ability to develop and transmit the virus and which also facilitate the pervasiveness and persistence of Wolbachia infection among mosquito population.

▶CP-Tu-E-62-3 16:40–17:00

A MATHEMATICAL MODELLING ANALYSIS OF THE DYNAMICS AND CONTROL OF EBOLA VIRUS DISEASE TRANSMISSION

Kassem, Titus Univ. of Jos
Ikpechukwu, Paschal Univ. of Jos

Abstract: We constructed a twin dynamic mathematical model to examine two possible scenarios for the spread of the ebola virus disease (EVD). The first model mimics the initial spread of the disease before a substantial scale-up in public health strategies towards the control of the ebola virus disease was established while the second model takes into account strategies put in place to halt the spread of the disease. We derived EVD parameters from epidemiological data for the current epidemic and propagated uncertainty in epidemiological parameters onto model predictions by using Markov Chain Monte Carlo based sampling methods. We established that if the running reproductive number is unit for large time in the first model then the epidemic will pass even if R0 ¿ 1. Also, using data from Guinea, Sierra Leon, Liberia and Nigeria, we carry out numerical simulation of our models and establish threshold conditions for the eradication of disease.

▶CP-Tu-E-62-4 17:00–17:20

The Impact of Additional Food as A Part of Prey Harvesting Effort for A Bio-economic Predator-prey Model

Kumar, Dinesh Indian Inst. of Tech. Guwahati
Chakrabarty, Siddhartha Indian Inst. of Tech. Guwahati

Abstract: We consider two bio-economic ratio-dependent predator-prey models for prey harvesting, one without and the other with additional food supply to the predators. We analyze the stability of the equilibrium points and determine the maximum sustainable yield. We then study the problem from the perspective of control theory with the additional food supply as a part of the effort, in addition to the traditional approach of adding a harvesting term. It is shown that the inclusion of additional food into the effort could result in more profitable harvesting even after accounting for the cost of additional food supply.

▶CP-Tu-E-62-5 17:20–17:40

Estimating Parameters of Biological Models Using Ensemble Kalman Filter

Apri, Mochamad Industrial & Financial Mathematics Research Division

Abstract: Biological processes are very complex; involving many components with intricate interactions and also influenced by environment. Modelling such processes into mathematical equations often leads to a very large nonlinear differential equation system with many parameters. Some or even all of these parameters might have to be estimated from noisy experimental data. Although some methods are available, the task of estimating parameters remains a challenging task, especially due to the high number of parameter to estimate, noisy data, and limited number of measurable components. In this work, we propose an alternative method to estimate the parameters based on the ensemble Kalman filter. To test the performance, the method is applied to estimate parameters in the heat shock response model. The results show a good agreement.

▶CP-Tu-E-62-6 17:40–18:00

A Mathematical Model to Diagnose the Level of Diabetes Using Fuzzy Logic System

Kumar, Sanjeev Dr. B.R. Ambedkar Univ., Agra
Chaudhary, Sanjay Dr. B.R. Ambedkar Univ., Agra

Abstract: The diagnosis of disease involves several levels of uncertainty and imprecision and it is inherent to medicine. A single disease may manifest itself quite differently, depending on patient and with different intensities. A single symptom may correspond to different diseases. On the other hand several diseases present in a patient may interact and interfere with usual description of any of diseases. The fuzzy logic has been utilized in several different approaches to modeling the diagnostic process. In this work diagnosis of the level of diabetes is addressed by using fuzzy logic. Here trapezoidal membership function is used for fuzzification process.

▶CP-Tu-E-62-7 18:00–18:20

Epigenetic Modelling of Developmental Plasticity

Wake, Graeme Massey Univ.,

Abstract: Mathematics-in-Medicine is now a fast growing area. The traditional empirical models are being supplemented by the development of new conceptual models, which provide new ways of obtaining underpinning decision support. Evolution is driven by the degree of plasticity, by which living organisms mutate to optimise their fitness. A mechanism is proposed and analysed in which the phenotype is modelled on a continuous scale providing a parameter to quantify the phenotype state and fitness. RNA viruses can serve as an excellent testing model for verifying hypotheses and addressing questions in evolutionary biology. A simple deterministic mathematical model of the within-host viral dynamics is proposed which assumes a continuous distribution of viral strains in a one-dimensional phenotype space. Simulations show that random mutations combined with competition for a resource results in evolution towards higher Darwinian fitness in the phenotype space. The steady-state(s) of the steady phenotype distribution involves non-local (integro-differential) equations.

▶CP-Tu-E-62-8 18:20–18:40

The Role of the Immune System in the Dynamics of Chronic Myeloid Leukemia

Clapp, Geoffrey Univ. of Maryland, College Park

Abstract: We develop a mathematical model of chronic myeloid leukemia (CML) and the immune system, and apply it to patient data collected throughout therapy. Many patients who respond well to therapy exhibit a biphasic exponential decline in cancer load, followed by a period of damped oscillations. Our data and modeling results suggest that a patient's immune system plays a significant role in these dynamics and that the oscillations may represent an immune response to CML.

CP-Tu-E-63 16:00–18:00 103

Numerical Analysis

Chair: Tanaka, Ken'ichiro Musashino Univ.

Abstract:

▶CP-Tu-E-63-1 16:00–16:20

A fast and accurate numerical method for the symmetric Lévy processes based on the Fourier transform and sinc-Gauss sampling formula

Tanaka, Ken'ichiro Musashino Univ.

Abstract: We propose a fast and accurate numerical method based on Fourier transform to solve Kolmogorov forward equations of symmetric scalar Lévy processes. The method is based on the accurate numerical formulas for Fourier transform proposed by Ooura. These formulas are combined with nonuniform fast Fourier transform (FFT) and fractional FFT to speed up the numerical computations. Moreover, we propose a formula for numerical indefinite integration on equispaced grids as a component of the method. The proposed integration formula is based on the sinc-Gauss sampling formula, which is a function approximation formula. This integration formula is also combined with the FFT. Therefore, all steps of the proposed method are executed using the FFT and its variants. The proposed method realizes exponential convergence and allows us to be free from some special treatments for a non-smooth initial condition and numerical time integration.

▶CP-Tu-E-63-2 16:20–16:40

A New Method to Select Neighboring Points in the Finite Directional Difference Meshless Method

Lv, Guixia Inst. of Applied Physics & Computational Mathematics
Shen, Longjun Inst. of Applied Physics & Computational Mathematics

Abstract: This paper considers the finite directional difference method (FDDM) on the 2D scattered point distribution. Based on some theoretical analyses to the FDDM, we obtain new difference formulae for computing first-order and second-order directional differentials, in which the difference coefficients related to scattered neighboring points have definite geometric meanings, and consequently present a new method to select neighboring points on the 2D scattered point distribution.

▶CP-Tu-E-63-3 16:40–17:00

Fast Method for Systems of Smolushowski-type Kinetic Equations.

Matveev, Sergey Lomonosov Moscow State Univ.
Tyrtyshnikov, Eugene Inst. of Numerical Mathematics of Russian Acad. of Sci.

Smirnov, Alexander — Lomonosov Moscow State Univ.

Abstract: We propose a new computational techique for large systems of kinetic equations of aggregation and fragmentation processes. In contrast to standard Monte Carlo methods, we solve the grid equations by the predictor-corrector scheme. Using low-rank approximations of the solution and as well of the coagulation kernel, we tremendously accelerate every time step keeping the same level of accuracy. The complexity is reduced from $O(N^2)$ to $O(N \log N)$, where N is the number of nodes. We prove that our method applies to problems with typical coagulation kernels. The results of simulation are demostrated on one-dimensional models, however the tecnique can be generalized to the multidimensional case.

▶ CP-Tu-E-63-4 17:00–17:20

On with and without Memory Root Finding Iterative Methods Based on Inverse Interpolation; Attraction Basins

Zafar, Fiza — Bahauddin Zakariya Univ. Multan
Zainab, Aqsa — Bahauddin Zakariya Univ. Multan
Habib, Naila — Bahauddin Zakariya Univ. Multan

Abstract: We present a family of without memory three-step optimal eighth order iterative methods by using the multipoint inverse interpolation in which first two steps are of any optimal two-step fourth order method. A biparametric derivative free extension involving weight function is given which is further extended as a with memory iterative method having accelerated order of convergence. The comparisons are given with other predefined methods of respective domain for many types of non-linear functions. Basins of Attraction are also given to analyze the effectiveness of the new methods.

▶ CP-Tu-E-63-5 17:20–17:40

Derivative Free General Family of with and without Memory Root Finding Methods

Yasmin, Nusrat — Bahauddin Zakariya Univ. Multan Pakistan
Zafar, Fiza — Bahauddin Zakariya Univ. Multan
Junjua, Moin-ud-din — Bahauddin Zakariya Univ. Multan, Pakistan
Akram, Saima — Bahauddin Zakariya Univ., Multan

Abstract: In this work, we propose a general procedure to achieve a class of optimal derivative free iterative methods using rational interpolant. The class is further extended to a general with memory family of iterative methods with increased order of convergence. We used a suitable variation of the two free parameters involved to increase the order of convergence from 2^n to $2^n + 2^(n-1)$ without any additional function evaluation. Hence, the with memory class retain better computational efficiency as compared to without memory methods. Numerical tests are presented to compare the performance of newly developed with and without memory families with the existing schemes of this domain which confirm robustness and efficiency of the presented families.

▶ CP-Tu-E-63-6 17:40–18:00

Application Monte Carlo Method for Evaluation the Price of Multi-Asset Rainbow Options

Rasulov, Abdujabar — Univ. of World Economy & Diplomacy

Abstract: In multidimensional case one of useful features Monte Carlo method allows the solution of boundary value problems to be found at just one point. This property be useful in problems of option pricing, where the value of an option is required only at the time of striking. In this work we consider European multi-asset options which described by the system of stochastic differential equations and construct Monte Carlo algorithms for the solution.

CP-Tu-E-64	16:00–18:00	104
Control and Systems Theory		

Chair: Guo, Ya-Ping — Beijing Inst. of Tech.

Abstract:

▶ CP-Tu-E-64-1 16:00–16:20

Stabilization of the Rotating Body-Beam System with Nonlinear Damping

Guo, Ya-Ping — Beijing Inst. of Tech.
Wang, Jun-Min — Beijing Inst. of Tech.

Abstract: In this paper, we deal with the stabilization of the rotating body-beam system with nonlinear damping. The well-posedness of the closed-loop system is established by the nonlinear maximal monotone theories, and using LaSalle's Invariance Principle, the asymptotic stability of system is discussed. Last, we estimate the rate of decay of system by the multiplier method.

▶ CP-Tu-E-64-2 16:20–16:40

Boundary Stabilization of A Flexible Beam Attached to A Rotating Disk

Wang, Jun-Min — Beijing Inst. of Tech.
Kang, Lingnan — Beijing Inst. of Tech.

Abstract: We consider the boundary feedback stabilization of a ﬂexible beam attached to the center of a rotating disk. We propose the torque and shear force boundary controls applied on the disk and flexible beam respectively, so that the disk can be rotated with the desired angular velocity and the beam can be stabilized. Due to the rotation of the disk, we prove that there is the critical angular velocity of the disk, which is the square root of the smallest natural frequency, so that the beam can not be stabilized when the angular velocity is greater than or equal to this critical value. When the angular velocity is less than the critical value, we prove that the beam is exponentially stable. This result is illustrated by a set of numerical simulations.

▶ CP-Tu-E-64-3 16:40–17:00

Robust H_∞ Control for Bilinear Systems using Linear Matrix Inequalities

Solikhatun, Solikhatun — Institut Teknologi Bandung
Saragih, Roberd — Institut Teknologi Bandung
Joelianto, Endra — Institut Teknologi Bandung
Naiborhu, Janson — Institut Teknologi Bandung

Abstract: The robust H_∞ control design for bilinear systems which adopts the parallel distribution compensation is investigated. First, the bilinear system is represented as dynamic Takagi-Sugeno (TS) fuzzy systems by using sector nonlinearity approach. The dynamic TS fuzzy system is a convex combination of local linear systems. The local robust H_∞ controller is designed on each the local linear system. The controller synthesis for the local linear systems is then formulated in the bilinear matrix inequalities (BMIs) problem. After that, the BMIs problem is reduced to an equivalent parameter of linear matrix inequalities (LMIs) problem which have a feasible solution. The existence of the local robust H_∞ controller of the local linear systems is presented.The simulation results are given to clarify the proposed method for the robust H_∞ control design of the bilinear systems.

▶ CP-Tu-E-64-4 17:00–17:20

Optimal Control Algorithm for Stochastic Logical Dynamical Systems and Its Application to Gasoline Engines

Wu, Yuhu — Sophia University
Shen, Tielong — Sophia University

Abstract: In this work, the optimal control problem for the stochastic logical dynamical system is considered. Based on the semi-tensor product of matrix, we establish a matrix expression of dynamic programming for the optimal control problem. As an application, a stochastic logical transient model is proposed to represent the cycle-to-cycle behavior of residual gas fraction in gasoline engines, and an optimal feedback control law, which targets on rejection of residual gas fraction fluctuation, is derived.

CP-Tu-E-65	16:00–18:00	105
Optimization and Operations Research		

Chair: Nagar, Harish — Mewar Univ., Gangrar, Chittorgarh

Abstract:

▶ CP-Tu-E-65-1 16:00–16:20

Fuzzy Inventory Model for Deteriorating Items with Fluctuating Demand and Using Inventory Parameters as Pentagonal Fuzzy Numbers........

Nagar, Harish — Mewar Univ., Gangrar, Chittorgarh
Surana, Priyanka — Mewar Univ., Gangrar, Chittorgarh

Abstract: In this paper, a fuzzy inventory model for deteriorating items with time varying demand and shortages under fully backlogged condition is formulated and solved. In which demand increases with time. Shortages are allowed and fully backlogged. Fuzziness is introduced by allowing the cost components (holding cost, shortage cost, etc.), demand rate and the deterioration. In fuzzy environment, all related inventory parameters are assumed to be pentagonal fuzzy numbers. The purpose of this paper is to minimize the total cost function in fuzzy environment. Graded Mean Representation method is used to defuzzify the total cost function and the results obtained by this method are explained with the help of a numerical example. Sensitivity analysis is also carried out to explore the effect of changes in the values of some of the system parameters.

▶ CP-Tu-E-65-2 16:20–16:40

Shape Optimization Techniques for An Inverse Problem

Timimoun, Chahnaz Zakia — Univ. of Oran

Abstract: We aim to determine the form and the location of an inaccessible obstacle ω around which a viscous fluid is flowing in a greater domain Ω and governed by the Stokes equations with Dirichlet and Neumann conditions via some boundary measurement of the velocity and Cauchy forces on ∂Ω. We study the inverse problem of reconstructing ω using the tools of shape optimization by defining a cost functionnel. .

▶ CP-Tu-E-65-3 16:40–17:00

Interior Point Method with the Continued Iteration

Berti, Lilian Ferreira UNICAMP
Ghidini, Carla FCA - UNICAMP
Oliveira, Aurelio UNICAMP

Abstract: In this work, the continued iteration is presented and incorporated into the predictor corrector interior point method in order to reduce the number of iterations and consequently the computational time necessary to solve large-scale linear programming problems. In the continued iteration a new direction is computed and combined with the predictor corrector one. Computational results show the improvement achieved by the proposed approach.

▶ CP-Tu-E-65-4 17:00–17:20

Multi-Objective Fixed-Charge Transportation Problem under Random Rough Environment

Roy, Sankar Kumar Vidyasagar Univ.

Abstract: This paper studies the multi-objective fixed-charge transportation problem (MOFCTP) under uncertain environment. Due to globalization of the market, some of the parameters of MOFCTP are treated as rough variables and others are random rough variables. A procedure is shown for converting from uncertain MOFCTP to MOFCTP. Different methods are used to derive the optimal solutions of MOFCTP and then compared. Finally, a real-life example on MOFCTP is included to illustrate the paper.

▶ CP-Tu-E-65-5 17:20–17:40

A FRAMEWORK INTEGRATING BIOGEOGRAPHY-BASED OPTIMIZATION AND SUPPORT VECTOR REGRESSION FOR FREEWAY TRAVEL TIME PREDICTION AND FEATURE SELECTION

Bansal, Prateek The Univ. of Texas at Austin

Abstract: Freeway travel time prediction models have been proposed in literature, but identification of important predictors has not received much attention. Identification of important predictors reduces dimensions of input data, lessens computational load, and provides better understanding of underlying relationship between important predictors and travel time. Moreover, collection of only important predictors can lead to a significant equipment savings in data collection. Therefore, this study proposes a hybrid approach for feature selection (identifying important predictors) along with developing a robust freeway travel time prediction model. A framework integrating biogeography-based optimization (BBO) and support vector regression (SVR) has been developed. It was validated by predicting travel time at 36.1 km long segment of National Taiwan Freeway No. 1. The proposed hybrid approach is able to develop a prediction model with only six predictors, which is found to have accuracy equivalent to a stand-alone SVR prediction model developed with all forty three predictors.

▶ CP-Tu-E-65-6 17:40–18:00

Feasibility Sampling in Interval Methods for Special Multi-Constrained Global Optimization

Ying, Mengyi Univ. of North Georgia

Abstract: A supplementary feasibility sampling procedure is added to the framework of interval method for finding optimal solutions of global optimization problem over a bounded interval domain subject to multiple linear constraints. Its main feature is the ability to detect infeasibility or actually locate a feasible sample in any working subinterval. Thus it provides tighter upper bounds of the optimal objective function value than the standard methods. Numerical results will be provided to demonstrate its effectiveness.

MS-Tu-E-66 16:00–18:30 VIP4-3

Inverse Problems Based on Partial Differential Equations with Applications

Organizer: Liu, Jijun Southeast Univ.
Organizer: CHENG, JIN Fudan Univ.
Organizer: Wang, Haibing Southeast Univ.

Abstract: Inverse problems have found wide applications in industry and many modern technique areas such as material sciences, nondestructive test and imaging process, with the essential difficulties of ill-posedness. There are different ways to the modeling of inverse problems, among which the inverse problems based on partial differential equations occupy an important position. In this minisymposium, we will organize several talks covering inverse scattering, inverse boundary value problems, inverse source problems, abnormal diffusion process and imaging process. These problems are described by elliptic and parabolic equations. The related mathematical theory and inversion algorithms will be discussed, dealing with the ill-posedness and nonlinearity of the corresponding problems. The speakers come from Austria, China, Germany, Japan, Korea, Vietnam.

▶ MS-Tu-E-66-1 16:00–16:30

Determining the Initial Condition or the Right Hand Side in Parabolic Equations from Interior Observations.

Dinh-Nho, Hao Hanoi Inst. of Mathematics, Vietnam Acad. of Sci. & Tech.
Oanh, Nguyen-Thi-Ngoc Thai Nguyen Univ.

Abstract: The problem of identifying the initial condition or the right hand side in parabolic equations with time-dependent coefficients from interior observations is studied. The problem is ill-posed and we numerically analyze its degree of ill-posedness. Then, we propose the conjugate gradient method based on the splitting method for solving the problem numerically. Some numerical results are presented.

▶ MS-Tu-E-66-2 16:30–17:00

Inverse Source Problems and Its Numerical Computation

Lu, Shuai School of Mathematical Sci., Fudan Univ.
CHENG, JIN Fudan Univ.

Abstract: In this talk, we investigate an interior Helmholtz inverse source problem with multiple frequencies. By implementing sharp uniqueness of the continuation results and exact observability bounds for the wave equation, a (nearly Lipschitz) increasing stability estimate is explicitly obtained for Cauchy measurements in a non-empty wave-number interval.

▶ MS-Tu-E-66-3 17:00–17:30

Spectral Theory and Inverse Problems for Schroedinger Operators on Perturbed Periodic Lattices

Isozaki, Hiroshi Univ. of Tsukuba

Abstract: We talk about the spectral properties of Schroedinger operators on perturbed lattices. The main topics are the non-existence or the discreteness of embedded eigenvalues, the limiting absorption principle for the resolvent, spectral representations, the S-matrix and the associated inverse problems. Our theory covers the square, triangular, diamond, Kagome lattices, as well as the ladder, the graphite and the subdivision.

▶ MS-Tu-E-66-4 17:30–18:00

The Equivalent Refraction Index for the Acoustic Scattering by Many Small Obstacles: with Error Estimates

Sini, Mourad RICAM

Abstract: Let M be the number of bounded and regular bodies having a maximum radius 'a', a¡¡1, located in a bounded domain of R3. We are concerned with the time harmonic acoustic scattering problem by a very large number M of such small bodies. We derive the limiting scattering problems when 'a' goes to zero and provide explicit error estimates in terms of 'a'. Then, we discuss two applications in engineering materials.

▶ MS-Tu-E-66-5 18:00–18:30

Multiple Parameters Determination in Textile Material Design

Xu, Dinghua Zhejiang Sci-Tech Univ.

Abstract: We give a overall review on the mathematical formulation of textile material design based on clothing heat-moisture comfort, and corresponding results of theoretical analysis and numerical algorithms for direct/inverse problems.

SL-Tu-1 19:00–20:00 Ballroom C

Special Lecture

Chair: Cook, L. Pamela

Abstract:

▶ SL-Tu-1 19:00–20:00

Mathematical aspects of collective dynamics: consensus, the emergence of leaders and social hydrodynamics

Tadmor, Eitan University of Maryland

Abstract:

Wednesday, August 12, 2015

IL-We-1 8:30–9:30 Ballroom A
Invited Lecture
Chair: Arnold, D. N.
Abstract:

▶ IL-We-1 8:30–9:30
Refinement strategies for spline based methods
Buffa, Annalisa Istituto di Matematica Applicata e Tecnologie Informatiche

Abstract: In the last ten years the use of splines as a tool for the discretisation of partial differential equations has gained interests thanks to the advent of isogeometric analysis (2005, Hughes et al). In this context, the development of methods capable of local refinement and adaptivity is extremely important as they alleviate the constraints on meshing imposed by the tensor product structure of spline spaces. A few techniques have been proposed in the last years, but somehow their use in adaptivity and the related mathematical understanding are, to a large extend, open research topics. I will present my recent contributions to this field with a special attention to two approaches: T-splines and hierarchical splines.

IL-We-2 8:30–9:30 Ballroom B
Invited Lecture
Chair: Zuazua, Enrique
Abstract:

▶ IL-We-2 8:30–9:30
Stabilization of control systems: From the water clocks to the regulation of rivers
Coron, Jean Michel Université Pierre et Marie Curie

Abstract: A control system is a dynamical system on which one can act by using controls. For these systems a fundamental problem is the stabilization issue: Is it possible to stabilize a given unstable equilibrium by using suitable feedback laws? (Think to the classical experiment of an upturned broomstick on the tip of one's finger.) On this problem, we present some pioneer devices and works (Ctesibius, Watt, Maxwell, Lyapunov...), some more recent results, and an application to the regulation of the rivers La Sambre and La Meuse in Belgium. A special emphasize is put on positive or negative effects of the nonlinearities.

IL-We-3 8:30–9:30 Ballroom C
Invited Lecture
Chair: Ball, John
Abstract:

▶ IL-We-2 8:30–9:30
Weak universality of the KPZ equation
Hairer, Martin Warwick University

Abstract: The KPZ equation is a popular model of one-dimensional interface propagation. From heuristic consideration, it is expected to be "universal" in the sense that any "weakly asymmetric" or "weakly noisy" microscopic model of interface propagation should converge to it if one sends the asymmetry (resp. noise) to zero and simultaneously looks at the interface at a suitable large scale. In particular, although the equation is not even classically well-posed, any "reasonable" numerical method is expected to converge to it, possibly with limiting parameters different from the "naive" ones.
However, the only microscopic models for which this has been proven so far all exhibit some very particular structure allow to perform a microscopic equivalent to the Hopf-Cole transform. In this talk, we will see that there exists a rather large class of continuous models of interface propagation for which convergence to KPZ can be proven rigorously. The main tool for both the proof of convergence and the identification of the limit is the recently developed theory of regularity structures, but with an interesting twist.

IL-We-4 10:00–11:00 Ballroom A
Invited Lecture
Chair: Shu, Chi-Wang
Abstract:

▶ IL-We-4 10:00–11:00
What's new in high-dimensional integration? – designing Quasi Monte Carlo for applications
Sloan, Ian The University of New South Wales

Abstract: This paper, based on an invited talk at ICIAM 2015, describes an approach to high-dimensional integration, developed over the past 15 years, in which the numerical integration rule is a Quasi Monte Carlo rule (i.e. an equal weight rule) especially designed to match a particular problem.

IL-We-5 10:00–11:00 Ballroom B
Invited Lecture
Chair: Grötschel, Martin
Abstract:

▶ IL-We-5 10:00–11:00
Computational Progress in Linear and Mixed Integer Programming
Bixby, Bob Gurobi Optimization

Abstract: We describe progress in linear and mixed-integer programming (MIP) algorithms and software over the last 25 years. As a result of this progress, modern linear programming (LP) codes are now capable of robustly and efficiently solving instances with multiple millions of variables and constraints. With these LP advances as a foundation, MIP then provides a mathematical framework that enables the representation and solution to provable optimality of a wide range of real-world planning and scheduling models, this in spite of the fact that MIP is NP-hard. Describing the remarkable performance improvements in MIP over the last 25 years and the mathematical underpinnings will central to this talk.

IL-We-6 10:00–11:00 Ballroom C
Invited Lecture
Chair: Xu, Zongben
Abstract:

▶ IL-We-6 10:00–11:00
Image Restoration: A Data-Driven Perspective
Shen, Zuowei National University of Singapore

Abstract: We describe progress in linear and mixed-integer programming (MIP) algorithms and software over the last 25 years. As a result of this progress, modern linear programming (LP) codes are now capable of robustly and efficiently solving instances with multiple millions of variables and constraints. With these LP advances as a foundation, MIP then provides a mathematical framework that enables the representation and solution to provable optimality of a wide range of real-world planning and scheduling models, this in spite of the fact that MIP is NP-hard. Describing the remarkable performance improvements in MIP over the last 25 years and the mathematical underpinnings will central to this talk.

IL-We-7 11:10–12:10 Ballroom A
Invited Lecture
Chair: Xu, Jinchao
Abstract:

▶ IL-We-7 11:10–12:10
Solution Techniques for the Stokes System: A Priori and A Posteriori Modifications, Resilient Algorithms
Wohlmuth, Barbara Technische Universität München

Abstract: This article proposes modifications to standard low order finite element approximations of the Stokes system with the goal of improving both the approximation quality and the parallel algebraic solution process. Different from standard finite element techniques, we do not modify or enrich the approximation spaces but modify the operator itself to ensure fundamental physical properties such as mass and energy conservation. Special local a priori correction techniques at re-entrant corners lead to an improved representation of the energy in the discrete system and can suppress the global pollution effect. Local mass conservation can be achieved by an a posteriori correction to the finite element flux. This avoids artifacts in coupled multi-physics transport problems. Finally, hardware failures in large supercomputers may lead to a loss of data in solution subdomains. Within parallel multigrid, this can be compensated by the accelerated solution of local subproblems. These resilient algorithms will gain importance on future extreme scale computing systems.

IL-We-8 11:10–12:10 Ballroom B
Invited Lecture
Chair: Yuan, Yaxiang
Abstract:

▶ IL-We-8 11:10–12:10
On Convergence of the Multi-Block Alternating Direction Method of Multipliers
Ye, Yingyu Stanford University

Abstract: The alternating direction method of multipliers (ADMM), after a long

"silent" period, has recently witnessed a "renaissance" in many application domains, such as signal and imagine processing, statistics analysis, machine learning, engineering computation, etc. The convergence of ADMM was established 40 years ago when two blocks of variables are alternatively updated. It is computationally beneficial to extend the ADMM directly to the case of a multi-block convex minimization problem. However, whether or not the ADMM is convergent was open until very recently. In this survey paper, we summarize recent approaches and results in this pursuit. Mainly, we illustrate an example to show that the direct extension of ADMM is not necessarily convergent with three or more blocks. On the positive side, we present the result that, if in each iteration one randomly and independently permutes the updating order of variable blocks followed by the standard Lagrangian multiplier update, then ADMM will converge in expectation when solving certain convex optimization problems.

IL-We-9 11:10–12:10 Ballroom C
Invited Lecture
Chair: Mitsui, Taketomo
Abstract:

▶ IL-We-9 11:10–12:10
On the interplay between intrinsic and extrinsic instabilities of spatially localized patterns
Nishiura, Yasumasa — Tohoku University

Abstract: Spatially localized dissipative structures are observed in various fields, such as neural signaling, chemical reactions, discharge patterns, granular materials, vegetated landscapes and binary convection. These patterns are much simpler than single living cells, however they seem to inherit several characteristic "living state" features, such as self-replication, self-healing and robustness as a system. Adaptive switching of dynamics can also be observed when these structures collide with each other, or when they encounter environmental changes in the media. These behaviors stem from an interplay between the intrinsic instability of each localized pattern and the strength of external signals. To understand such an interplay, we explore the global geometric interrelation amongst all relevant solution branches of a corresponding system with approximate unfolding parameters. For instance, it has been uncovered that large deformation at strong collision is mapped into the network of unstable patterns called scattors, and that an organizing center for 1D pulse generators is a double homoclinic orbit of butterfly type. We will illustrate the impact of this approach by presenting its application in relation to the decision making process of amoeboid locomotion and hierarchical structures of ordered patterns arising in reaction diffusion systems and binary fluids.

EM-We-D-01 13:30–15:30 311A
Third Workshop on Hybrid Methodologies for Symbolic-Numeric Computation - Part V of VIII
For Part 1, see EM-Mo-D-01
For Part 2, see EM-Mo-E-01
For Part 3, see EM-Tu-D-01
For Part 4, see EM-Tu-E-01
For Part 6, see EM-We-E-01
For Part 7, see EM-Th-BC-01
For Part 8, see EM-Th-D-01
Organizer: Giesbrecht, Mark — Univ. of Waterloo
Organizer: Kaltofen, Erich — North Carolina State Univ.
Organizer: Safey El Din, Mohab — Univ. Pierre & Marie Curie
Organizer: Zhi, Lihong — Acad. of Mathematics & Sys. Sci.

Abstract: Hybrid symbolic-numeric computation methods, which first appeared some twenty years ago, have gained considerable prominence. Algorithms have been developed that improve numeric robustness (e.g., in quadrature or solving ODE systems) using symbolic techniques prior to, or during, a numerical solution. Likewise, traditionally symbolic algorithms have seen speed improvements from adaptation of numeric methods (e.g., lattice reduction methods). There is also an emerging approach of characterizing, locating, and solving "interesting nearby problems", wherein one seeks an important event (for example a nontrivial factorization or other useful singularities), that in some measure is close to a given problem (one that might have only imprecisely specified data). Many novel techniques have been developed in these complementary areas, but there is a general belief that a deeper understanding and wider approach will foster future progress. The problems we are interested are driven by applications in computational physics (quadrature of singular integrals), dynamics (symplectic integrators), robotics (global solutions of direct and inverse problems near singular manifolds), control theory (stability of models), and the engineering of large-scale continuous and hybrid discrete-continuous dynamical systems. Emphasis will be given to validated and certified outputs via algebraic and exact techniques, error estimation, interval techniques and optimization strategies.
Our workshop will follow up on the seminal SIAM-MSRI Workshop on Hybrid Methodologies for Symbolic-Numeric Computation held in November 2010 and the Fields Institute Workshop on Hybrid Methodologies for Symbolic-Numeric Computation, November 16-19, 2011 at the University of Waterloo, Canada. We will provide a forum for researchers on all sides of hybrid symbolic-numeric computation.

▶ EM-We-D-01-1 13:30–14:30
A Bounded Degree SOS Hierarchy for Polynomial Optimization
LASSERRE, Jean Bernard — LAAS-CNRS

Abstract: We provide a new hierarchy of semidefinite relaxations for polynomial optimization which combines some advantages of the standard LP- and SDP-relaxations: (a) the size of the matrix associated with the semidefinite constraint is the same and fixed in advance, (b) finite convergence occurs at the first step of the hierarchy for an important class of convex problems, and (c) using point evaluations and rank-one matrices make an efficient implementation possible as testified on numerical examples.

▶ EM-We-D-01-2 14:30–15:00
Smaller SDP for SOS Decomposition
Bican, Xia — Peking Univ.

Abstract: Two types of polynomials, convex cover polynomials and split polynomials, are defined. A convex cover polynomial or a split polynomial can be decomposed into several smaller sub-polynomials such that the original polynomial is SOS if and only if the sub-polynomials are all SOS. Thus the original SOS decomposition problem can be reduced equivalently to smaller sub-problems.

▶ EM-We-D-01-3 15:00–15:30
Applications of Homogenization in Semidefinite Relaxations of Polynomial Optimization Problems
Guo, Feng — Dalian Univ. of Tech.

Abstract: Recently, polynomial optimization with semidefinite relaxations has been well studied. It applies Positivstellensatz and sums-of-squares technique to relax a polynomial optimization problem to semidefinite programs. Due to the Positivstellensatz, most of the results are only valid for problems with compactness assumption. In this talk, we solve this problem by the technique of homogenization. We apply this method to the problems of minizing rational functions, semi-infinite polynomial programming and semidefinite representations of non-compact semi-algebraic sets.

EM-We-D-02 13:30–15:30 309A
Differential Algebra and Related Topics - Part V of VIII
For Part 1, see EM-Mo-D-02
For Part 2, see EM-Mo-E-02
For Part 3, see EM-Tu-D-02
For Part 4, see EM-Tu-E-02
For Part 6, see EM-We-E-02
For Part 7, see EM-Fr-D-02
For Part 8, see EM-Fr-E-02
Organizer: Feng, Ruyong — Acad. of Mathematics & Sys. Sci.,CAS
Organizer: Guo, Li — Rutgers Univ. at Newark, USA
Organizer: Gao, Xiao-Shan — Acad. of Mathematics & Sys. Sci., Chinese Acad. of Sci.

Abstract: This meeting is to offer an opportunity for participants to present original research , to learn of reserch progress and new developments on differential algebra and related topics, particularly, the applications of differential algebra to control theory, physics, chemistry, biology and so on.

▶ EM-We-D-02-1 13:30–14:30
Reductions for Integration, Summation and Creative Telescoping
Li, Ziming — KLMM,AMSS,Chinese Acad. of Sci.

Abstract: We review recent progress in reduction algorithms for integration, summation and creative Telescoping. These algorithms allow to determine integrability and summability more efficiently, and help us to separate the computation of telescopers from that of the corresponding certificates. Moreover, the properties of the reductions, together with a structure theorem on compatible rational functions, enable us to give a criterion on the existence of telescopers for mixed hypergeometric terms.

▶ EM-We-D-02-2 14:30–15:00
Combinatorial Hopf Algebra and the Feedback Loop in Nonlinear Control Theory

Ebrahimi-Fard, Kurusch — ICMAT Inst. of Mathematical Sci.

Abstract: Fliess operators play a central role in the theory of nonlinear control systems. They are combined in several ways through interconnections to represent systems made out of subsystems. In this talk, we present a combinatorial description of the Hopf algebra underlying interconnections as well as the feedback loop by realizing its (co)algebraic structures on rooted circle trees. A Zimmermann forest formula for the antipode is given. Joint work with S. Gray and L.A. Duffaut Espinosa.

▶ EM-We-D-02-3 15:00–15:30

Two Applications of Polynomial Systems

Du, Daniel — Center for Applied Mathematics, Tianjin Univ.
Hou, Qing-Hu — Tianjin Univ.
Wang, Rong-Hua — Center for Combinatorics, Nankai Univ.

Abstract: We present two applications of polynomial systems in combinatorics. The first application comes from the problem of counting lattice walks restricted to the non-negative octant. We confirm the conjecture proposed by Bostan, Bousquet-Mélou, Kauers and Melczer which states that most 3-dimensional walks associate with a group of an infinity order. The second application is using polynomial system to prove Ramanujan type congruences.

MS-We-D-03 13:30–15:30 306A

Applied Integrable Systems - Part V of V

For Part 1, see MS-Mo-D-03
For Part 2, see MS-Mo-E-03
For Part 3, see MS-Tu-D-03
For Part 4, see MS-Tu-E-03

Organizer: Hu, Xing-Biao — Inst. of Computational Mathematics, Chinese Acad. of Sci. (CAS), China
Organizer: Kajiwara, Kenji — Kyushu Univ.
Organizer: Kakei, Saburo — RIkkyo Univ.
Organizer: Maruno, Kenichi — Waseda Univ.

Abstract: In recent years, there have been major developments in applications of integrable systems. Originally, integrability has been recognized through solitons, which are particle-like nonlinear waves in various physical systems. Thanks to rich mathematical structure of integrable systems, recent applications of integrable systems extend to a wide range of pure/applied mathematics and physical sciences, such as algebraic geometry, combinatorics, probability theory, numerical algorithms, cellular automata, (discrete) differential geometry, computer visualizations, statistical physics, nonlinear physics and so on. The purpose of this minisymposium is to bring together researchers to discuss recent advances on various aspects of applied integrable systems.

▶ MS-We-D-03-1 13:30–14:00

Algebraic Solutions of Soliton Equations and Their Applications

Ohta, Yasuhiro — Kobe Univ.

Abstract: For some soliton equations, a class of algebraic solutions is constructed by using the direct method. The solutions are expressed in terms of the Gram type determinants. The algebraic structure and some properties of the solutions are discussed.

▶ MS-We-D-03-2 14:00–14:30

Darboux Transformations of the Dunkl-shift Operator

Tsujimoto, Satoshi — Kyoto Univ.

Abstract: We will discuss the Darboux transformations of the Dunkl-shift operator containing the shift and the reflection operators. Then we show that this transformation leads to an exceptional orthogonal polynomial system of the Bannai-Ito polynomials.

▶ MS-We-D-03-3 14:30–15:00

A Focusing and Defocusing Complex Short Pulse Equation

Feng, Bao-Feng — The Univ. of Texas-Pan American

Abstract: In this talk, we are concerned with a focusing and defocusing complex short pulse equation (CSPE). Similar to the NLS equation, the focusing CSPE admits bright soliton solution, while the defocusing CSPE possessing dark soliton solution. Through a reduction from 2DTL hierarchy and Hirota's bilinear method, multi-soliton solutions of both bright type and dark type are constructed for focusing and defocusing complex short pulse equation, respectively.
This is a joint work with Dr. Ohta at Kobe University and Dr. Maruno at Waseda University of Japan.

▶ MS-We-D-03-4 15:00–15:30

An Integrable Self-adaptive Moving Mesh Scheme in 3 Dimension

Maruno, Kenichi — Waseda Univ.

Abstract: An integrable self-adaptive moving mesh scheme of the local induction approximation equation for a vortex filament is constructed. Various numerical simulations by the self-adaptive moving mesh schemes are shown.

IM-We-D-04 13:30–15:30 308

Mathematics and Algorithms in Computer-Aided Manufacturing, Manufacturing Systems and Numerical Control - Part V of VI

For Part 1, see IM-Mo-D-04
For Part 2, see IM-Mo-E-04
For Part 3, see IM-Tu-D-04
For Part 4, see IM-Tu-E-04
For Part 6, see IM-We-E-04

Organizer: Li, Hongbo — Acad. of Mathematics & Sys. Sci., Chinese Acad. of Sci.
Organizer: Shpitalni, Moshe — Technion, Israel

Abstract: The fast development of advanced manufacturing technology has witnessed the growing importance of mathematical methods and algorithms, ranging from algebraic geometry, discrete geometry and differential geometry to differential equations, computational mathematics and computer mathematics. Conversely, problems arising from the field of advanced manufacturing have also stimulated the development of such branches in pure and applied mathematics as computational geometry and mathematics mechanization.
Mathematics and Algorithms for Computer-Aided Manufacturing, Engineering and Numerical Control is intended to be an interdisciplinary forum focusing on the interaction between the side of mathematical methods and algorithms, and the other side of computer-aided manufacturing (CAM), computer-aided engineering (CAE) and computer numerical control (CNC). It concentrates on (but is not restricted to) the following topics: tool path planning, multiscale simulation, feature-based process chain with CAM/CNC coupling, interpolation for CNC controllers.
The proposed industrial mini-symposium of 20 talks will provide an excellent platform for the participants to get acquainted with new research results, to exchange new ideas, and to create new collaboration.
To ensure full success of the proposed mini-symposium, we have invited 8 speakers from abroad. All are knowledgeable world experts in their fields, with impressive records of research, publications and awards, as well as solid background of mathematics. The invited speakers are from various countries and represent different aspects in Manufacturing, Manufacturing Systems and Computer Numerical Control.

▶ IM-We-D-04-1 13:30–14:15

Toward Manufacturing of Freeform Geometry Using Algebraic-based Analysis

Elber, Gershon — Technion, Israel Inst. of Tech.

Abstract: Manufacturing of freeform models is a highly difficult task. We will discuss algebraic methods to analyze freeform geometry toward precise c-space analysis, accurate 5-axis machining, and line accessibility in wire-EDM. All problems are handled under one framework that reduces these problems to sets of algebraic constraints, and robustly solved. Results demonstrating these applications will be presented.
* In collaboration with Michael Barton, Myung-Soo Kim, Yong Joon Kim, Jonathan Mizhari, Helmut Pottmann, and Aviv Segal

▶ IM-We-D-04-2 14:15–15:00

Accelerating Geometric Algorithms for Freeform Curves and Surfaces under Deformation

Kim, Myung-Soo — Seoul National Univ.

Abstract: We consider the construction of dynamic bounding volume hierarchy (BVH) for planar freeform curves and surfaces under deformation. The dynamic BVH construction is compared with conventional bounding volumes. The effectiveness of our approach is then demonstrated using a few test examples of geometric computing.

▶ IM-We-D-04-3 15:00–15:30

Towards Realistic Surgery Simulation for Training

Liu, Peter — Carleton Univ.

Abstract: Surgical simulators have a number of advantages over conventional training approaches. While a small number of companies are starting to offer surgical simulation training systems of varying quality, no simulators are able to provide a sufficiently high degree of resemblance to real-life surgery. There still exist numerous fundamental challenges and technical difficulties. In the presentation, we will talk about some of these existing problems and potential solutions.

MS-We-D-05 13:30–16:00 215

Evolutionary games on complex networks

Organizer: Mu, Yifen Acad. of Mathematics & Sys. Sci., Chinese Acad. of Sci.

Abstract: Evolutionary game theory on complex networks has been a hot topic in recent years and gotten lots of interest of scientist from many different fields, like economics, biology, control theory, computer science, etc. By playing games on complex networks, we are able to simulate the interaction among large population with certain social structures. Then the evolution of individual strategy and global equilibrium can help explain the emergence and change of social norms. Additionally, evolutionary games can bring great insight into human behavior, which is the focus of many fields. At the beginning, most related research focused on simulation because of great difficulty on analysis. Kinds of networks with more details have been studied, reflecting different respects of the story, such as noise, time delay, coevolution of games and networks, etc. In this minisymposia, we will introduce the latest development on the topic, both theoretically and numerically. The reporters are young scientist in this field for many years. Dr. Chunyan Yang is associated professor in Nankai University and her research interests include evolutionary game theory and evolutionary dynamics. Dr. Luoluo Jiang is associated professor in Wenzhou University, with his research interests including evolutionary game theory and complex networks. Dr. Quanyan Zhu is assistant professor in NewYork University, USA and studies control theory, game theory and applications. Dr. Zhigang Cao is assistant professor in CAS and studies game theory.

▶ MS-We-D-05-1 13:30–14:00

The Control of Cooperative Behaviour in Interdependent Spatial Games

Jiang, Luo-Luo Wenzhou Univ.

Abstract: We investigated interdependent of snowdrift games (SG) and the prisoner' s dilemma game (PDG) where strategies in the two games are associated by social influence. It is found that there exists a critical threshold of social influence strength, and cooperation is greatly promoted when social influence strength exceeds the critical threshold.

▶ MS-We-D-05-2 14:00–14:30

Mechanisms to Foster Cooperation in Public Goods Games

Zhang, Chunyan Nankai Univ.
Zengqiang, Chen Nankai Univ.

Abstract: We study the effectiveness of punishing defectors in the evolution of cooperation in rational populations within the threshold public goods game models. We establish two scenarios: defectors will suffer possible punishment whether the game succeeds or not, and defectors will incur punishment only when game fails. A key observation of this work is that given this assumption, punishing free riders can significantly influence the evolution outcomes, and the results are driven by the specific components.

▶ MS-We-D-05-3 14:30–15:00

Coexistence of Competing Strategies in Interaction Networks

Zhang, Jianlei Nankai Univ.

Abstract: In this work for two-strategy evolutionary games in structured populations, we follow a different approach, bypassing the requirement for explicit knowledge about the exact payoffs, by encoding the payoffs into the willingness of any player to switch from her current strategy to the competing one. Theoretical computations and numerical simulations show that the evolutionary dynamics are intrinsically regulated by contact relationships specified by the network topologies of the populations.

▶ MS-We-D-05-4 15:00–15:30

Equilibrium in Repeated Stackelberg Public Goods Game with Two-leaders-one-follower and One-step-memory

Mu, Yifen Acad. of Mathematics & Sys. Sci., Chinese Acad. of Sci.

Abstract: Stackelberg game with hierarchical and information structures has broad background and applications in practice. In this paper the repeated Stackelberg Public Goods game with 2 leaders and 1 follower will be investigated, where the leaders' strategies are with one-step-memory with respect to the follower's action. The players act simultaneously at each step. By constructing the state transfer graph for given leaders' strategy profile, the equilibrium of the game can be solved.

▶ MS-We-D-05-5 15:30–16:00

Structure Identification of Uncertain Dynamical Networks

Fu, Xinchu Shanghai Univ.

Abstract: Topological structures and node dynamics of dynamical networks have important influence on their dynamical behaviors. In practical applications, not all of them can be well determined beforehand; therefore this talk investigates the structure identification of an uncertain dynamical network coupled with complex-variable chaotic systems. Based on the Barbalat's lemma, corresponding network estimators are designed for identifying the unknown or uncertain topological structure and node dynamics. This talk is based on joint work with Zhaoyan Wu.

MS-We-D-06 13:30–15:30 201

Analysis of nonsmooth PDE systems with applications to material failure - Part I of II

For Part 2, see MS-We-E-06

Organizer: Knees, Dorothee Univ. of Kassel

Organizer: Thomas, Marita Weierstrass Inst. for Applied Analysis & Stochastics (WIAS Berlin)

Abstract: The understanding and modeling of failure processes in solids is a central task in materials sciences. Mathematical models typically result in highly nonlinear, coupled systems of partial differential equations, where additional nonsmooth constraints, as for instance the unidirectionality of evolution processes or the impenetrability of the material, have to be taken into account. This minisymposium intends to discuss recent advances in the mathematical treatment of failure phenomena, and brings together scientists from the fields of modeling, analysis, and numerics. Analytical methods and numerical strategies both for (quasi-)static and rate-dependent, non-smooth failure models will be presented.

▶ MS-We-D-06-1 13:30–14:00

Quasi-optimal Error Estimates for Rate-independent Evolution Problems

Bartels, Soeren Univ. of Freiburg

Abstract: We derive quasi-optimal error bounds for implicit discretizations of a class of rate-independent evolution problems. No regularity assumptions on the exact solutions are made but involved load functionals are assumed to be twice continuously differentiable in time. Key ingredients in the analysis are the reformulation of the evolution problem as a subdifferential flow and precise estimates for corresponding implicit discretizations.

▶ MS-We-D-06-2 14:00–14:30

On Reconstruction of A Spot Welding Area in An Electric Conductive Body

Itou, Hiromichi Tokyo Univ. of Sci.

Abstract: We consider a mathematical model for nondestructive evaluation of spot-welds between two electric conductive plates. By use of injecting a direct current and measuring the resulted voltage on the accessible side of welded plates, we establish an extraction formula of location of tips of the welds from the single measurement. This is based on joint research with Masaru Ikehata (Hiroshima University, Japan) and Akira Sasamoto (National Institute of Advanced Industrial Science and Technology, Japan).

▶ MS-We-D-06-3 14:30–15:00

Phase Field Approximation of Cohesive Fracture Models

Iurlano, Flaviana IAM, Univ. of Bonn
Conti, Sergio IAM, Univ. of Bonn
Focardi, Matteo Univ. of Florence

Abstract: We present an approximation result for Barenblatt's cohesive fracture energies in the case of antiplane shear. The regularizing functionals are damage energies of Ambrosio–Tortorelli type and the approximation is obtained in the sense of Gamma-convergence. We also discuss how the phase field convergence scheme can be applied to approximate different special fracture models, like Griffith's model, Dugdale's model, and models with surface energy density having a power-law growth at small openings.

▶ MS-We-D-06-4 15:00–15:30

Analysis of Nonsmooth PDE Systems with Applications to Material Failure – Towards Dynamic Fracture

Thomas, Marita Weierstrass Inst. for Applied Analysis & Stochastics (WIAS Berlin)

Abstract: This talk addresses certain key points arising in the analysis of material failure models. Processes, such as plastification, damage, delamination, and fracture, are often considered rate-independent and interact with other phaenomena of rate-dependent nature like heat conduction, inertia, and viscous material properties. Mathematically, this leads to nonlinear PDE systems of mixed type also involving non-smooth constraints. A general analytical framework for such systems is discussed and applied to the treatment of models describing dynamic fracture.

MS-We-D-07 13:30–15:40 202A

Sparsity-promoting seismic data analysis - Part II of II

For Part 1, see MS-Tu-E-07

Organizer: Ma, Jianwei — Harbin Inst. of Tech.
Organizer: Fomel, Sergey — The Univ. of Texas at Austin

Abstract: The objective of this high-level mini-symposia is to bring international experts in geophysics and applied mathematics together to present their recent research work, to exchange ideas, and to develop new visions for the future of the area. The mini-symposia will focus on the sparsity-promoting seismic data analysis. The invited speakers are all well-known experts from the fields of exploration geophysics, optimization, harmonic analysis and computing methods. The mini-symposia will provide an opportunity for participants both from university and industry to share information and experiences, and a platform for their research collaboration.
We are also submitting the list of speakers (including eight professors from MIT, Stanford, etc) and titles of their presentations. The mini-symposia could include two sessions.

▶ MS-We-D-07-1 13:30–14:00

Applications of Phase Tracking in Seismic Imaging

Demanet, Laurent — MIT
Li, Yunyue Elita — Massachusetts Inst. of Tech.

Abstract: Interpretation of seismic shot records in terms of coherent atomic events can be formulated as a hard, nonconvex optimization problem. I will present a method that empirically finds the global minimum of this functional in the case of simple synthetic shot records, even when events cross. I will discuss applications to low-frequency extrapolation and parameter-based FWI. Joint work with Yunyue Elita Li.

▶ MS-We-D-07-2 14:00–14:30

Synchrosqueezed Transforms and Their Application in Seismic Data Analysis

YING, LEXING — Stanford Univ.
Yang, Haizhao — Stanford Univ.

Abstract: This talk will discuss synchrosqueezed transforms and their application in seismic data analysis.

▶ MS-We-D-07-3 14:30–15:00

Wavefield Reconstruction Inversion with Convex Constraints

Herrmann, Felix — UBC-SLIM

Abstract: During this talk, we discuss how to exploit the special structure of Wavefield Reconstruction Inversion (WRI) to include convex bound and total-variation constraints in a computationally feasible manner. The resulting method shows promising results on challenging models that include high-velocity high-contrast inclusions such as salt or basalt.
This is joint work with Ernie Esser who will be dearly missed.

▶ CP-We-D-07-4 15:00–15:20

A Hybrid Numerical Scheme Based on ONAD Method and Weighted Runge-Kutta Discontinuous Galerkin Method for Wavefield Modeling

He, Xijun — Tsinghua Univ.
Yang, Dinghui — Tsinghua Univ.

Abstract: We develop an effective numerical hybrid scheme based on finite difference method (FDM) and discontinuous Galerkin method (DGM) for seismic wavefield modeling. The FDM we used is a newly-developed and efficient numerical method —the optimal nearly-analytic method, which can effectively suppress the numerical dispersion. The DGM we used is a weighted Runge-Kutta DGM. The scheme combines the advantages of the FDM and DGM. It splits the computational domain into several parts, where the DGM is used to model the complex structures, whereas the FDM is used for regular parts. A transition zone is needed to combine them together. The variables near the transition zone should be carefully treated to keep the accuracy and stability of the hybrid scheme. Numerical tests show that the hybrid scheme is effective, and can save CPU time and storage space.

▶ CP-We-D-07-5 15:20–15:40

Local Earthquake Reflection Tomography of the Landers Earthquake Area Using Wave-equation Based Traveltime Seismic Tomography

Xueyuan, Huang — Tsinghua Univ.
Yang, Dinghui — Tsinghua Univ.

Abstract: High resolution seismic tomographic images for the crust of the 1992 Landers earthquake (M 7.3) region in southern California are determined by wave-equation based traveltime seismic tomography technique using reflected phases from Moho discontinuity (PmP, SmS) as well as first arriving P and S waves. Deatailed 3-D P and S wave velocity models and Poisson's ratio structure of the crust are given in this paper. Strong heterogeneities are revealed in the crust of this area and local earthquake occurrence is thought to be closely related to the crustal heterogeneities. Significant low-velocity anomalies are revealed in the lower crust along the faults, which may reflect fluids in the lower crust. A high-velocity anomaly extended into the upper mantle beneath the hypocenter of the main shock of Landers earthquake is also discovered.The tomographic results indicate the Moho reflection phases are very helpful in improving the spatial resolution of crustal tomographic images.

MS-We-D-08 13:30–15:30 202B

The Ginzburg-Landau Model and Related Topics - Part I of IV

For Part 2, see MS-We-E-08
For Part 3, see MS-Th-BC-08
For Part 4, see MS-Th-D-08

Organizer: Golovaty, Dmitry — The Univ. of Akron
Organizer: Giorgi, Tiziana — New Mexico State Univ.

Abstract: The focus of the minisymposium is on mathematical problems related to Ginzburg-Landau model with application in physics and materials science including but not limited to: superconductivity, superfluidity, liquid crystals, and polymers. The speakers in this minisymposium will describe their recent research, including the development and structure of singular solutions of the Ginzburg-Landau-type problems and the dynamics of vortex motion. This minisymposium is sponsored by the SIAM Activity Group on Mathematical Aspects of Materials Science (SIAG/MS).

▶ MS-We-D-08-1 13:30–14:00

Interaction between Neel Walls

Moser, Roger — Univ. of Bath

Abstract: Neel walls are transition layers in thin ferromagnetic films. We study a model with some similarities to Ginzburg-Landau vortices, but with a twist: while we may have a global topological constraint, there is no quantized topological charge for individual singularities. As a consequence, there is an interaction between the core of one Neel wall and the tail of another, a phenomenon that is absent for Ginzburg-Landau vortices. This is joint work with Radu Ignat (Toulouse).

▶ MS-We-D-08-2 14:00–14:30

Purely Nonlocal Attractive-Repulsive Interaction Energies

Topaloglu, Ihsan — McMaster Univ.

Abstract: The asymptotic states of many physical and biological systems such as models of granular media, molecular self-assembly and biological swarming can be described as minimizers of purely nonlocal interaction energies. In this talk I will consider minimizers of such energies with different constraints using methods of variational analysis (such as relaxation, regularization, etc.). This talk will survey a collection of recent work joint with R. Choksi, K. Craig, R. Fetecau, R. Simione and D. Slepcev.

▶ MS-We-D-08-3 14:30–15:00

On the Minimization of Energy Functionals Consisting of Competing Attractive and Repulsive Potentials

Choksi, Rustum — McGill Univ.

Abstract: We consider existence and properties of minimizers for a class of nonlocal functionals consisting of power-law attractive and repulsive potentials. We will address different cases where these functionals are defined over measures, functions, and binary functions (set interactions). Comparison will be made with minimizers of a high-order isoperimetric problem with nonlocal interactions of Coulombic type. This is joint work with I. Topaloglu (McMaster University) and, in part, R. Fetecau (Simon Fraser University).

▶ MS-We-D-08-4 15:00–15:30

Line Defects in the Asymptotic Analysis of A Three-dimensional Landau-de Gennes Model

Canevari, Giacomo — Pierre et Marie Curie Univ. - Paris 6

Abstract: The Landau-de Gennes model is a variational model for nematic liquid crystals which shares similarities with the Ginzburg-Landau theory. In this talk, we consider the asymptotic behavior of minimizers in three-dimensional domains, as the elastic constant tends to zero. If the energy blows up at most logarithmically, then there exists a closed set S of dimension one (a line defect), such that minimizers locally converge to a harmonic map, away from S.

MS-We-D-09 13:30–15:30 203A
Nonlocal problems: modeling, analysis and computation - Part II of III
For Part 1, see MS-Tu-E-09
For Part 3, see MS-We-E-09

Organizer: Lipton, Robert LSU
Organizer: Du, Qiang Columbia Univ.
Organizer: Mengesha, Tadele The Univ. of Tennessee

Abstract: The goal of this minisymposium is to bring together researchers work- ing on problems related to the nonlocal modeling of physical phenomena and their mathematical analysis. The theme is on modeling, analysis and simulation with a focus on nonlocal continuum equations that arise from applications. The session will be multifaceted so as to cover work related nonlocal modeling and computational simulations of models, and analyti- cal and numerical aspects such as well-posedness of nonlocal stationary and evolution equations, regularity of solutions and numerical approximations.
Nonlocal mathematical models arise naturally in many important fields and they are found to be useful where classical (local) models cease to be predictive. Moreover, nonlocal models are suitable for multiscale modeling as they can be effective in capturing the underlying nonsmooth microscale fields. An example is peridynamics, a nonlocal reformulation of the basic equations of motion of continuum mechanics, which is being used to model cracks and discontinuous fields in solid mechanics. Other areas of application include image processing, modeling population aggregation, wave propaga- tion, pattern formation, and porous media flow. In this minisymposium, research works which have produced novel analytical and numerical methods for nonlocal problems will be presented.

▶ MS-We-D-09-1 13:30–14:00
Localization of Nonlocal Gradients and Some Applications in Variational Convergence
Mengesha, Tadele The Univ. of Tennessee

Abstract: We study weighted directed difference quotients and their localization to classical notions of derivatives in several function spaces. We will characterize vector fields in the space of Sobolev spaces, space of BV functions and space of BD functions in a unified way. As an application, we will use the characterization and localization mechanism to compute Gamma limits of some nonlocal functionals that appear in peridynamics.

▶ MS-We-D-09-2 14:00–14:30
A Fast Numerical Method for Nonlocal Models
Wang, Hong Univ. of South Carolina

Abstract: Peridynamic/nonlocal diffusion models provide a very effective modeling of phenomena with long range interactions and nonlocal behavior. However, these models involve complex and singular integral operators. Consequently, resulting numerical methods generate dense matrices, for which direct solvers require $O(N^3)$ computational complexity and $O(N^2)$ memory for a problem of size N. This imposes significant computational and memory challenge in realistic applications. We present a fast numerical method for a nonlocal diffusion model by exploiting the structure

▶ MS-We-D-09-3 14:30–15:00
A Nonlocal Strain Measure for Digital Image Correlation
Lehoucq, Richard Sandia National Labs

Abstract: We propose a nonlocal strain measure for use with digital image correlation (DIC). Whereas the traditional notion of compatibility (strain as the derivative of the displacement field) is problematic when the displacement field varies substantially either because of measurement noise or material irregularity, the proposed measure remains robust, well-defined and invariant under rigid body motion. Moreover, when the displacement field is smooth, the classical and nonlocal strain are in agreement.

▶ MS-We-D-09-4 15:00–15:30
Local Boundary Conditions in Nonlocal Problems
Celiker, Fatih Wayne State Univ.

Abstract: We study nonlocal wave equations on bounded domains related to peridynamics. We display a methodology for enforcing boundary conditions (periodic, antiperiodic, Dirichlet, or Neumann) through an integral convolution. We present a numerical study of the approximate solution, study convergence order with respect to the polynomial order of approximation, and observe optimal convergence. We depict solutions for each boundary condition to ascertain the behavior of waves under the nonlocal theory.

MS-We-D-10 13:30–15:30 206B
Robustness and Fragility of Complex Networks

Organizer: Wu, Jun National Univ. of Defense Tech.
Organizer: Li, Daqing Beihang Univ.

Abstract: Networks are everywhere. Examples include the Internet, metabolic networks, electric power grids, supply chains, urban road networks, the world trade web, among many others. In the past few years, the discovery of small-world and scale-free properties has stimulated a great deal of interest in studying the underlying organising principles of various complex networks. The investigation of complex networks has become an important area of multidisciplinary area involving physics, mathematics, operations research, biology, social sciences, informatics, and other theoretical and applied sciences.
The function and performance of complex networks rely on their robustness, i.e. the ability to maintain connectivity when a fraction of their nodes or edges is damaged. For example, modern society is dependent on its critical infrastructure networks: communication, electrical power, rail, and fuel distribution networks. Failure of any of these critical infrastructure networks can bring the ordinary activities of work and recreation to a stand- still. Other examples of network robustness arise in nature, such as the food webs robustness to biodiversity loss. Due to its broad applications, the robustness or fragility of complex networks has received growing attention.
This mini-symposium aims to provide a forum for recent developments in the field of network robustness and fragility. Topics of interest include, but are not limited to: robustness of weighted networks; robustness of directed networks; robustness of spatial networks; robustness of Network of Networks; robustness of temporal networks; cascading failure in complex networks; attack and defence in complex networks; optimization of network robustness; application of network robustness.

▶ MS-We-D-10-1 13:30–14:00
Spectral Measure of Structural Robustness in Complex Networks
Wu, Jun National Univ. of Defense Tech.

Abstract: We introduce the concept of natural connectivity as a measure of structural robustness in complex networks. The natural connectivity has an intuitive physical meaning and a simple mathematical formulation. Physically, it characterizes the redundancy of alternative paths and can also be interpreted as the Helmholtz free energy of a network. Mathematically, the natural connectivity can be derived from the graph spectrum as an average eigenvalue and increases strictly monotonically with the addition of edges.

▶ MS-We-D-10-2 14:00–14:30
Spatial Propagation of Cascading Failures
Li, Daqing Beihang Univ.

Abstract: Transportation systems, power grids and even financial systems are organized by large amount of components and their intrinsic complex coupling. When these systems are disturbed randomly or maliciously, the local perturbations can propagate through the coupling and ultimately induce global cascading failures and catastrophic consequences. The spatial propagation of cascading failures has become a fundamental question in the study of complex system reliability.

▶ MS-We-D-10-3 14:30–15:00
Cascading Failures in Networks of Networks
Havlin, Shlomo Bar Ilan Univ.

Abstract: Network science have been focused on the properties of a single isolated network that does not interact or depends on other networks. In reality, many real-networks, such as power grid, protein networks, transportation and communication infrastructures interact and depend on other networks. I will present a framework for studying the vulnerability of networks of interdependent networks. In interdependent networks, when nodes in one network fail, they cause dependent nodes in other networks to also fail.

▶ MS-We-D-10-4 15:00–15:30
Fragility and Node Importance in Epidemics on Temporal Networks
Holme, Petter Sungkyunkwan Univ.

Abstract: Infectious disease outbreaks are determined both by the network topology and timing of human contacts. We argue that the temporal component is as important as the topology. We will review some structural factors that influence disease spreading, and how to identify important nodes. We argue that the notion of importance of nodes is subtler than usually assumed - the most important individual need not to belong to the most important group of n nodes.

MS-We-D-11 13:30–15:30 203B
Nonlinear Eigenvalue Problems - Part I of III
For Part 2, see MS-We-E-11
For Part 3, see MS-Th-BC-11
Organizer: Kressner, Daniel EPFL
Organizer: Su, Yangfeng Fudan Univ.
Abstract: Eigenvalue problems that are nonlinear in the eigenvalue parameter regularly appear in the analysis of vibrations and frequency-dependent material properties. It is not uncommon to find that model reduction techniques turn linear into nonlinear eigenvalue problems (NEP). Current research directions for NEPs include efficient and reliable algorithms for problems of small size, memory-efficient and robust algorithms for large-scale problems, as well as structure-preserving algorithms for structured NEPs. This MS aims to give an overview of state-of-the-art developments on the analysis, algorithms, and applications.

▶MS-We-D-11-1 13:30–14:00
A Brief Survey of Recent Progress on Nonlinear Eigenvalue Problems
Kressner, Daniel EPFL

Abstract: The last years have witnessed a number of important new developments in the analysis and numerical solution of nonlinear eigenvalue problems. The purpose of this talk is to give a brief survey of these developments and sketch a number of applications that give rise to such eigenvalue problems. Particular emphasis will be placed on recent algorithmic innovations.

▶MS-We-D-11-2 14:00–14:30
Deflation of Singularities, as Well as Infinite and Zero Eigenvalues in Structured Nonlinear Eigenvalue Problems
Mehrmann, Volker TU Berlin

Abstract: Singular polynomial eigenvalue problems arsie naturally in the vibration analysis of structures. Classical techniques, based on linearization may fail because linearizations do not preserve all the singular structure. Similar problems arise when the problem is structured and certain eigenvalues (like zero and infinity) prevent structured linearization. We discuss a new deflation procedure. The work is motivated by an industrial aplication in the context of understanding and treating disk brake squeal. Joint work with Hongguo Xu

▶MS-We-D-11-3 14:30–15:00
Structured Linearizations That Preserve the Sign Characteristic of Hermitian Matrix Polynomials
Dopico, Froilan M. Universidad Carlos III de Madrid

Abstract: The development of linearizations of matrix polynomials that preserve interesting structures that a matrix polynomial might have has been a very active topic of research in the last decade, since they have applications in the development of structure preserving algorithms for computing eigenvalues.Despite this fact, only one linearization is known that preserve, for Hermitian polynomials, the Hermitan structure and the sign characteristic. In this talk, we present a large family of linearizations with these properties.

▶MS-We-D-11-4 15:00–15:30
CORK: A Generic Framework for Solving Non-linear Eigenvalue Problems
Meerbergen, Karl KU Leuven
Van Beeumen, Roel KU Leuven
Michiels, Wim KU Leuven

Abstract: We propose a new uniform framework of Compact Rational Krylov (CORK) methods for solving the nonlinear eigenvalue problem. For many years, linearizations are used for solving such problems. The major disadvantage of methods based on linearizations is the growing memory cost with the iteration count. The CORK family of rational Krylov methods exploits the structure of the linearization pencils and uses a generalization of the compact Arnoldi decomposition.

MS-We-D-12 13:30–15:30 208B
Epidemic dynamics on complex networks
Organizer: Jin, Zhen Shanxi Univ.
Organizer: Fu, Xinchu Shanghai Univ.
Abstract: Networks have been studied extensively in the social sciences. Many real systems can be properly described by complex networks whose nodes represent individuals or organizations and links denote the interactions among them. One of the original and primary reasons for studying networks is to understand the mechanisms by which diseases and other things (information, computer viruses, rumors) spread over them. The topology structures of complex networks can have dramatic effects on the behavior of epidemic dynamical processes running on top of it, and it has attracted a great deal of interest due to its practical real-world implications is the modeling of epidemic spreading on contact networks. This minisymposia is mainly focused on the research of modeling approaches of infectious disease on complex networks, and how the topology structures of complex networks affect the behaviors of disease spread.

▶MS-We-D-12-1 13:30–14:00
Disease Spread on Dynamics Contact Networks
Ma, Junling Univ. of Victoria

Abstract: Epidemic spreading may be affected by the dynamical topological structures. Here we study disease dynamics in populations in which infection occurs along the links of a dynamical contact network. We obtain the formula of the basic reproduction number R0. It is found that it can have a larger impact on the spread of the disease. This model illustrates how dynamics network topology can affect disease dynamics.

▶MS-We-D-12-2 14:00–14:30
Complex Contagion Through Direct and Indirect Interactions
Xu, Xin-Jian Shanghai Univ.

Abstract: Contagion in structured populations is one of the most interesting topics in the study of cmplex systems. We model this process with a threshold model in homogeneous and heterogeneous networks. Both direct and indirect influences are considered. It was found that the addition of indirect interactions can speed up spreading process with the high possibility of global cascading. Moreover, the heterogenities of individual threshold and population structure have dual effects on the contagion process.

▶MS-We-D-12-3 14:30–15:00
Social Contagions on Complex Networks
Tang, Ming Web Sci. Center, Univ. of Electronic Sci. & Tech. of China

Abstract: A key ingredient in social contagion dynamics is reinforcement.We first propose a general social contagion model with reinforcement. Then, we develop a unified edge-based compartmental theory to analyze this model. Using a spreading threshold model to understand the memory effect. We find that the memory characteristic markedly affects the dynamics. Strikingly, we uncover a transition phenomenon in which the dependence of the final adoption size on some key parameters.

▶MS-We-D-12-4 15:00–15:30
Study the Correlation between State and Degree of Nodes Based on Epidemic Model on Complex Networks
Zhang, Juping Shanxi Univ.

Abstract: The correlation between the states and edges of nodes has great influence.We established the epidemic model with the correlation coefficient between state and degree of nodes on complex network. We analytically derive the expression for the epidemic threshold and its dependence with the correlation coefficient between the states and degree of nodes. The correlation coefficient would have an effect on the spreading of infectious diseases.

MS-We-D-13 13:30–15:30 VIP3-2
Vanishing viscosity limit and incompressible flow - Part II of II
For Part 1, see MS-Tu-E-13
Organizer: Lopes Filho, Milton Universidade Federal do Rio de Janeiro
Organizer: Jiu, Quansen Capital Normal Univ.
Abstract: Much of the research on fluid dynamics is concerned with the phenomena of boundary layers and of turbulence. Both of these physical phenomena are associated with flows in the large Reynolds number regime and therefore are directly related with the mathematical study of the vanishing viscosity limit. Vanishing viscosity limits are an active área of research, focusing both on boundary-related issues, motivated by boundary layers, and on bulk flow issues more closely related to turbulence. The purpose of this minisymposium is to showcase current developments along both these lines, primarily focusing on describing the behavior of solutions of the Navier-Stokes and related system when viscosity is very small.

▶MS-We-D-13-1 13:30–14:00
Vanishing Viscosity Limit and Related Problems of the Incompressible Flow under the Helical Symmetry
Niu, Dongjuan Capital Normal Univ.

Abstract: Helical symmetry is invariance under a one-dimensional group of rigid motions generated by a simultaneous rotation around a fixed axis and trans- lation along the same axis. In this talk we study the limits of three-dimensional helical viscous and inviscid incompressible flows in an infinite circular pipe as the viscosity and helical parameters vanish, repectively. In addition, the well-posedness of weak solutions to three-dimensional Euler equations are also mentioned.

▶MS-We-D-13-2 14:00–14:30

Approximation of 2D Euler Equations by the Second-Grade Fluid Equations with Dirichlet Boundary Conditions

Zang, Aibin — Yichun Univ.

Abstract: We prove three results. First, we establish convergence of the solutions of the second-grade model to those of the Euler equations provided $\nu = \mathcal{O}(\alpha^2)$, as $\alpha \to 0$, Second, we prove equivalence between convergenceand vanishing of the energy dissipation in a suitably thin region near the boundary, in the asymptotic regime $\nu = \mathcal{O}(\alpha^{6/5})$, $\nu/\alpha^2 \to \infty$ as $\alpha \to 0$.Finally, we obtain an extension of Kato's classical criterion to the second-grade fluid model.

▶ CP-We-D-13-3 14:30–14:50

CONTINUOUS DEPENDENCE ESTIMATE FOR STOCHASTIC BALANCE LAWS DRIVEN BY LEVY NOISE

Biswas, Imran — Tata Inst. of Fundamental Research

Abstract: We are concerned with multidimensional stochastic balance laws driven by Levy processes. Using BV solution framework, we derive explicit continuous dependence estimate on the nonlinearities of the entropy solutions. This result is used to show the error estimate for the stochastic vanishing viscosity method. In addition, we establish fractional BV estimate for vanishing viscosity approximations in case the the noise coefficient depends on both the solution and spatial variable.

▶ CP-We-D-13-4 14:50–15:10

The Viscosity Method for the Homogenization of Soft Inclusions

Yoo, Minha — National Inst. for Mathematical Sci.

Abstract: In this talk, we consider periodic soft inclusions T_ϵ with periodicity ϵ where the solution u_ϵ satisfies semi-linear elliptic equations of non-divergence in $\Omega_\epsilon = \Omega \setminus T_\epsilon$ with a Neumann data on T_ϵ. The difficulty lies in the non-divergence structure of the operator where the standard energy method based on the divergence theorem can not be applied. The main object is developing a viscosity method to find the homogenized equation satisfied by the limit of u_ϵ, called as u_0, as " approaches to zero. We introduce the concept of a compatibility condition between the equation and the Neumann condition on the boundary for the existence of uniformly bounded periodic first correctors. The concept of second corrector has been developed to show the limit u_0 is the viscosity solution of a homogenized equation.

MS-We-D-14 13:30–15:30 111

Optimality in reduced order modeling and inversion - Part II of II

For Part 1, see MS-Tu-E-14

Organizer: Mamonov, Alexander — Schlumberger

Organizer: Zaslavsky, Mikhail — Schlumberger-Doll Research

Abstract: In a wide range of applications, the model reduction techniques provide a well-established tool for efficient approximation of the transfer functions of large dynamical systems with multiple inputs and outputs. Rather recently the range of applications was extended to reducing the complexity of inverse problems. The optimal choice of the parameters of reduced order models (ROMs) is crucial for the efficiency of the approach. We will consider different ways to parameterize ROMs, for both forward and inverse PDE problems, and discuss optimal sampling of the parameters.

▶ MS-We-D-14-1 13:30–14:00

Efficiencies in Global Basis Approximation for Model Order Reduction in Diffuse Optical Tomography

Kilmer, Misha — Tufts Univ.

Abstract: We consider the nonlinear inverse problem of reconstructing parametric images of optical properties from diffuse optical tomographic data. Recent work shows MOR techniques have promise in mitigating the computational bottleneck associated with solving for the parameters. In this talk, we give an algorithm for efficiently computing the approximate global basis needed in MOR by utilizing a new interpretation of the transfer function and by capitalizing on Krylov recycling in a novel way.

▶ MS-We-D-14-2 14:00–14:30

The Iterative Rational Krylov Algorithm for Bilinear Descriptor Systems

Benner, Peter — Max Planck Inst. for Dynamics of Complex Technical Sys.

Abstract: We discuss the extension of the bilinear rational Krylov algorithm (BIRKA) to descriptor systems. Recently, its linear analogue IRKA was extended to linear descriptor systems by Gugercin, Stykel, and Wyatt. We follow the same approach for the extension of BIRKA to bilinear descriptor systems. We also show how this algorithm can be used for model order reduction of nonlinear systems based on (quadratic-)bilinearization. [Joint work with Pawan Goyal and Mian Ilyas Ahmad.]

▶ MS-We-D-14-3 14:30–15:00

Numerical Quadrature for Data-driven Optimal Rational Approximation

Gugercin, Serkan — Virginia Tech

Beattie, Christopher — Virginia Tech

Drmac, Zlatko — Univ. of Zagreb

Abstract: Iterative Rational Krylov Algorithm (IRKA) is an effective tool for optimal H2 rational approximation. In this talk, we use the reproducing kernel formulation of the underlying Hilbert space to introduce a quadrature-based formulation of IRKA where a number of transfer function evaluation are computed only at the beginning (the offline phase) and the IRKA steps (the online phase) never revisit the original transfer function performing all the computations in the reduced order dimension.

▶ MS-We-D-14-4 15:00–15:30

Subspace Reconstruction Algorithms for Some Severely Ill-posed Inverse Problems

Ren, Kui — Univ. of Texas at Austin

Abstract: We propose a class of reconstruction methods based on subspace minimization techniques for severely ill-posed inverse problems. The general philosophy is to split the unknowns or some intermediate unknowns into low-frequency and high-frequency components, and uses SVD and related techniques to recover parts of low-frequency information, and then use minimization techniques to recover part of the high-frequency components. Numerical simulations with synthetic data will be presented to demonstrate the performance of the proposed algorithms.

MS-We-D-15 13:30–15:30 213B

Ranking nodes in complex networks

Organizer: Lu, Linyuan — Hangzhou Normal Univ.

Abstract: The study of complex networks has become a common focus of many branches of science. Great effort has been devoted to understand the evolution of networks, the relations between topologies and functions, and the network characteristics. It is well-known that many dynamical processes such as cascading, propagation, and synchronization are highly affected by a small fraction of influential nodes. Researches on finding these influential nodes not only help to reveal microscopic structural features, but also provide assistant tools on analyzing network dynamics. Meanwhile, it can find real applications with great social and economic values, such as controlling rumor and disease spreading, and creating new marketing tools. I therefore propose to organize a mini-symposium called "Ranking nodes in complex networks". In this session, we will review the recent progresses of theoretical works in this field, as well as report some applications in various real systems. Moreover, we will discuss the existing problems and outline open issues as main challenges in the near future.

▶ MS-We-D-15-1 13:30–14:00

Important Nodes Identification in Complex Networks Based on Multi-source Spreading

Chen, Duanbing — Univ. of Electronic Sci. & Tech. of China

Abstract: Identifying top-k influential nodes in complex networks effectively and efficiently has become a big challenge. In this report, a simple but effective method named VoteRank is presented. In VoteRank, both the number of nodes influenced and these nodes can be affected by other top-k influential nodes or not are considered so as to avoid selecting out close nodes. The experimental results indicate that VoteRank outperforms the benchmark algorithms on identifying top-k influential nodes.

▶ MS-We-D-15-2 14:00–14:30

Ranking the Centrality of Nodes in Citation Networks

Zeng, An — Beijing Normal Univ.

Abstract: Ranking the significance of scientific publications is a long-standing challenge. In this work, we introduce nonlinearity to the PageRank algorithm when aggregating resources from different nodes to further enhance the effect of important papers. The validation of our method is performed on the data of American Physical Society (APS) journals. The results indicate that the nonlinearity improves the performance of PageRank in terms of ranking effectiveness, as well as robustness against malicious manipulations.

▶ MS-We-D-15-3 14:30–15:00

Leadership Identification on Complex Networks

Lu, Linyuan — Hangzhou Normal Univ.

Abstract: Social networks constitute a new platform for information propagation, but its success is crucially dependent on the choice of spreaders who initiate the spreading of information. In this talk, we will review some representative methods for leadership identification and introduce possible applications in real systems, such as new marketing tools for e-commercial website.

Moreover, we will discuss the existing problems and outline open issues as main challenges in the near future.

▶ MS-We-D-15-4 15:00–15:30

Maximise Viral Spreading Using Percolation-Based Algorithm

Hu, Yanqing School of Mathematics, Southwest Jiaotong Univ.
Feng, Ling Inst. of High Performance Computing, A-Star
Ji, Shenggong School of Mathematics, Southwest Jiaotong Univ.
Jin, Yuliang Ecole normale superieure

Abstract: Online social networks (OSN) have transformed information spreading from centralised broadcasting to autonomous transmission, such that viral spreading becomes increasingly important. Studies have focused on finding efficient computation algorithms to accurately locate the set of most influential individ- uals. Here we look into the fundamental nature of viral spreading in terms of the super-critical phase in percolation theory, and construct a simple measure to accurately predict spreadability of a node using only local information.

MS-We-D-16 13:30–15:30 205A

Lie Symmetries, Solutions and Conservation laws of nonlinear differential equations - Part I of III

For Part 2, see MS-We-E-16
For Part 3, see MS-Th-BC-16

Organizer: Khalique, Chaudry Masood North-West Univ., Mafikeng Campus
Organizer: Zhang, Lijun Zhejiang Sci-Tech Univ.

Abstract: This mini-symposium is devoted to all research areas that are related to nonlinear differential equations and their applications in science and engineering. The main focus of this mini-symposium is on the Lie symmetry analysis, conservation laws and their applications to ordinary and partial differential equations. These differential equations could originate from mathematical models of diverse disciplines such as architecture, chemical kinetics, civil engineering, ecology, economics, engineering, fluid mechanics, biology and finance. Other approaches in finding exact solutions to nonlinear differential equations will also be discussed. This includes, but not limited to, asymptotic analysis methodologies, bifurcation theory, inverse scattering transform techniques, the Hirota method, the Adomian decomposition method, and others.

▶ MS-We-D-16-1 13:30–14:00

Multiple Wave Solutions and Conservation Laws of the DJKM Equation via Symbolic Computation

Adem, Abdullahi Rashid North-West Univ.

Abstract: Exact solutions and conservation laws for the Date-Jimbo-Kashiwara-Miwa equation with the aid of symbolic computation are presented. The exact solutions of the Date-Jimbo-Kashiwara-Miwa equation are constructed by using the multiple exp-function method, which is a generalization of Hirota's perturbation scheme. The solutions obtained involve generic phase shifts and wave frequencies. Furthermore, infinitely many conservation laws are derived by using the multiplier method.

▶ MS-We-D-16-2 14:00–14:30

Compacton Solutions of Integrable Equations

Chen, Aiyong Guilin Univ. of Electronic Tech.

Abstract: In this talk, we use dynamical system theory to several types of fully nonlinear wave equations. These equations can be reduced to planar polynomial differential systems by transformation of variables. We treat these polynomial differential systems by phase space analytical technique. The results of our study demonstrate that there exist close connection between nilpotent singular points and compactons. Moreover, we find some new elliptic function compactons instead of well-known trigonometric function compactons by analyzing nilpotent points. Two new compactons induced by singular elliptic are also obtained. We obtain yet kink-compacton and half-compacton solutions for some integrable equations.

▶ MS-We-D-16-3 14:30–15:00

EXACT SOLUTIONS AND CONSERVATION LAWS OF THE (3+1)-DIMENSION SINH-GORDON EQUATION

Magalakwe, Gabriel North-West Univ.

Abstract: A second order nonlinear wave equation, namely, the (3+1)-dimension sinh-Gordon equation, which appears in a diverse range of physics and engineering such as solid state physics, non-linear optics and stability of fluid motion is studied. Lie symmetry analysis together with (G' /G)-expansion method is used to obtain travelling wave solutions for the underlying equation. In addition, we derive conservation laws of the (3+1)-dimension sinh-Gordon equation using the direct method.

▶ MS-We-D-16-4 15:00–15:30

Conservation Laws of the Modified Camassa-Holm-Degasperis-Procesi Equation

Mhlanga, Isaiah North-West Univ.

Abstract: In this talk we present conservation laws of the modified Camassa-Holm-Degasperis-Procesi equation. This equation is a model for the propagation of the unidirectional gravitational waves in a shallow water approximation over a flat bed. The new conservation theorem due to Ibragimov will be used to obtain conservation laws.

MS-We-D-17 13:30–15:30 205B

Reaction-diffusion-advecton systems arising from mathematical biology modeling chemotaxis - Part III of III

For Part 1, see MS-Tu-D-17
For Part 2, see MS-Tu-E-17

Organizer: Xiang, Tian Renmin Univ. of China

Abstract: As with all living organisms, single cells and bacteria sense and respond to the environment where they live. The primary way these organisms achieve this is through the phenomenon of chemotaxis. Chemotaxis is the oriented movement of cells and organisms along chemical gradients, as a response to gradients of the concentration of chemical substances. It plays a significant role in many biological fields, and chemotaxis models have been successfully applied to the aggregation patterns in bacteria, slime molds, skin pigmentation patterns, angiogenesis in tumor progression and wound healing and many other examples. Therefore, a huge number of works, both theoretical and experimental, have been devoted to exploring and hence understanding the mechanistic basis of chemotaxis.

In 1953, Patlak contributed the first mathematical idea to model chemotaxis. In 1970s, Keller and Segel introduced a classical and important chemotaxis model (a advection-diffusion type parabolic-parabolic quasi-linear PDE systems) to describe the aggregation process of cellular slime mold by chemical attractions. These pioneering works have initiated an intensive mathematical investigation of the (Patlak-)Keller-Segel model and chemotaxis models have become one of the best study models in mathematical biology over the last 40 years.

Despite its simple looking, the Keller-Segel model exhibits the phenomenon of cell aggregation, which is usually modeled by time-dependent solutions blowing up in finite or infinite time. Thus, the issue whether or not the solutions of the proposed chemotaxis models are globally bounded or blow-up becomes the main concern in studying K-S type models. It is a very active research subject; up to now, there are at least 5 beautiful survey papers, Horstsmann [1,2], Hillen and Painter [3], Wang [4] and Blanchet [5], where one is provided with a broad survey on the progress of various chemotaxis models as well as with a rich selection of references. The key phenomena are: no blow-up in 1-D, except in some extreme nonlinear diffusion models, critical mass blow-up in 2-D, and generic blow-up in ≥ 3-D, a breakthrough made in Winkler [6].

Chemotaxis phenomenon has been also successfully applied to other equations, for instance, Navier-Stokes equations, see [7] for a glimpse.

Thus, in our mini-symposium, our group topics center mainly on reaction-diffusion-advecton systems modeling chemotaxis arising from mathematical biology. We bring together active researchers to share and discuss their very recent results on boundedness versus blow-up, critical mass blow-up, global existences, stability and large time behavior so as to understand more insights on the mechanism of chemotaxis. This mini-symposium will definitely stimulate more inspirations. [1] D. Horstman, From 1970 until now: the Keller-Segal model in chaemotaxis and its consequence I, Jahresber DMV, 105 (2003), 103–165. [2] D. Horstman, From 1970 until now: the Keller-Segal model in chaemotaxis and its consequence II, Jahresber DMV, 106 (2003), 51–69. [3]T. Hillen and K. J. Painter, A user's guide to PDE models for chemotaxis, J. Math. Biol., 58 (2009), 183–217. [4] Z. A. Wang, Mathematics of traveling waves in chemotaxis, Discrete Contin. Dyn. Syst. Ser. B 18 (2013), 601–641. [5] A. Blanchet, On the Parabolic-Elliptic Patlak-Keller-Segel System in Dimension 2 and Higher, preprint, arXiv:1109.1543 [6] M. Winkler, Finite-time blow-up in the higher-dimensional parabolic-parabolic Keller-Segel system, J. Math. Pures Appl. 100 (2013), 748–767. [7] R. J. Duan and Z.Y. Xiang, A note on global existence for the chemotaxis-Stokes model with nonlinear diffusion. Int. Math. Res. Not. IMRN 2014, no. 7, 1833-1852.

▶ MS-We-D-17-1 13:30–14:00

Global Existence and Boundedness in A Quasilinear Chemotaxis-Navier-Stokes System with Position Dependent Sensitivity

Ishida, Sachiko Tokyo Univ. of Sci.

Abstract: This talk will give global existence and global-in-time boundedness in a coupled chemotaxis and Navier-Stokes system with quasilinear diffusion and position dependent sensitivity in 2D domains. Most of studies on

chemotaxis-fluid systems without position dependent sensitivity use an energy estimate to find global solutions. In this research the energy estimate is unnecessary, and it makes the proof easy and the system could have the position sensitivity. Finally we can construct the global bounded weak solutions.

▶ MS-We-D-17-2 14:00–14:30

Boundedness in A Three-dimensional Chemotaxis-haptotaxis Model

Cao, Xinru Dalian Univ. of Tech.

Abstract: We study the chemotaxis-haptotaxis system on bounded domains with smooth boundary. We show that the chemotaxis dominate the boundedness of solution.

▶ MS-We-D-17-3 14:30–15:00

Eventual Smoothness and Asymptotics in A Three-dimensional Chemotaxis System with Logistic Source

Lankeit, Johannes Paderborn Univ.

Abstract: We prove existence of weak solutions to the chemotaxis system

$$u_t = \Delta u - \nabla \cdot (u \nabla v) + \kappa u - \mu u^2$$
$$v_t = \Delta v - v + u$$

under homogeneous Neumann boundary conditions in a smooth bounded convex domain $\Omega \subset R^3$, for arbitrary values of $\mu > 0$.
Additionally, we show that, after some time, these solutions become classical solutions, provided that κ is not too large.

▶ MS-We-D-17-4 15:00–15:30

Boundedness of Solutions to A Quasilinear Degenerate Keller-Segel System with Subcritical Sensitivity

Yokota, Tomomi Tokyo Univ. of Sci.

Abstract: We study boundedness of weak solutions to a quasilinear degenerate Keller-Segel system with subcritical sensitivity on R^N. Global existence of weak solutions to the system was established by Sugiyama-Kunii (2006) and Ishida-Yokota (2012). However, it is still open whether (KS) admits a weak solution that is uniformly-in-time bounded. In this talk we would like to give an answer to this open question.

MS-We-D-18 13:30–15:30 209B

Nonlinear aggregation-diffusion equations - Part III of III

For Part 1, see MS-Tu-D-18
For Part 2, see MS-Tu-E-18

Organizer: Huang, Yanghong Univ. of Manchester
Organizer: Carrillo, Jose A. Imperial College London
Organizer: Yao, Yao Univ. of Wisconsin Madison

Abstract: A large variety of stationary and dynamic patterns are the results of the competition between nonlinear diffusion and aggregation effects, including the well-known Patlak-Keller-Segel system. These systems are typically modelled from the collective behaviour of individuals, as the kinetic and/or continuum description based on mean-field type PDEs. The aim of the minisymposium is to highlight recent advances on the interplay between the aggregation and the nonlinear diffusion, by developing tools to understand the long time asymptotics, stability of the patterns, related functional inequalities and numerical schemes.

▶ MS-We-D-18-1 13:30–14:00

Nonlocal Interaction Equations: Phenomena and Structures

Slepcev, Dejan Carnegie Mellon Univ.

Abstract: Nonlocal-interaction equations are a basic model of biological aggregation. We discuss several phenomena: patterns that stable steady states exhibit, rolling traveling swarms in heterogeneous environments, and phase separation (flock / empty space) in systems with a local dispersal mechanism. A new model of aggregation which takes into account that long-range interactions are not additive will also be discussed. Based on joint work with Carrillo, Eisenbeis, Pego, Simione, Topaloglu, and Wu.

▶ MS-We-D-18-2 14:00–14:30

Derivation of A Modified Keller-Segel Model for E.coli Chemotaxis

Tang, Min shanghai jiao tong Univ.

Abstract: Recently, the biochemical pathways regulating the flagellar motors were uncovered. This knowledge gave rise to a class of kinetic-transport equations, that takes into account an intra-cellular molecular content and which relates the tumbling frequency to this information. Starting from the pathway based kinetic model, we derive the standard Kinetic-transport models that heuristically include tumbling frequencies depending on the pathwise gradient of chemotactic signal and a modified Keller-Segel Model whose coefficients depends on the environmental change.

▶ CP-We-D-18-3 14:30–14:50

Mixed Convection from An Impermeable Exponentially Stretching Surface

Patil, Prabhugouda M. Karnatak Univ., Dharwad-580003

Abstract: In this paper we focus on to obtain non-similar solutions numerically for steady two dimensional double diffusive mixed convection boundary layer flows over an impermeable exponentially stretching sheet in an exponentially moving free stream under the influence of chemically reactive species. The nonlinear partial differential equations governing the flow, temperature and species concentration fields are presented in non-dimensional form with the help of suitable non-similar transformations. The resulting final non-dimensional set of coupled nonlinear partial differential equations is solved by using an implicit finite difference scheme in combination with the Newton' s linearization technique. The effects of various non-dimensional physical parameters on velocity, temperature and species concentration fields are discussed. We have also discussed the variations of the skin friction and heat and mass transfer rate parameters. The results reveal that the streamwise co-ordinate significantly influences the flow, thermal and solutal concentration fields which display the importance of non-similar solutions.

▶ CP-We-D-18-4 14:50–15:10

On the Richards Equation with Hysteresis

El Behi-Gornostaeva, Elena Technical Univ. Munich

Abstract: We study an evolution problem for filtration trough porous media, where we account for hysteresis in the saturation vs. pressure constitutive relation. Mass conservation and Darcy's law yield a nonlinear diffusion equation, which is coupled with boundary conditions of Neumann and Signorini type. Existence of solutions for the resulting system of PDEs with hysteresis nonlinearities is established, which also applies to the case where the hysteresis operator is of Preisach-type.

MS-We-D-19 13:30–15:30 307B

Variational Multiscale and Stabilised finite element methods for incompressible flow problems

Organizer: Barrenechea, Gabriel R. Univ. of Strathclyde

Abstract: Since their appearance in the mid nineties, Variational Multiscale Methods (VMS) have become a extrenely powerful tool to derive new finite element methods in different areas of continuos mechanics. These methods can be applied directly, in a multiscale finite element framework, or can be used as a formal tool to derive perturbed formulations, by either solving the fine scale problems, or model their impact in the macroscale formulation. This latter process has been extensively studied and used as a tool to derive new stabilised finite element formulations. The main focus of this minisymposium is to discuss recent developments in VMS-related approaches for fluid mechanics problems. Talks wiill range from more theoretical aspects of these sort of methods (and their relationship to stabilisation) to more challenging three-dimensional applications involving turbulent flows.
This minisymposium will be organised by myself and Prof. Tomas Chacon-Rebollo, from Universidad de Sevilla, Spain, and University of Bordeaux, France. The reason I am signing this with only my name is because I have not had access to Prof. Chacon's pin. I hope this doesn't present a big problem.

▶ MS-We-D-19-1 13:30–14:00

Old and New Results in Positivity Preserving Schemes for the Convection-diffusion Equation

Barrenechea, Gabriel R. Univ. of Strathclyde

Abstract: In this talk I will review some recent results in nonlinear schemes for the convection-diffusion equation. The common point in all the schemes I will present is the fact that they respect the Discrete Maximum Principle. The main part of the talk will be devoted to the Algebraci Flux Correction scheme, for which stability and convergence analyses will be presented. But, I will also present some more recent results on variations and improvements.

▶ MS-We-D-19-2 14:00–14:30

Spectral Variational Multi-Scale Method for the Two-dimensional Convection-diffusion Problem

Dia, Ben Mansour King Abdullah Univ. of Sci. & Tech.
Chacon Rebollo, Tomas Univ. of Sevilla

Abstract: We present an extension of the spectral-VMS method developed in [1] to the two-dimensional convection-diffusion equations as the first step towards a generalization of the method for incompressible flow model. The cited method relies on the computation of the sub-grid contribution which is based on the resolution of eigenvalue problem of a certain normal operator. For the numerical experiments, we consider rectangular elements Q1 so that the contribution of the sub-grid solution is analytically computable.

▶ MS-We-D-19-3 14:30–15:00

Finite Element Approximation of A Projection-based VMS Turbulence Model with Wall Laws.

Rubino, Samuele — Univ. of Seville
Chacon Rebollo, Tomas — Univ. of Sevilla

Abstract: We propose a Variational MultiScale (VMS) model improved with wall laws for the simulation of wall-bounded incompressible flows in laminar and turbulent regimes.
This is a finite element projection-based VMS model. In view of proposing a viable numerical method, we also consider the combination with stabilized ad-hoc discretizations that perfectly fit into the VMS framework.
The numerical analysis and the validation through the simulation of some relevant flow situations justify the interest of our approach.

▶MS-We-D-19-4 15:00–15:30

A New Hybrid Finite Element Scheme for Advection-diffusion-reaction Equation

Araya, Rodolfo — Universidad de Concepcion

Abstract: In this work we will introduce a new hybrid scheme to discretize the advection-diffusion-reaction equation. This new method relaxes the continuity of the primal variable through the action of Lagrange multipliers, while assuring the strong continuity of the normal component of the flux (dual variable). We prove existence and uniqueness of a solution for this method as well as convergence estimates. Also, we propose a face-residual a posteriori error estimator which is used to improve

MS-We-D-20 13:30–15:30 210B

Theory, Computation, and Application of Transmission Eigenvalues - Part I of III

For Part 2, see MS-We-E-20
For Part 3, see MS-Th-BC-20

Organizer: Sun, Jiguang — Michigan Technological Univ.
Organizer: Cakoni, Fioralba — Univ. of Delaware

Abstract: Transmission eigenvalue problem is a new research area arising from the inverse scattering theory of inhomogeneous media. The problem is non-selfadjoint, non-standard and not covered by any classical partial differential equation. Since 2007, the problem received significant attention including a special issue of transmission eigenvalues of Inverse Problems. This mini symposium will bring top researchers from America, Europe, and Asia to present the recent advances of the theory, computation, and applications of transmission eigenvalues. It will also be a great chances for these researchers to exchange new ideas and discuss the future development for the transmission eigenvalue problem.

▶MS-We-D-20-1 13:30–14:00

DETERMINING TRANSMISSION EIGENVALUES OF ANISOTROPIC INHOMOGENEOUS MEDIA FROM FAR FIELD DATA

Peters, Stefan — AG inverse problems, Univ. Bremen

Abstract: We characterize interior transmission eigenvalues of penetrable anisotropic acoustic scattering objects by a technique known as inside-outside duality. Under certain conditions on the anisotropic material coefficients of the scatterer, the inside-outside duality allows to rigorously characterize interior transmission eigenvalues from multi-frequency far field data. This theoretical characterization moreover allows to derive a simple numerical algorithm for the approximation of interior transmission eigenvalues.

▶MS-We-D-20-2 14:00–14:30

C^0 IPG for Transmission Eigenvalue Problems

Ji, Xia — chinese Acad. of Sci.

Abstract: We concerns numerical computation of transmission eigenvalue problems. For high order problems, discontinuous Galerkin methods are competitive since they avoid some difficulties arising from other approaches. We show the well-posedness of the source problem. An interior penalty discontinuous Galerkin method using Lagrange elements (C0IPG) is proposed and its convergence is studied. The method is then used to compute the transmission eigenvalues. We show that the method is spectrally correct and prove the optimal convergence.

▶MS-We-D-20-3 14:30–15:00

Some Estimates for Interior Transmission Problems and Their Applications

Qu, Fenglong — Yantai Univ.
Yang, Jiaqing — Xi'an Jiaotong Univ.
Zhang, Bo — Acad. of Mathematics & Sys. Sci., CAS

Abstract: In this talk we will give some estimates for the refractive index of interior transmission problems on the use of interior transmission eigenvalues, the radius of the scattering domain, the first Dirichlet eigenvalue of the negative Laplace operator. Then we prove some uniqueness results for the refractive index based on the estimates for interior transmission problems and some L_P (1¡P¡2) estimates for the direct scattering problems.

▶MS-We-D-20-4 15:00–15:30

Some Results on Electromagnetic Transmission Eigenvalues

Zeng, Fang — Chongqing Univ.
Sun, Jiguang — Michigan Technological Univ.

Abstract: The electromagnetic interior transmission problem is a boundary value problem, which is neither elliptic nor self-adjoint. In this paper, we show that, in general, there do not exist purely imaginary electromagnetic transmission eigenvalues. For constant index of refraction, we prove that it is uniquely determined by the smallest (real) transmission eigenvalue. Finally, we show that complex transmission eigenvalues must lie in a certain region in the complex plane. The result is verified by examples.

MS-We-D-21 13:30–15:30 309B

Minisymposium on discontinuous Galerkin method: recent development and applications - Part III of VIII

For Part 1, see MS-Tu-D-21
For Part 2, see MS-Tu-E-21
For Part 4, see MS-We-E-21
For Part 5, see MS-Th-BC-21
For Part 6, see MS-Th-D-21
For Part 7, see MS-Th-E-21
For Part 8, see MS-Fr-D-21

Organizer: Xu, Yan — Univ. of Sci. & Tech. of China
Organizer: Shu, Chi-Wang — Brown Univ.

Abstract: Over the last few years, discontinuous Galerkin (DG) methods have found their way into the main stream of computational sciences and are now being successfully applied in almost all areas of natural sciences and engineering. The aim of this minisymposium is to present the most recent developments in the design and theoretical analysis of DG methods, and to discuss relevant issues related to the practical implementation and applications of these methods. Topics include: theoretical aspects and numerical analysis of discontinuous Galerkin methods, non-linear problems, and applications. Particular emphasis will be given to applications coming from fluid dynamics, solid mechanics and kinetic theory.

▶MS-We-D-21-1 13:30–14:00

Fast Solver for the Local Discontinuous Galerkin Discretization of High Order Time-dependent Partial Differential Equations

Xu, Yan — Univ. of Sci. & Tech. of China

Abstract: In this paper, we will develop a fast iterative solver for the system of equations arising from the local discontinuous Galerkin (LDG) spatial discretization and implicit time marching method for high order time-dependent PDEs. Being implicit in time, the severe time step ($\Delta t = O(\Delta x^k)$, with the k-th order of the PDEs) restriction for explicit methods will be removed. We demonstrate an efficient, practical multigrid (MG) method for solving the equations.

▶MS-We-D-21-2 14:00–14:30

CONVERGENCE OF DISCONTINUOUS GALERKIN SCHEMES FOR FRONT PROPAGATION WITH OBSTACLES

Cheng, Yingda — Michigan State Univ.

Abstract: We study semi-Lagrangian discontinuous Galerkin (SLDG) and RungeKutta discontinuous Galerkin (RKDG) schemes for some front propagation problems in the presence of an obstacle term, modeled by a nonlinear Hamilton-Jacobi equation in one space dimension. New convergence results and error bounds are obtained for Lipschitz regular data. These "low regularity" assumptions are the natural ones for the solutions of the studied equations.

▶MS-We-D-21-3 14:30–15:00

High Order Asymptotic Preserving Nodal Discontinuous Galerkin IMEX Schemes for the BGK Equation

Xiong, Tao — Univ. of Houston

Abstract: In the asymptotic limit, the BGK equation in the hyperbolic scaling will lead to the macroscopic models such as Euler and compressible Navier-Stokes equations. We develop high-order asymptotic preserving (AP) schemes based on micro-macro decomposition, which involve nodal discontinuous Galerkin (DG) spatial discretization and globally stiffly accurate implicit-explicit (IMEX) temporal discretization. It is formally demonstrated that the scheme, when the Knudsen number is small, becomes a local DG discretization of the compressible Navier-Stokes equations.

MS-We-D-22 13:30–15:30 206A
Cooperative Control and Optimization for High-order Multi-agent Systems
Organizer: Chen, Fei Xiamen Univ.
Abstract: In many biological and engineering applications, the overall system consists of a number of subsystems that are required to work cooperatively to achieve a common goal. Each subsystem is interconnected with a subset of the other subsystems to form a multi-agent network, where local information sharing is essential in achiving certain group-level goal. The proposed session brings expertise in the analysis of multi-agen systems to the audience of the International Congress on Industrial and Applied Mathematics (ICIAM). The session in particular emphasizes high-order dynamics, directed network topologies, gain adaptation, and distributed optimization. The invited articles cover synchronisation of multi-agent systems with general linear dynamics, leader-following formation control for nonlinear multi-agent systems with directed topologies, consensus with gain adaptation over a directed graph, and distributed finite-time optimization of second-order multi-agent systems.

▶ MS-We-D-22-1 13:30–14:00
Leader-following Formation Control for Nonlinear Multi-agent Systems with Directed Topologies
Lyu, Jing Beihang Univ.
Abstract: This paper presents two nonsmooth leader-following formation protocols for identical and nonidentical Lipschitz nonlinear multi-agent systems, respectively, with directed communication network topologies. In these protocols, the given directed network topology is only required to contain a spanning tree, while the states of all the agents are available locally within their neighborhoods. The proposed formation protocols are applied to multi-spacecraft systems in deep-space exploration, with numerical simulations demonstrating the effectiveness of the theoretical results.

▶ MS-We-D-22-2 14:00–14:30
Synchronisation of Multi-agent Systems with General Linear Dynamics
Chen, Michael Z. Q. The Univ. of Hong Kong
Abstract: In this talk, the results of synchronisation for general linear multi-agent systems (MAS) via methods such as bounded control and event-triggered control will be reported. In the past decade, the cooperative control has been studied extensively for homogeneous MAS networks with single-integrator and double-integrator dynamics. When high-order integrator and general linear dynamics are considered, the distributed control design and the stability analysis become much more difficult than those for the single-integrator and double-integrator networks.

▶ MS-We-D-22-3 14:30–15:00
Consensus with Gain Adaptation over A Directed Graph
Mei, Jie Harbin Inst. of Tech. Shenzhen Graduate School
Abstract: In this presentation, we will introduce a gain adaptation strategy, where the gains in the algorithms are varying and updated by using only local information. To analyze the consensus stability, we will establish a connection between a strongly connected directed graph and an undirected graph. We will propose fully distributed algorithms for second-order MAS with heterogeneous varying inertias, second-order MAS with intrinsic Lipschitz nonlinear dynamics, and MAS with general linear dynamics.

▶ MS-We-D-22-4 15:00–15:30
Distributed Finite-time Optimization of Second-order Multi-agent Systems
Lin, Peng UESTC
Abstract: In this paper, a distributed finite-time optimization problem with general differentiable convex objective functions is studied for second-order multi-agent systems. A distributed algorithm is presented in which the interaction gain of each agent can be adaptively adjusted according to the variation of the gradients of the local objective functions. A corresponding condition is then given to guarantee that all agents reach a consensus while minimizing the team performance function in finite time.

MS-We-D-23 13:30–15:30 208A
Study on social networks
Organizer: Fan, Ying Beijing Normal Univ.
Abstract: This symposium address the analysis of social networks. Including: 1 How to get Social system data? 2. Using graphs and matrices represent social relations. 3. Basic properties of networks. 4 some examples: on-line social network, social media networks, scientific citation network 5. Algorithms for networks analysis 6. Centrality and community And so on

▶ MS-We-D-23-1 13:30–14:00
Evolution of Social Media Networks
Li, Menghui Beijing Inst. of Sci. & Tech. Intelligence
Abstract: By analyzing the growth of empirical social media networks, we found that triadic links plays a dominant role in the evolution of networks. Thus, we propose a simple reaction-diffusion-like coevolving model, in which individuals are activated to create links based on their states, influenced by local dynamics and their own intention. It is shown that the model can reproduce the remarkable properties observed in empirical social media networks.

▶ MS-We-D-23-2 14:00–14:30
Domain-specific Tweet Sentiment Analysis
Ribeiro, Patricia Brasilia Univ.
Weigang, Li Univ. of Brasilia
Li, Tiancheng Univ. of Salamanca
Abstract: Tweet sentiment analysis (TSA) provides the public opinion of the users from Twitter about culture, products and political agendas. To execute efficient TSA on a particular topic or domain, an approach with unified tool, UnB TSA, is proposed consisting of four steps: tweets collection, refinement (excluding noisy tweets), sentiment lexicon creation and sentiment analysis. Experiment results on the 'iPhone 6' domain show superiority of the domain-specific TSA approach over a generic one.

▶ MS-We-D-23-3 14:30–15:00
Collective Behavior Analysis of User-object Bipartite Networks
Jianguo, Liu Univ. of Shanghai for Sci. & Tech.
Abstract: The presentation will introduce the collective behavior analysis results for online users, including the relationship between the common interests and the trust relationship, the node importance identication method as well as the stability anlaysis of the similarity measurements for bipartite networks, which is helpful for deeply understanding the statistical properties of online systems.

▶ MS-We-D-23-4 15:00–15:30
Leader-Following Consensus of Linear Multi-Agent Systems with Communication Noise
Wang, Yunpeng Inst. of Automation, Chinese Acad. of Sci.
Abstract: Similar to the previous works, in the proposed protocol a time-varying gain is employed to attenuate the noise's effect. However, different from most previous works where all agent share a same time-varying gain, each agent is allowed to have its own time-varying gain in this paper. It is proved that consensus can be achieved in mean square sense, if some conditions hold. Finally, several simulation examples are presented to verify the theoretical results.

MS-We-D-24 13:30–15:30 211
Recent Advances in Numerical Approximation of Singular Solutions - Part II of III
For Part 1, see MS-Tu-E-24
For Part 3, see MS-We-E-24
Organizer: Li, Hengguang Wayne State Univ.
Organizer: Nistor, Victor Pennsylvania State Univ. & U. Lorraine
Organizer: Ovall, Jeffrey Portland State Univ.
Abstract: In this mini-symposium, we will mainly discuss new developments and open questions concerning the approximation of singular solutions of partial differential equations. The scope of the mini-symposium includes but is not limited to: a-priori estimates of the equation, sharp numerical error analysis, novel discretizations, and effective numerical solvers. We hope to bring together both recognized experts and junior researchers with common interest but diverse backgrounds and knowledge, thereby bringing in a wide range of expertise for extensive discussions and communications.

▶ MS-We-D-24-1 13:30–14:00
A New Approach for Numerical Simulation of the Time-dependent Ginzburg-Landau Equations
Li, Buyang Nanjing Univ.
Zhimin, Zhang Beijing Computational Sci. Research Center, & Wayne State Univ.
Abstract: We introduce a new approach for finite element simulations of the time-dependent Ginzburg–Landau equations (TDGL) in a general curved polygon, possibly with reentrant corners. Specifically, we reformulate the T-DGL into an equivalent system which avoids direct computation of the singular magnetic potential. Numerical simulations of vortex dynamics show that, in a domain with reentrant corners, the new approach is much more stable and accurate than the old approaches of solving the TDGL directly.

▶ MS-We-D-24-2 14:00–14:30
Optimal discretization in Banach spaces: Residual minimization, nonlinear Petrov–Galerkin, and monotone mixed methods

Van Der Zee, Kris NOTTINGHAM Univ.

Abstract: We consider nonstandard Petrov – Galerkin discretizations of linear problems in Banach spaces. We build on ideas of residual minimization and the recent theory of optimal Petrov-Galerkin methods in Hilbert space settings. We propose an optimal discretization method in the setting of certain Banach spaces, proof a priori error estimates, and present some numerical experiments. This is joint work with Ignacio Muga of Pontificia Universidad Catolica de Valparaiso.

▶ MS-We-D-24-3 14:30–15:00

A Nonconforming Finite Element Method for An Acoustic Fluid-Structure Interaction Problem

Cui, Jintao Hong Kong Polytechnic Univ.

Abstract: In this talk we discuss a nonconforming finite element approximation of the vibration modes of an acoustic fluid-structure interaction. Displacement variables are used for both the fluid and the solid. The numerical scheme is based on the irrotational fluid displacement formulation; hence it is free of spurious eigenmodes. The method uses weakly continuous P1 vector fields for the fluid; and it satisfies optimal order error estimates on properly graded meshes.

MS-We-D-25 13:30–15:30 210A

Numerical Methods for Stochastic PDE and Uncertainty Quantification - Part II of IV

For Part 1, see MS-Tu-E-25
For Part 3, see MS-We-E-25
For Part 4, see MS-Th-BC-25

Organizer: ZHOU, TAO AMSS, the Chinese Acad. of Sci.
Organizer: Yu, Xijun Inst. of Applied Physics & Computational Mathematics
Organizer: Xiu, Dongbin Univ. of Utah

Abstract: Efficient solution strategy for stochastic partial differential equations (SPDE) has been a classical topic, as many physical phenomena are inherently random. The topic has received an increasing amount of attention in recent years, driven by the need for uncertainty quantification (UQ). In UQ, even deterministic systems need to be modeled as random because of the uncertainty in the system inputs. Stochastic problems become more challenging to solve, as they often reside in high dimensional random space. The purpose of this mini-symposium is to gather researchers from mathematics and computer science and engineering to interchange the latest advances in simulation techniques for SPDE and UQ. The focus will be on efficient algorithms for practical systems, particularly those arising from multidisciplinary problems.

▶ MS-We-D-25-1 13:30–14:00

Bayesian Based Numerical Homogenization

Zhang, Lei Shanghai Jiao Tong Univ.

Abstract: Recently, we proposed the so-call RPS (rough polyharmonic splines) basis, which has the optimal accuracy and localization property for the numerical homogenization of divergence form elliptic equation with rough (L^∞) coefficients. Surprisingly, this basis can be obtained by the reformulation of the numerical homogenization problem as a Bayesian inference problem, and furthermore, this formulation can be used to coarse grain the Boltzmann distribution for atomistic system.

▶ MS-We-D-25-2 14:00–14:30

A Sequential Experimental Design Approach to Construct Surrogates for Failure Probability Estimation

Li, Jinglai shanghai jiaotong univerisity

Abstract: Gaussian processes surrogates have been used in estimating failure probabilities in computationally expensive models. A key in constructing such surrogates in to determine sampling points. We present a method based on Bayesian experimental design to address this problem. Our method is theoretically rigorous and able to determine multiple sampling points in each iteration. Numerical examples are provided to demonstrate its effectiveness.

▶ MS-We-D-25-3 14:30–15:00

Model Reduction Methods for High-dimensional Stochastic Multiscale Models

Jiang, Lijian Hunan Univ.

Abstract: The uncertainty in multiscale structure properties is often parameterized by a high-dimensional random variable. To efficiently tackle the high-dimensionality in stochastic multiscale models , we combine the stochastic dimension reduction techniques and the multiscale methods to reduce the stochastic multiscale models in both stochastic space and physical space. This significantly decreases the computation complexity. A few numerical experiments are carried out to confirm the performance of these techniques.

▶ MS-We-D-25-4 15:00–15:30

A Christoffel Least Squares Algorithm for Collocation Approximations

Narayan, Akil Univ. of Massachusetts Dartmouth
Jakeman, John Sandia National Laboratories
ZHOU, TAO AMSS, the Chinese Acad. of Sci.

Abstract: We consider a novel algorithm for the Monte Carlo solution of least-squares polynomial approximation problems in a collocation framework. A standard Monte Carlo approach would draw samples according to the density of orthogonality. Our proposed algorithm samples with respect to the (weighted) pluripotential equilibrium measure of the parametric domain, and subsequently solves a weighted least-squares problem, with weights given by evaluations of the Christoffel function. We validate the algorithm with theoretical analysis and computational results.

MS-We-D-26 13:30–15:35 110

Recent advances in modeling, analysis, and methodology for interface and free boundary problems and applications - Part III of V

For Part 1, see MS-Mo-D-57
For Part 2, see MS-Mo-E-57
For Part 4, see MS-We-E-26
For Part 5, see MS-Th-BC-26

Organizer: Li, Zhilin North Carolina State Univ.
Organizer: Lai, Ming-Chih National Chiao Tung Univ.

Abstract: In recent years, there is increasing interest in the development and application of advanced computational techniques for interface problems, problem with free boundary and moving interface, fluid-structure interactions driven by applications in physiology, fluid mechanics, material sciences, porous media flow, and biology. There are also many numerical approaches developed in recent years. The aim of this mini-symposium is to bring together scientists in the field to exchange their recent research discoveries and future directions, to stimulate novel ideas, and to nurture collaborations. The focus would be on Cartesian grid method such as the immersed boundary/interface methods, the level set methods, fluid-structure interactions, and applications.

▶ MS-We-D-26-1 13:30–13:55

Simulations of Passive and Active Motion of Blood Elements

Misbah, Chaouqi CNRS & Univ. J. Fourier, Grenoble

Abstract: Blood is primrarily composed by RBCs (Red Blood Cells), but contains also other components, like leukocytes. RBCs are transported passively by flow, while leukocytes, besides the passive transport, can also move in an active way, when they fight infections, thanks to an internal machinery. Examples will be discussed on modeling passive and active motion, and various intricate numerical results are presented.

▶ MS-We-D-26-2 13:55–14:20

A Fast Parallel Algorithm for Direct Simulation of Particulate Flows Using Conforming Grids

Minev, Peter Univ. of Alberta

Abstract: This study presents a development of ta parallel direction splitting algorithm for flows containing rigid particles. The main novelty of this method is that the grid is fit to the boundaries of the particle and therefore the spatial discretization is very accurate. The equations of motion of each particle are discretized explicitly and the resulting velocity is imposed as boundary condition for the split momentum equations. The pressure is fictitiously extended within the particles.

▶ MS-We-D-26-3 14:20–14:45

An Augmented Method for Stokes-Darcy Coupling and Applications

Li, Zhilin North Carolina State Univ.

Abstract: A new finite difference method based on Cartesian meshes is proposed for solving the fluid structure interaction between a fluid flow modeled by the Stokes equations and a porous media modeled by the Darcy's law. The idea is to introduce several augmented variables along the interface between the fluid flow and the porous media so that the problem can be decoupled as several Poisson equations. The augmented variables should be chosen so that the Beavers-Joseph-Saffman (BJS) and other interface conditions are satisfied. In the discretization, the augmented variables have co-dimension one compared with that of the primitive variables and are solved through the Schur complement system. A nontrivial analytic solution with a circular interface is constructed to check second order convergency of the proposed method. Numerical examples with various interfaces and parameters are also presented. Some simulations show interesting behaviors of the fluid structure interaction between the fluid flow and the porous media. The computational framework can be applied to other multi-phase and multi-physics problems.

▶ MS-We-D-26-4 14:45–15:10

The Immersed Interface Method for Flow Around Rigid Objects in 3D

Xu, Sheng — Southern Methodist Univ.

Abstract: In this talk, I will present some development of the immersed interface method toward distributed memory parallel computing for flow around complex rigid objects in 3D. I will present how to compute necessary jump conditions for the immersed interface method using triangular mesh representation of complex interfaces, and how to handle communication among processors in parallel computing for moving objects.

▶ MS-We-D-26-5 15:10–15:35

Sharp Interface Methods for Fluid-Solid Interaction

Bhalla, Amneet Pal Singh — Univ. of North Carolina - Chapel Hill
Griffith, Boyce — Univ. of North Carolina at Chapel Hill

Abstract: Fluid-solid systems are common in scientific and engineering applications. The immersed boundary (IB) method is a general approach to modeling such systems. A difficulty of this IB formulation is that the pressure and viscous stress are generally discontinuous at fluid-solid interfaces. We will describe extensions of the IB method that sharply resolve stress discontinuities at fluid-solid interfaces. These methods can be viewed as extensions of the immersed interface method to non-interfacial (codimension-0) solid bodies.

MS-We-D-27 13:30–15:30 407

Decoupling methods for multi-physics and multi-scale problems - Part II of VIII

For Part 1, see MS-Tu-E-27
For Part 3, see MS-We-E-27
For Part 4, see MS-Th-BC-27
For Part 5, see MS-Th-D-27
For Part 6, see MS-Th-E-27
For Part 7, see MS-Fr-D-27
For Part 8, see MS-Fr-E-27

Organizer: He, Xiaoming — Missouri Univ. of Sci. & Tech.
Organizer: Xu, Xuejun — Inst. of Computational Mathematics, AMSS, CAS

Abstract: The inherent multi-physics and multi-scale features of many real world problems accentuate the importance to develop efficient and stable numerical methods for the relevant PDEs, especially the decoupling methods. Although great efforts have been made for solving these problems, many practical and analytical challenges remain to be solved. This mini-symposium intends to create a forum for junior and senior researchers from different fields to discuss recent advances on the decoupling methods for multi-physics and multi-scale problems with their applications.

▶ MS-We-D-27-1 13:30–14:00

Time-Parallel Methods Based on Waveform Relaxation for Time-dependent Differential Equations

Song, Bo — Xi'an Jiaotong Univ.
Jiang, Yao-Lin — Xi'an Jiaotong Univ./Xinjiang Univ.

Abstract: The parareal algorithm, which permits to solve evolution problems in a time parallel fashion, has created a lot of attention over the past decade. In this talk, we will present a parareal algorithm with the waveform relaxation propagator as the fine propagator for initial-value and time-periodic differential equations. Especially, we will present two new parareal algorithms for time-periodic problems. Several realistic applications are also provided to illustrate the effectiveness of the new strategies.

▶ MS-We-D-27-2 14:00–14:30

A Simple Treatment of the Corner Singularity Using Nonconforming Elements for Cavity Flow

Sheen, Dongwoo — Seoul National Univ.

Abstract: In the numerical simulation of cavity flow, one needs to pay attention to deal with the well-known corner singularities. In particular, if conforming finite elements are used, special care should be taken of. In this talk we will introduce a simple treatment of corner singularity using stable cheapest nonconforming elements for cavity flow. Several numerical comparisons show superiority with the proposed method.

▶ MS-We-D-27-3 14:30–15:00

Solving An Inverse Stefan Problem by A Novel Fictitious Domain Method

Huang, Jianguo — Shanghai Jiao Tong Univ.

Abstract: A novel fictitious domain method is proposed for solving an inverse Stefan problem, in order to determine a free boundary during the phase transition, by means of measurement data of temperature and heat flux at the left end point of the material. Theoretical analysis and numerical simulation are provided to show the computational performance of the method. This is a joint work with Huashan Sheng and Wan Tang from Shanghai Jiao Tong University.

MS-We-D-28 13:30–15:30 109

FLOW, HEAT AND MASS TRANSFER IN FLUID MECHANICS - Part II of II

For Part 1, see MS-Tu-E-28

Organizer: P A, Dinesh — M S Ramaiah Inst. of Tech., Bangalore

Abstract: The objective of this mini symposium is to develop a mathematical model and to investigate analytically or numerically and systematically the study of flow problems; free, forced and mixed convection heat and mass transfer arises in fluid mechanics. Study of such type of problems in fluid mechanics has received enormous attention of many researchers in industrial applications, scientific and engineering fields. The subject is multidisciplinary and completely encircles the main views of applied mathematics to areas like soil physics, hydrogeology, petroleum industry, filtration of solids from liquids, chemical engineering, biological systems, oil reservoir modelling, food processing, casting and welding, manufacturing processes, the dispersion of pollutants into environment, storage of nuclear waste, power plant stream lines, bio mechanical, polymerization, fluid mechanics, filters, chemical, mechanical, paper and cloth industry, geophysics, chemistry etc.
The following are the abstracts proposed for the mini symposia:
A numerical solution for the free convective, unsteady, laminar convective heat and mass transfer in a MHD viscoelastic fluid along a semi-infinite vertical plate with Soret and Dufour effects is presented. The Walters-B liquid model is employed to simulate medical creams and other rheological liquids encountered in biotechnology and chemical engineering. This rheological model introduces supplementary terms into the momentum conservation equation. The dimensionless unsteady, coupled, and non-linear partial differential conservation equations for the boundary layer regime are solved by an efficient, accurate and unconditionally stable finite difference scheme of the Crank-Nicolson type.
The aim of this study is to present chemical reaction and thermophoretic effects on MHD mixed convective incompressible flow, viscous and electrically conducting fluid over a radiate isothermal inclined plate embedded in a porous medium in the presence of heat source/sink.
We analyzed the effects of thermal radiation, viscous dissipation and magneticfield on boundary layer flow of a nanofluid past a nonlinear permeable stretching/shrinking sheet.
In this problem the flow of a Viscoelastic fluid due to a linearly and quadraticaly stretching sheet and heat transfer characteristics using variable thermal conductivity is studied in the presence of a non uniform heat source/sink. The thermal conductivity is assumed to vary as a liner function of temperature. The similarity transformation is used to convert the governing partial differential equations of flow and heat transfer into a ordinary differential equations. Shooting method is used to obtain the numerical solution for the resulting boundary value problem. The effects of Chandrashekar Number, Prandltl Number, Non-Uniform heat source/sink parameters and Variable Thermal Conductivity parameter on the dynamics are shown graphically in several plots.
In this paper, a multi grid analysis of the effect of surface roughness in hydrodynamic lubrication of a porous journal bearing with a heterogeneous slip/no-slip surface is studied. In the traditional lubrication theory, it has been assumed that all the bearing surfaces are smooth but it is unrealistic study for the bearing with small film thickness.
This study reports a numerical investigation of the convective flow and heat transfer in a square porous cavity with partially active thermal walls. Five different heating and cooling zones are considered along the vertical walls

▶ MS-We-D-28-1 13:30–14:00

EFFECT OF VELOCITY SLIP ON TWO PHASE FLOW IN AN ECCENTRIC ANNULAR REGION

DEVI, B.UMA — J S S Acad. of Technical Education
P A, Dinesh — M S Ramaiah Inst. of Tech., Bangalore
C.V, VINAY — J S S Acad. of Technical Education

Abstract: A mathematical model is developed to study the effects of particle drag and slip parameter on the velocity of the flow in an annular cross sectional region bounded by two eccentric cylinders. The velocity of the fluid phase is obtained by transforming conformally eccentric to concentric. As slip parameter increases then the velocity will be decreased. As particulate drag parameter increases then the velocity decreases. Eccentricity facilitates transport of more fluid then the velocity increases.

▶ MS-We-D-28-2 14:00–14:30

Compositional Optimization in Combinatorial Catalyst Using ASBO Approach

Pennagaram, Devika — M.S. Engineering College
P A, Dinesh — M S Ramaiah Inst. of Tech., Bangalore
Singh, Manoj Kumar — Manuro Tech

Prasad, Ramakrishna JNTUH

Abstract: For Heterogeneous catalysts, their catalytic activity and selectivity are dependant on chemical composition, microstructure and reaction conditions. Hence it is worth doing research over the composition of the catalyst and the reaction conditions that will enhance its performance. In this paper a computational intelligence approach based on adaptive social behavior optimization (ASBO) for catalyst composition optimization to enhance the resulting yield or to achieve the maximal objective is proposed.

▶MS-We-D-28-3 14:30–15:00

Radiation and Magneticfield Effects on Boundary Layer Flow of A Dissipative Nanofluid Past A Nonlinearly Permeable Stretching/shrinking Sheet

Naramgari, Sandeep VIT Univ.

Abstract: We analyzed the effects of thermal radiation, viscous dissipation and magneticfield on boundary layer flow of a nanofluid past a nonlinear permeable stretching/shrinking sheet. The governing equations are solved numerically by using Shooting Technique. Effects of Thermal Radiation parameter, Magneticfield parameter, Viscous Dissipation parameter, Brownian motion parameter, Suction parameter, Thermophoresis parameter and the stretching/shrinking sheet parameter on velocity, temperature, concentration, skin friction, local Nusselt and Sherwood numbers are thoroughly investigated and presented through graphs and

▶MS-We-D-28-4 15:00–15:30

FINITE DIFFERENCE ANALYSIS OF UNSTEADY MHD FREE CONVECTION IN A WALTER' S-B VISCOELASTIC FLOW PAST A SEMI-INFINITE VERTICAL PLATE

Bangalore, Rushi Kumar VIT Univ.

Abstract: A numerical solution for the free convective, unsteady, laminar convective heat and mass transfer in a MHD viscoelastic fluid along a semi-infinite vertical plate with Soret and Dufour effects is presented. The Walters-B liquid model is employed to simulate medical creams and other rheological liquids encountered in biotechnology and chemical engineering. The dimensionless unsteady, coupled, and non-linear partial differential equations are solved by an efficient and unconditionally stable finite difference scheme of the Crank-Nicolson type.

MS-We-D-29 13:30–15:30 305

High Order Numerical Methods for PDEs - Hybrid Methods - Part II of III

For Part 1, see MS-Tu-E-29
For Part 3, see MS-We-E-29

Organizer: Jung, Jae-Hun SUNY at Buffalo
Organizer: Don, Wai Sun Ocean Univ. of China/Brown Univ.
Organizer: Ling, Leevan Hong Kong Baptist Univ.
Organizer: Yoon, Jungho Ewha W. Univ.

Abstract: In this mini-symposium, we gather together researchers in the areas of high order numerical approximation methods for PDEs and Images and their applications. The mini-symposium will present recent progress in high-order methods including ENO/WENO methods, spectral methods, discontinuous Galerkin methods, and radial basis function methods. Particularly we are interested in the recent development of the hybrid methods that combine the different high order methods in a single frame. The proposed mini-symposium will gain a significant attention since it will provide a valuable opportunity for researchers from different areas to investigate the idea of hybridization of their methods.

▶MS-We-D-29-1 13:30–14:00

Single Domain Hybrid Fourier Continuation Method and WENO Finite Difference Scheme for Conservation Laws

Li, Peng Beijing Inst. of Tech.
Gao, Zhen Ocean Univ. of China
Don, Wai Sun Ocean Univ. of China/Brown Univ.
Xie, Shusen Ocean Univ. of China

Abstract: We introduce a hybrid FC method and WENO finite difference scheme, together with the high order multi-resolution algorithm in solving hyperbolic conservation laws in a single domain framework , as opposed to a multi-domain framework. The Hybrid scheme conjugates an efficient shock-capturing WENO-Z nonlinear scheme in discontinuous stencils with an essentially non-dispersive and non-dissipative linear FC method in smooth stencils. Extensive examples regarding the efficiency and accuracy of the Hybrid scheme will be shown.

▶MS-We-D-29-2 14:00–14:30

Investigation of Hybrid Fourier-Continuation Method and WENO Finite Difference Scheme for Complicated Flow Structures

Li, Peng Beijing Inst. of Tech.
Gao, Zhen Ocean Univ. of China
Don, Wai Sun Ocean Univ. of China/Brown Univ.

Abstract: We investigate a hybrid Fourier-Continuation method and fifth order WENO finite difference scheme in the simulation of complex flows containing both discontinuous and complex small scale structures. The Hybrid scheme is used to keep the discontinuities captured by the WENO-Z scheme in an essentially non-oscillatory manner while the smooth parts are highly resolved by an linear, essentially non-dissipative and non-dispersive Fourier Continuation method which can also speedup the computation of the overall scheme.

▶MS-We-D-29-3 14:30–15:00

Hybrid WENO Finite Difference Scheme for the Ideal Magnetohydrodynamics Equations

Ha, Youngsoo Seoul National Univ.

Abstract: We study the hybrid high-order accurate WENO finite difference scheme for solving the idea MHD(Magnetohydrodynamics) equations. We focus on hybrid schemes of WENO schemes with high order up-wind linear schemes using different discontinuity indicators and explore the possibility in avoiding the local characteristic decompositions reducing the cost but still maintaining non-oscillatory properties for ideal MHD equations.

▶MS-We-D-29-4 15:00–15:30

An Adaptive Finite Volume Method for Steady Euler Equations with 2-exact WENO Reconstruction

Hu, Guanghui Univ. of Macau

Abstract: A finite volume method with k-exact solution reconstruction for 2D steady Euler equations is presented in this talk. To prevent the numerical oscillation around the shock, the WENO process is introduced in the solution reconstruction. To partially resolve the high requirement of the high order methods on the computational resources, the h-adaptive methods are developed. Numerical examples show the effectiveness of our methods, and the importance on handling curved boundary appropriately.

MS-We-D-30 13:30–15:30 VIP2-2

Numerical approaches in optimization with PDE constraints: recent progress and future challenges - Part I of VII

For Part 2, see MS-We-E-30
For Part 3, see MS-Th-BC-30
For Part 4, see MS-Th-D-30
For Part 5, see MS-Th-E-30
For Part 6, see MS-Fr-D-30
For Part 7, see MS-Fr-E-30

Organizer: Yan, Ningning Chinese Acad. of Sci.
Organizer: Hinze, Michael Universität Hamburg

Abstract: The numerical treatment of optimization problems with PDE constraints is a very active field of mathematical research with great importance for many practical applications. To achieve further progress in this field of research, the development of tailored discretization techniques, adaptive approaches, and model order reduction methods has to be intertwined with the design of structure exploiting optimization algorithms in function space.
This minisymposium covers mathematical research in PDE constrained optimization ranging from numerical analysis and adaptive concepts over algorithm design to the tailored treatment of optimization applications with PDE constraints. It thereby forms a platform and fair for the exchange of ideas among young researchers and leading experts in the field, and for fostering and extending international collaborations between research groups in the field.

▶MS-We-D-30-1 13:30–14:00

Immersed Finite Elements for Optimal Control Problems of Elliptic PDEs with Interfaces‍

Zhang, Zhiyue Nanjing Normal Univ.

Abstract: This paper presents a numerical method, based on the variational discretization concept, for optimal control problems governed by elliptic PDEs with interfaces. This method uses a simple uniform mesh which is independent of the interface. Because of discontinuous coefficients, which often represent different conductivities, densities, or permeability of distinct materials separated by the interface, the standard linear finite element method can not achieve optimal convergence when the uniform mesh is used. Therefore the immersed finite element method (IFEM) developed in Li et al. (Numer. Math. 96:61 – 98, 2003) is used to discretize the state equation required in the variational discretization approach. Optimal error estimates for the control, state and adjoint state are derived. The method is efficient and easy for implement, especially, for the problem with time-dependent moving interfaces or complex interfaces. Numerical examples are provided to confirm the theoretical results.‍

▶ MS-We-D-30-2 14:00–14:30

Optimal Control of Surface PDEs

Hinze, Michael — Universität Hamburg

Abstract: We consider optimal control of surface PDEs with special emphasis on tailored discretization of the underlying optimal control problem. We numerically analyze the errors stemming from the discretization of the surface and of the finite element discretization of the surface PDE. We present numerical examples which support our numerical findings.

▶ MS-We-D-30-3 14:30–15:00

Error Estimates and Superconvergence of Mixed Finite Element Methods for Bilinear Optimal Control Problems

Chen, Yanping — South China Normal Universtiy

Abstract: In this work, we investigate error estimates and superconvergence of the bilinear elliptic optimal control problems by Raviart-Thomas mixed finite element methods. The control variable enters the state equation as a coefficient. The state and the co-state variables are approximated by Raviart-Thomas mixed finite element spaces and the control variable is approximated by piecewise linear or constant functions. We obtain a prioti and a posteriori error estimates for the control variable and coupled state variable. Finally, we obtain the superconvergence property between average L^2 projection and the approximation of the control variable, the convergence order is h^2.

MS-We-D-31 13:30–15:30 405

Integration, Approximation and Discrepancy - Part I of III

For Part 2, see MS-We-E-31
For Part 3, see MS-Th-BC-31

Organizer: Ullrich, Mario — Johannes Kepler Univ.
Organizer: Gnewuch, Michael — Christian-Albrechts-Universität zu Kiel

Abstract: Numerical methods for high dimensional integration and approximation play a crucial role in a number of applications. This session brings together experts from the areas of integration, approximation, discrepancy theory, information-based complexity, potential theory, and partial differential equations (PDE) to discuss numerical methods for these types of problems. In this context, well distributed point sets are important. The generation of good point sets for various problems as well as bounds for their discrepancy and integration error will be covered in the minisymposium. Particular emphasis is given to the dependence of the results on the dimension. Approximation of functions is intimately related with the integration problem and the proposed minisymposium should stimulate the exchange between both communities.

▶ MS-We-D-31-1 13:30–14:00

Quasi-Monte Carlo Sampling for Non-uniform Measures

Aistleitner, Christoph — Univ. Linz

Abstract: Usually it is assumed that the QMC method for numerical integration is carried out with respect to the uniform measure on a multi-dimensional unit cube. In this talk we discuss problems concerning the transformation of an integral with respect to a general measure into an integral with respect to the uniform measure, particularly in the case of dependence between different coordinates, and we investigate the efficiency of sampling directly with respect to the non-uniform measure.

▶ MS-We-D-31-2 14:00–14:30

A Universal Cubature Formula for Functions with Mixed Smoothness

Ullrich, Mario — Johannes Kepler Univ.

Abstract: We prove upper bounds on the order of convergence of Frolov's cubature formula for numerical integration in function spaces of dominating mixed smoothness on the unit cube. More precisely, we study worst-case integration errors for Besov and Triebel-Lizorkin spaces, and our results treat the whole range of admissible parameters. In particular, we study the effect of small smoothness. (Joint work with Tino Ullrich, HCM Bonn)

▶ MS-We-D-31-3 14:30–15:00

Probabilistic Discrepancy Bounds for Latin Hypercube Samples

Gnewuch, Michael — Christian-Albrechts-Universität zu Kiel

Abstract: The best known upper bound for the minimal star discrepancy of a point set in the d-dimensional unit cube with explicit dependence on the dimension and on the number of points is based on a probabilistic discrepancy bound for random i.i.d. points that are uniformly distributed. We were able to improve the constant in this upper bound and to generalize the probabilistic discrepancy bound to certain sets of random points that include Latin hypercube samples.

▶ MS-We-D-31-4 15:00–15:30

Optimality of Taylor Algorithm for Solving IVPs with Presence of Noise

Morkisz, Pawel — AGH Univ. of Sci. & Tech., Krakow

Abstract: Initial value problems are widely studied in case of Hölder right-hand side function. Our aim is to generalize these results for problems when the information we may gain about the function is perturbed by some deterministic noise. It turns out that Taylor algorithm is optimal also in this case.

MS-We-D-32 13:30–15:30 307A

Structured-mesh methods for interface problems. - Part II of VIII

For Part 1, see MS-Tu-E-32
For Part 3, see MS-We-E-32
For Part 4, see MS-Th-BC-32
For Part 5, see MS-Th-D-32
For Part 6, see MS-Th-E-32
For Part 7, see MS-Fr-D-32
For Part 8, see MS-Fr-E-32

Organizer: Chen, Huanzhen — College of Mathematical Sci. Shandong Normal Univ.
Organizer: He, Xiaoming — Missouri Univ. of Sci. & Tech.
Organizer: KWAK, Do Young — Korea Advanced Inst. of Sci. & Tech.
Organizer: Zhang, Xu — Purdue Univ.

Abstract: In many real world applications it is more convenient or efficient to utilize structured meshes for solving different types of interface problems. Since the structured meshes may not fit the non-trivial interfaces, special methods need to be developed to deal with the difficulties arising from the interface problems in order to solve them on these meshes. Therefore, great efforts have been made for solving interface problems and tracing the moving interfaces based on structured meshes in the past decades. This mini-symposium intends to create a forum for researchers from different fields to discuss recent advances on the structured-mesh numerical methods for interface problems and their applications.

▶ MS-We-D-32-1 13:30–14:00

Thermodynamically Consistent and Meta-Stable Equation of State Models for Hydro and Solid Dynamics

Grove, John — Los Alamos National Laboratory

Abstract: Simulations of real engineering interest require the use of thermodynamic and constitutive models that go beyond simple analytic equations of state. In this talk we will discuss the complications that arise from using general equations of states for fluids and solids. Issues that need to be addressed include equilibrium and non-equilibrium treatments for mixed and separated species and robust treatments for incompatible mixtures such as metals in tension and gases.

▶ MS-We-D-32-2 14:00–14:30

A Flux Preserving Immersed Finite Element Method for Elliptic PDEs

Jeon, Youngmok — Ajou Univ.

Abstract: An immersed finite element method based on the flux continuity on intercell boundaries is introduced. To overcome non-symmetry of the stiffness system we introduce a modification based on the Riesz representation and a local postprocessing to recover local fluxes. This approach yields a P1 immersed nonconforming finite element method with a slightly different source term. An optimal rate of convergence in the energy norm is obtained and numerical examples are provided.

▶ MS-We-D-32-3 14:30–15:00

Multiscale Model of Blood Cell-Vessel Wall Interaction in Blood Flow

Xu, Zhiliang — Univ. of Notre Dame

Abstract: I will present a new 3D multiscale model to simulate receptor-mediated adhesion of deformable platelets at the site of vascular injury under different shear rates of blood flow. The model couples submodels at three biological scales crucial for the early clot formation: hybrid cell membrane submodel to represent physiological elastic properties of a platelet, stochastic receptor-ligand binding submodel to describe cell adhesion kinetics and blood flow submodel. A new FSI method is also introduced.

▶ MS-We-D-32-4 15:00–15:30

An Immersed Finite Volume Element Method for 2D-PDEs with Discontinuous Coefficients and Nonhomogeneous Jump Conditions

Zhang, Zhiyue — Nanjing Normal Univ.

Abstract: An immersed finite volume element method is developed to solve the 2D-elliptic interface problem with variable coefficients and nonhomogeneous jump conditions. Using the source removal technique, an equivalent elliptic interface problem with homogeneous jump conditions is obtained. The nodal basis functions are constructed to satisfy the homogeneous jump conditions near the interface and the usual finite element nodal basis functions are applied away from the interface.Numerical experiments demonstrate the convergence rates $O(h^2)$ in some norms.

MS-We-D-33 13:30–15:30 406

Mathematical Modelling, Analysis and Computation for Bose-Einstein condensation - Part I of III

For Part 2, see MS-We-E-33
For Part 3, see MS-Th-BC-33

Organizer: Wang, Hanquan Yunnan Univ. of Finance & Economics

Abstract: Recently, modeling and simulation of Bose-Einstein condensates (BEC) at zero temperature are one of most interesting research topics in physics as well as applied mathematics. At such low temperature, different kinds of BEC can be modeled by the famous Gross-Pitaevskii equation (GPE) or coupled GPEs or nonlocal GPE(s). How to analyze and solve the GPE(s) for understanding the physics of BEC is interested by mathematicians and physicists . In this minisymposium, we aim to discuss the mathematical properties of these nonlinear Schrodinger type models, find solutions to those models both analytically and numerically, do numerical analysis for efficient numerical methods, and show their applications into simulation of BEC and related physics. This minisymposium can be helpful to design efficient numerical methods for nonlinear Schrodinger type equation. It can be also helpful for applied mathematician to share their latest research work with physicists who are working on research of BEC and related physics.

▶MS-We-D-33-1 13:30–14:00

Gross-Pitaevskii Equations in Modeling Bose-Einstein Condensates and Their Numerical Computations

Hanquan, Wang Yunnan Univ. of Finance & Economics

Abstract: At zero temperature, BEC can be modelled by the famous Gross-Pitaevskii equation (GPE) or coupled GPEs or nonlocal GPE. In this talk, firstly, we first analyze the mathematical properties of those models and their applications. Secondly we propose efficient numerical methods for solving these GPEs. Finally we employ these efficient numerical methods and investigate both the ground state and dynamics of various kinds of BEC at zero temperature.

▶MS-We-D-33-2 14:00–14:30

Numerical Study of Quantized Vortex Dynamics and Interaction in Superfluidity and Superconductivity

Tang, Qinglin INRIA - Univ. of Lorraine

Abstract: The appearance of quantized vortices is regarded as the key signature of superfluidity and superconductivity, and their phenomenological properties have been well captured by the Ginzburg-Landau-Schrodinger (GLSE) equation and the Gross-Pitaevskii equation (GPE). In this talk, we will propose accurate and efficient numerical methods for simulating GLSE and GPE. Then we apply them to study various issues about the quantized vortex phenomena based on GLSE and GPE.

▶MS-We-D-33-3 14:30–15:00

Accurate and Efficient Computation of Some Nonlocal Potentials Based on Gaussian-sum Approximation

Zhang, Yong Wolfgang Pauli Inst.

Abstract: We introduce an accurate and efficient method for the evaluation of a class of free space nonlocal potentials, such as the free space Coulomb and Poisson potential in 2D/3D and dipolar potential in 2D/3D. Starting from the convolution formulation, for smooth and fast decaying densities, we make a full use of the Fourier pesudospectral (plane wave) approximation of the density and a separable Gaussian sums approximation of the kernel.

▶MS-We-D-33-4 15:00–15:30

Mathematical Models and Numerical Simulations for Solid-state Dewetting Problems

Jiang, Wei Wuhan Univ.

Abstract: The Solid-state dewetting problem of thin films is a hot research topic which is attracting increasing attention from a lot of scientists. In the talk, I will discuss several mathematical models which are used to simulate the solid-state dewetting problems, such as the phase field model and sharp-interface model.

MS-We-D-34 13:30–15:30 112

Mathematics and Algorithms in Quantum Chemistry - Part III of III

For Part 1, see MS-Tu-D-34
For Part 2, see MS-Tu-E-34

Organizer: Melgaard, Michael Univ. of Sussex
Organizer: Shao, Sihong Peking Univ.

Abstract: Ab initio models of electronic structures has had an immense impact in the physics and chemistry communities, as well as the materials science community, due to the capacity for carrying out realistic computations. The mathematical formulation and the efficient numerical simulation of such models is a notoriously difficult problem for several reasons, e.g., high dimensional configurations spaces, multi-particle interactions, multiple scales, nonlinear effects, and/or degeneracies of eigenspaces. Further developments in this area require the integration of physical modeling, mathematical analysis, and algorithm development in order to obtain reliable computational tools. The mini-symposium aims to bring together quantum chemists, applied and computational mathematicians, physicists and materials scientists all of whom are working in quantum chemistry to exchange ideas and to share their recent progress on the frontiers of theory and numerical methods as well as applications in material science. The mini-symposium will particularly focus on three topics: Time-dependent problems and excited states; Wave function methods; Relativistic effects.

▶MS-We-D-34-1 13:30–14:00

Critical Point Theory and Variational Methods with Applications to Electronic Structure Models Within Quantum Chemistry

Melgaard, Michael Univ. of Sussex

Abstract: We report on a series of rigorous results on the existence of ground states and excited states for various weakly coupled, semilinear nonlinear elliptic PDEs arising in electronic structure models of molecular systems in quantum chemistry.
For wave function methods, we give results for Hartree-Fock type models taking into account relativistic effects and magnetic fields by using the Lions-Fang-Ghoussoub critical point approach to multiple solutions on a noncompact Riemannian manifold.
Within Density Functional Theory (DFT), we give rigorous results on the open-shell, spin-polarized Kohn-Sham models for non-relativistic and quasi-relativistic N-electron Coulomb systems, that is, systems where the kinetic energy of the electrons is given by either the non-relativistic operator $-\Delta_{x_n}$ or the quasi-relativistic operator (nonlocal, pseudodifferential operator of order one) $\sqrt{-\alpha^{-2}\Delta_{x_n}+\alpha^{-4}}-\alpha^{-2}$; here α is Sommerfeld's fine structure constant. For standard and extended Kohn-Sham models in the local density approximation, we prove existence of a ground state (or minimizer) provided that the total charge $Z_{\rm tot}$ of K nuclei is greater than $N-1$. For the quasi-relativistic setting we also need that $Z_{\rm tot}$ is smaller than a critical charge $Z_{\rm c}=2\alpha^{-1}\pi^{-1}$.
This is joint work with C. Argaez (University of Iceland, Iceland), E. Chiumiento (IAM CONICET, Argentina) and M. Enstedt (Uppsala University, Sweden).

▶MS-We-D-34-2 14:00–14:30

Nonadiabatic Couplings Within Time-dependent Density Functional Theory

Li, Zhendong princeton Univ.

Abstract: Time-dependent density functional theory (TD-DFT) has emerged as a powerful tool for investigating electronic excitations of molecular systems. In this talk, I will show how the problem of calculating nonadiabatic couplings within TD-DFT is solved by extending the standard response theory to include nuclear derivatives.

▶MS-We-D-34-3 14:30–15:00

Electron Correlation in A Relativistic Framework

SAUE, Trond CNRS/Laboratoire de Chimie et Physique Quantiques

Abstract: The proper and efficient inclusion of electron correlation is a major challenge in molecular quantum chemistry. In 1958 Löwdin defined the correlation energy as the difference between the exact eigenvalue of the electronic Hamiltonian and the Hartree-Fock energy. In relativistic theory a severe complication arises since the electronic Hamiltonian has no bound solutions. In the present contribution we shall explore the proper definition of correlation energy in a relativistic framework.

▶MS-We-D-34-4 15:00–15:30

Relativistic Scales for Absolute Nuclear Magnetic Shielding Constant

Xiao, Yunlong College of Chemistry & Molecular Engineering, Peking Univ.

Abstract: The relativistic expression for nuclear magnetic shielding (NMS) constant and nuclear spin-rotation (NSR) constant are studied base on the relativistic body-fixed frame molecular Hamiltonian. Because of the closely connection of two properties (NMS and NSR constants), a relativistic scale for absolute nuclear magnetic shielding is proposed.

MS-We-D-35 13:30–15:30 408
Monte Carlo Methods for Solving Partial Differential Equations - Part I of III
For Part 2, see MS-We-E-35
For Part 3, see MS-Th-BC-35

Organizer: Mascagni, Michael Florida State Univ. CS Dept
Organizer: Cai, Wei Univ. of North Carolina at Charlotte

Abstract: Monte Carlo Methods (MCMs) have been used extensively in diverse computational applications in the sciences, engineering, and finance. This is due to their natural parallelism, data parsimony and locality, and their capability to tackle high dimension problems that are otherwise intractable. In this mini-symposium, we will present several talks that study the use of MCMs to solve partial differential equations (PDEs). These include using the Feynman-Kac formula to develop MCMs for PDEs, using polynomial chaos for solving stochastic PDEs, Monte Carlo linear solvers that arise from PDEs, algorithmic issues of the walk-on-sphere method, fault tolerance in multilevel MCMs, stability analysis of MCMs for mixed type PDEs, estimation of diffusion process sensitivities, as well as the application of MCMs in capacitance calculation of microchip ICs and multi-asset finance options.

▶ MS-We-D-35-1 13:30–14:00
Low Variance Estimation of Diffusion Process Sensitivities
Gobet, Emmanuel Ecole Polytechnique

Abstract: We design a Monte-Carlo method to compute efficiently the sensitivities of diffusion processes in a general framework with low variance estimates. Numerical experiments confirm the performance of the method, comparison tests with usual Malliavin calculus representations or Finite Difference based approaches are given. Joint work with Gang LIU (Ecole Polytechnique).

▶ MS-We-D-35-2 14:00–14:30
Monte Carlo Methods for Solving Direct and Inverse Stochastic Problems for Nonlinear Partial Integro-differential Equations.
Sabelfeld, Karl Inst. of computational mathematics & mathematical geophysics, Russian Acad. of Sci.

Abstract: In this presentation we deal with stochastic boundary value problems for nonlinear partial integro-differential equations.Our goal is to present recent Monte Carlo ideas, stochastic models and algorithms for solving different practically interesting problems: (1) simulation of annihilation of spatially separate electrons and holes in a disordered semiconductor, governed by nonlinear Smoluchowski equations with random initial distribution density, (2) recovering the particle nanosize distribution from diffusion battery measurements,(3) retrieving the step structure of the epitaxial.Comparative simulations.

▶ MS-We-D-35-3 14:30–15:00
Determining Optimal Multilevel Monte Carlo Parameters with Application to Fault Tolerance
Arbenz, Peter ETH Zurich

Abstract: In the multilevel Monte Carlo (MLMC) method numerous parameters have to be determined. Their choice is crucial for the work and error of the method. We propose to determine the number of samples per level, the finest and coarsest level by solving an integer optimization problem. Faults influence the MLMC levels to a different extent. We present a fault-tolerant MLMC method that adapts to experienced failures without a priori knowledge of the failure distribution.

▶ MS-We-D-35-4 15:00–15:30
Application Monte Carlo Method for Evaluation the Price of Multi-Asset Rainbow Options
Rasulov, Abdujabar Univ. of World Economy & Diplomacy

Abstract: In multidimensional case one of useful features Monte Carlo method allows the solution of boundary value problems to be found at just one point. This property be useful in problems of option pricing, where the value of an option is required only at the time of striking. In this work we consider European multi-asset options which described by the system of stochastic differential equations and construct Monte Carlo algorithms for the solution.

MS-We-D-36 13:30–15:30 409
Mori-Zwanzig formulation and applications - Part II of II
For Part 1, see MS-Tu-E-36

Organizer: Stinis, Panos Pacific Northwest National Laboratory
Organizer: E, Weinan Peking Univ. & Princeton Univ.

Abstract: The Mori-Zwanzig formalism allows reducing the number of variables in large systems of coupled equations. For differential equations, the reduced equations model the effect of the unresolved variables, leading to a Markovian, memory and fluctuating terms. This formalism can be a starting point for multiscale and meso-scale modeling, based on first principles calculations. We will investigate recent mathematical developments as well as applications to materials, fluid mechanics, soft matter, biology and uncertainty quantification.

▶ MS-We-D-36-1 13:30–14:00
Coarsening of Particle Systems
Levermore, C. David Univ. of Maryland

Abstract: We present a framework for constructing the dynamics for a coarsened system of simulated particles. We build an approximate solution to the Liouville equation for the original system from the solution of an equation for the phase-space density of the coarsened system. We do this with a Markov approximation in a Mori-Zwanzig formalism based on a reference density. We then identify the evolution equation for the reduced phase-space density as the forward Kolmogorov equation.

▶ MS-We-D-36-2 14:00–14:30
An Application of the Mori-Zwanzig Formulation to the Stochastic Burgers Equation
Venturi, Daniele Brown Univ.

Abstract: By using the Mori-Zwanzig formulation, we derive exact reduced-order equations for the one- and two-point probability density function of the solution to the stochastic Burgers equation. We study random flows generated by random initial conditions and random additive noise, yielding multiple interacting shock waves at random space-time locations. The new equations are solved numerically by using discontinuous Galerkin methods.

▶ MS-We-D-36-3 14:30–15:00
Quasi-Harmonic Approximation of Mori-Zwanzig Model
Lin, Guang Purdue Univ.
Wu, Lei Peiking Univ.
Li, Xiantao The Pennsylvania State Univ.
E, Weinan Peking Univ. & Princeton Univ.

Abstract: This work has been motivated by the observation that the harmonic approximation becomes inadequate when the coarse-grain variables undergo large changes. We simplify the Mori-Zwanzig model by a quasi-harmonic approximation. The result of our derivation is a generalized Langevin equation with a memory function that also depends on the history of the coarse-grained variables. The procedure reduced the random noise and the memory term, typically given by abstract expression, to more explicit forms.

▶ MS-We-D-36-4 15:00–15:30
Mori Zwanzig Atomistic to Continuum Coupling
Aristoff, David Colorado State Univ.

Abstract: We discuss possible approaches to using the Mori Zwanzig approach within an atomistic-to-continuum framework.

MS-We-D-37 13:30–15:30 301B
Control and analysis of multi-agent systems
Organizer: Hu, Jiangping Univ. of Electronic Sci. & Tech. of China

Abstract: Multi-agent systems are integrations of information and control systems with physical processes and interacting with the environment, and have attracted a great deal of attention in the control community. In the past decade, extensive studies have been conducted for the so-called complex systems, multi-agent systems, networked systems, etc. The minisymposium aims to present some recent developments in control and analysis of multi-agent systems, including 1) modeling and analysis of collective dynamics on coopetition networks; 2) distributed average tracking control of multi-agent systems; 3) event-triggered control and connectivity preservation; 4) high order consensus control.

▶ MS-We-D-37-1 13:30–14:00
Bipartite Consensus over Coopetition Networks
Hu, Jiangping Univ. of Electronic Sci. & Tech. of China

Abstract: Cooperation and competition are two typical interactional relationships in natural and engineering networked systems, which are called coopetition networks. Some interesting collective behaviors can emerge through local interactions over such networks with various kinds of structural balance conditions. In this talk, we will give an overview of our recent results on the relationship between collective dynamics and the structural balance and some bipartite control strategies as well.

▶ MS-We-D-37-2 14:00–14:30
Distributed Average Tracking in Multi-agent Systems
Chen, Fei Xiamen Univ.

Abstract: In a broad spectrum of applications for multi-agent systems, group-

s of agents are required to track the average of multiple time-varying reference signals in a distributed way, the so-called distributed average tracking (DAT) problem. In this talk, we will give an overview of our recent research progress on DAT of multi-agent systems. Theoretical results on DAT for general reference signals and DAT for agents with second-order dynamics and Euler-Lagrange dynamics will be presented.

▶ MS-We-D-37-3 14:30–15:00

Event-triggered Connectivity Control of Multi-agent Systems

Fan, Yuan — Anhui Univ.

Abstract: In this work we consider the rendezvous problem of multi-agent systems with event-triggered control schemes. Each agent has only a limited communication range and connectivity-preserving rendezvous controllers with bounded inputs have been developed. It is showed that with some very mild assumptions, existing communication links will be preserved and the group rendezvous can be achieved under the proposed controllers.

▶ MS-We-D-37-4 15:00–15:30

Consensus Control of Multi-Agent Systems with Switching Directed Topologies

Wen, Guanghui — Southeast Univ.

Abstract: Recently, consensus control of multi-agent systems has received much attention from various scientific research communities ranging from applied mathematics to control theory. To guarantee consensus in a network, individuals need to share information with their neighbors. However, the underlying communication topology may be time-varying, due to limitations of sonar radius, link failures and so forth. In this talk, consensus control for higher-order multi-agent systems with switching directed topologies will be discussed.

MS-We-D-38 13:30–15:30 302A

Analysis and design of hybrid dynamical systems

Organizer: Sun, Zhendong — AMSS, Chinese Acad. of Sci.

Abstract: Hybrid systems are dynamical systems with continuous dynamics, discrete (logic) dynamics. and their interactions. The hybrid/switching nature makes the analysis and control of the systems theoretically challenging and technically important in real-world applications. The minisymposium aim to present the state-of-the-art progress in analysis and control of several classes of hybrid systems, including 1) the design of cyber-physical systems and in particular multi-robot cooperative tasking; 2) stability analysis of matrix-valued Markovian chains; 3) dissipativity-based analysis of switched nonlinear systems; 4) performance analysis of multi-linear dynamical systems.

▶ MS-We-D-38-1 13:30–14:00

Spectral Abscissas of Sets of Matrices: Definition, Estimation, and Applications

Sun, Zhendong — AMSS, Chinese Acad. of Sci.

Abstract: For a set of real square matrices, we introduce the concept of spectral abscissa, which is an indirect extension of the spectral abscissa of a matrix. We prove that the abscissa is exactly the least common (induced matrix) measure of the matrix set under all possible vector norms. As an application, we discuss the connection between the spectral abscissa and the worst-case performance of a wide class dynamical systems with piecewise linear structures.

▶ MS-We-D-38-2 14:00–14:30

Formal Design of Distributed Cooperative Systems

Lin, Hai — Univ. of Notre Dame

Abstract: A common challenge in our future engineered system design, such as power grids, intelligent transportation networks and flexible-manufacturing systems, is how to make a large number of distributed systems work together in a reliable and efficient manner. Existing methods are either only suitable for small scale systematic synthesis, oversimplifying the nodal dynamics, or fail to adapt to changing environments. This motivates our research aiming at a scalable, correct-by-construction formal design methodology for distributed cooperative systems.

▶ MS-We-D-38-3 14:30–15:00

Exponential Stability of Time-nonhomogeneous Matrix-valued Markov Chains

Dai, Xiongping — Nanjing Univ.

Abstract: We characterize the uniform exponential stability of a matrix-valued Markov chain via its non-ignorable periodic data.

▶ MS-We-D-38-4 15:00–15:30

Dissipativity of Switched Systems Using Multiple Storage Functions

Zhao, Jun — Northeastern Univ.

Abstract: This talk will present a framework of dissipativity theory for switched systems using multiple storage functions and multiple supply rates. Stability is reached using the dissipativity property. Two special forms of dissipativity, passivity and L2 -gain, are addressed. This dissipativity theory for switched systems is an extension of the standard dissipativity theory for non-switched systems.

MS-We-D-39 13:30–15:30 302B

Optimization techniques in target tracking and multi-sensor information fusion

Organizer: Shen, Xiaojing — Sichuan Univ.

Abstract: Target tracking and multi-sensor information fusion have benefited from a surge of research in recent years, due in part to intense research in optimization theory and the connections made between the three fields. In this minisymposium, we present some progress in target tracking and multi-sensor information fusion including 1) minimized Euclidean error data association and tracking; 2) target tracking with constrained target motion; 3) robust optimization techniques in hypothesis testing problems; 4) decentralized detection/estimation fusion in multi-sensor networks. The new algorithms developed in this talk lead to improvement over standard approaches in target tracking and sensor network applications.

▶ MS-We-D-39-1 13:30–14:00

Minimized Euclidean Error Data Association for Multi-Target and Multisensor Uncertain Dynamic Systems

Shen, Xiaojing — Sichuan Univ.

Abstract: In this talk, mutltiple target tracking and data association problems are considered. In dynamic systems with biases, removing model biases requires enough well-associated measurements in advance. However, to obtain a good data association, one has to well estimate and remove the model biases. Such data association and tracking problems cannot be solved well by the existing methods. We present minimized Euclidean error data association (MEEDA) algorithms for single sensor and multi-sensor systems respectively.

▶ MS-We-D-39-2 14:00–14:30

Constrained Target Motion Analysis, Modeling and Tracking

Duan, Zhansheng — Xi'an Jiaotong Univ.

Abstract: Unconstrained target motion, e.g., air target, has been extensively studied. However, the motion of many targets are constrained by some tracks, e.g., ground target motion on road network. Comparatively, the study of constrained target motion is very scarce. In this talk, we will introduce our most recent work on the analysis of the difference between constrained target motion and unconstrained one, how to model constrained target motion and the tracking algorithms for constrained motion targets.

▶ MS-We-D-39-3 14:30–15:00

Robust Hypothesis Testing without A Symmetry Assumption of Nominal Densities under A Relative Entropy Tolerance

Song, Enbin — Sichuan Univ.

Abstract: We considers the open problem about a binary minimax test，where the nominal likelihood ratio is a monotone nondecreasing function and the actual probability densities of the observations are located in neighborhoods characterized by placing a bound on the relative entropy between actual and nominal densities. Without the restrictive symmetry assumption on two nominal conditional probability densities under the two hypotheses, the robust hypothesis testing problem is reduced to solving a nonlinear system involving two

▶ MS-We-D-39-4 15:00–15:30

Majorization Minimization Technqiues for Sparse Signal Recovery

Fang, Jun — Univ. of Electronic Sci. & Tech. of China

Abstract: In this talk, we study the problem of recovering a high-dimensional sparse signal from low-dimensional measurements. This problem has found many applications in array signal processing, MRI imaging, data mining, etc. The sparse signal recovery problem can be cast into an optimization problem which minimizes a certain sparsity-promoting functional subject to a data-fitting constraint. Some effective sparsity-promoting functions are discontinuous and non-convex. We will show how to use majorization-minimization techniques to solve these problems.

MS-We-D-40 13:30–15:30 303A

Analysis and Synthesis with Incomplete Information and Its Applications

Organizer: Shen, Bo — Donghua Univ.

Abstract: Recently, new challenging issues have emerged in the networked environment that may affect the performance of the whole systems, for example, network-induced time delay, data missing and quantization effect, etc.. These phenomena have made it difficult to analyze and synthesize functional information from real-world networked systems under the framework of traditional control theory. Therefore, to meet the application requirements, new analysis/synthesis paradigms are needed which must necessarily depart from classical analysis/control strategies. The minisymposium aims to bring together the latest approaches to understanding, estimating and controlling systems with incomplete information and present their applications in fault diagnosis and sensor networks.

▶ MS-We-D-40-1 13:30–14:00

Fault Estimation with Incomplete Information: Krein-Space Approaches

Shen, Bo — Donghua Univ.

Abstract: Fault estimation of time-varying systems serves as an important research topic owing to its significance for engineering reliability. In this presentation, some recent results are introduced. The system under consideration is subject to delayed measurements, missing measurements, uncertainties, and so on. For the time-varying nature, the Krein space approach is used to solve the fault estimation problems. Moreover, a fault detection scheme with an integrated online performance evaluation is proposed.

▶ MS-We-D-40-2 14:00–14:30

Probability-Dependent Gain-Scheduled Control and Filtering for Systems with Randomly Occurring Incomplete Information;

Wei, Guoliang — Universyty of Shanghai for Sci. & Tech.

Abstract: This talk presents an overview of the recent developments on the gain-scheduled control and filtering problems for the parameter-varying systems. First of all, we recall several important algorithms suitable for gain-scheduling method. Secondly, various important system models are reviewed. In particular, our recent work based on the probability-dependent gain-scheduling methods are reviewed. Furthermore, some latest progress in this area is discussed. Finally, conclusions are drawn and several potential future research directions are outlined.

▶ MS-We-D-40-3 14:30–15:00

Distributed Filtering for Sensor Networks–A Brief Introduction

Dong, Hongli — Northeast Petroleum Univ.

Abstract: The past few decades have witnessed constant research interests on various aspects of sensor networks. In particular, the distributed filtering or estimation for sensor networks has been an ongoing research issue that attracts increasing attention from researchers in the area. In this minisymposium, we will give a brief introduction about sensor networks, and then report our recent work on distributed filtering over sensor networks.

▶ MS-We-D-40-4 15:00–15:30

Recursive Approach to Filtering with Network-Induced Phenomena

Jun, Hu — Harbin Univ. of Sci. & Tech.

Abstract: In this talk, we will deal with the recursive filtering problems for time-varying nonlinear stochastic systems with network-induced phenomena. The network-induced phenomena under consideration mainly include missing measurements, fading measurements, signal quantization, probabilistic sensor delays, and sensor saturations. With respect to these network-induced phenomena, the recursive filters are designed for time-varying nonlinear s-tochastic systems. Both the theoretical research and engineering applications will be discussed, and a series of recently published results will be reported.

MS-We-D-41 13:30–15:30 303B

Systematic Rationalization of Industrial Alarm Systems

Organizer: Wang, Jiandong — Peking Univ.

Abstract: Alarm systems play a vital role for safe operation and high efficiency of modern large-scale industrial systems. This Minisymposium provides an overview of new quantitative methods for analysis and design of industrial alarm systems as an emerging research area. The Minisymposium targets academic researchers and industrial practitioners involved in alarm management. Four topics will be presented, namely, (1) Introduction to Industrial Alarm Systems, (2) Representation, Analysis and Visualization of Alarm Data, (3) Optimal Alarm Design for Univariate and Multivariate Alarm Systems, and (4) Root Cause Analysis and Alarm Flood Management. Industrial case studies will be provided to illustrate the effectiveness of developed techniques for advanced alarm systems.

▶ MS-We-D-41-1 13:30–14:00

Optimal Alarm Design

Wang, Jiandong — Peking Univ.

Abstract: Introduction to process data; Alarm design trade-offs: how to minimize false and missed alarms; ROC curves; Filtering, deadbands, delay-timers; Optimal design framework; Dealing with the tradeoff between latency (delays) and accuracy. Alarm processing and trip point design in a univariate framework with examples. Advantages of alarm design in a multivariate framework in terms of fewer false and missed alarms. Industrials case studies to illustrate alarm design procedures for univariate and multivariate processes.

▶ MS-We-D-41-2 14:00–14:30

Alarm Data: Representation, Analysis and Visualization

Chen, Tongwen — Univ. of Alberta

Abstract: Introduction to alarm data; Graphical representation; High density alarm plots; Alarm correlation color map; Parallel coordinate plots; Run-length distributions; Merged plots of process and alarm data. Detection of chattering and oscillating alarms.

▶ MS-We-D-41-3 14:30–15:00

Quantitative Analysis and Design of Alarm Systems

Shah, Sirish L. — Univ. of Alberta

Abstract: Alarm systems and process monitoring; Historical incidents; False and nuisance alarms; Alarm standards; Alarm systems life cycle; Alarm rationalization; Current status of alarm systems; How to deal with information resources (alarm data, process data, connectivity information).

▶ MS-We-D-41-4 15:00–15:30

Connectivity Information: Root Cause Analysis and Alarm Flood Management

Yang, Fan — Tsinghua Univ.

Abstract: Introduction to process connectivity information; Representation of connectivity information; Signed directed graphs; Ontological models, Process modeling and alarm design; Root cause determination of process faults using causality analysis; Root cause determination of plant-wide oscillations; Introduction to alarm floods; Analysis of alarm flood patterns.
Industrial case studies to illustrate root cause analysis and of alarm flood pattern analysis.

MS-We-D-42 13:30–15:30 301A

Cooperative Control and Multi-Agent Systems IV

Organizer: TCCT — Technical Committee on Control Theory, CAA

Abstract: Recent advances in sensing, communication and computation technologies have enabled a group of agents, such as robots, to communicate or sense their relative information and to perform tasks in a collaborative fashion. The past few years witnessed rapidly-growing research in cooperative control technology. Multi-agent system (MAS) is a computerized system composed of multiple interacting intelligent agents within an environment. Multi-agent systems can be used to solve problems that are difficult or impossible for an individual agent or a monolithic system to solve. The aim of this minisymposium is to share novel approaches and innovative applications of cooperative control and MAS, including：1) asynchronous time and event hybrid-driven consensus; 2) event-based consensus; 3) event-triggered consensus; 4) multiple UAVs coordinated control.

▶ MS-We-D-42-1 13:30–14:00

Asynchronous Time and Event Hybrid-Driven Consensus in Multi-Agent Systems

Xiao, Feng — Harbin Inst. of Tech.

Abstract: Several consensus protocols for asynchronous multi-agent systems are presented in the framework of time and event hybrid-driven control. In these protocols, event-triggering conditions could be checked periodically or aperiodically. We study their effectiveness in solving consensus problems and show their robustness against time delays.

▶ MS-We-D-42-2 14:00–14:30

Event-based Consensus of Multi-agent Systems with General Linear Models

ZHU, WEI — Chongqing Univ. of Posts & Telecommunications

Abstract: In this talk, our recent progress on event-based consensus of multi-agent systems with/without time-delays will be discussed. For each agent, the controller updates are event-based and only triggered at its own event time. It is shown that the continuous communication betweent neighboring agents can be avoided and the Zeno-behavior of triggering time sequence is excluded.

▶ MS-We-D-42-3 14:30–15:00

Event-Triggered Consensus for General Linear Multi-Agent System

Lu, Pingli — Beijing Inst. of Tech.
Yang, Dapeng — Beijing Inst. of Tech.
Liu, Xiangdong — Beijing Inst. of Tech.

Abstract: We study the event-triggered consensus problem for multi-agent systems with general linear dynamics under a general directed graph. We propose a decentralized event-triggered consensus controller (ETCC) for each agent to achieve consensus, without requiring continuous communication among agents. We prove that under the proposed ETCC there is no Zeno behavior exhibited. To relax the requirement of continuous monitoring of each agent' s own state, we further propose a self-triggered consensus controller (STCC).

▶ MS-We-D-42-4 15:00–15:30

Swarm Intelligence Approach to Multiple UAVs Coordinated Control

Duan, Haibin Beihang Univ. (BUAA)

Abstract: Swarm intelligence is the attempts to design algorithms or distributed problem-solving devices inspired by the collective behavior of social insect colonies and other animal societies. Multiple unmanned aerial vehicles (UAVs) can accomplish various types of complicated missions. In this talk, our new progresses in swarm intelligence will be introduced. Meanwhile, our recent researches on swarm intelligence based coordinated control for UAVs will also be discussed. Furthermore, the challenging areas in this field will be presented

MS-We-D-43 13:30–15:30 VIP4-1

SPDEs/SDEs, Queues, and Optimization with Applications

Organizer: Dai, Wanyang Nanjing Univ.

Abstract: We will address the theory, numerical methods, and applications of stochastic partial differential equations (SPDEs), queueing systems, and optimizations. The SPDEs cover both forward and backward forms with possible reflection over boundaries and include their degenerate form of stochastic differential equations (SDEs). The queueing systems are broadly viewed ones including those widely appeared in communication networks, quantum mechanics, cloud computing, service and management systems, etc. The optimizations mainly cover stochastic processes based optimizations and optimal controls/differential games. In particular, we will address the interactions among these SPDEs/SDEs, queueing systems, and optimization methods, for examples, to establish performance models, or to design dynamical control policies/algorithms and prove their optimality through diffusion approximations and asymptotic optimization/optimal control regimes.

▶ MS-We-D-43-1 13:30–14:00

A Unified B-SPDE with Levy Jumps: Well-Posedness, Algorithm with Numerics, and Applications

Dai, Wanyang Nanjing Univ.

Abstract: We study the well-posedness of adapted strong solution and design an algorithm with numerics for a unified backward stochastic partial differential equation (B-SPDE) with Levy jumps. We also study the applications of our unified B-SPDE in several areas: optimal control and stochastic differential game problems with general number of players, jumps, and possible skew reflections; reflecting diffusion processes associated with queueing networks for cloud computing, service, and communication systems; statistical physics and quantum mechanics.

▶ MS-We-D-43-2 14:00–14:30

Fractional Time Stochastic Partial Differential Equations

Chen, Zhen-Qing Univ. of Washington

Abstract: In this talk, we introduce a class of stochastic partial differential equations (SPDEs) with fractional time-derivatives, and study the L_2-theory of the equations. This class of SPDEs can be used to describe random effects on transport of particles in medium with thermal memory or particles subject to sticking and trapping. Based on joint work with K.-H. Kim and P. Kim.

▶ MS-We-D-43-3 14:30–15:00

Stationarity and Interchange of Limits in Heavy Traffic Analysis

Ye, Hengqing Hong Kong Polytechnic Univ.

Abstract: We develop a streamlined and systematic approach to validate the diffusion limit as an approximation to the stationary performance of stochastic processing networks. We first demonstrate that the stability of a deterministic dynamic complementarity problem is sufficient for both the diffusion limit and pre-limit networks to have stationary distributions, and given an additional and mild condition, also justifies the so-called interchange of limits. (Joint work with David D. Yao of Columbia University)

▶ MS-We-D-43-4 15:00–15:30

Hydrodynamic Limits of Large-scale Stochastic Systems

Ramanan, Kavita Brown Univ.

Abstract: We establish mean-field limits for a class of large-scale stochastic networks with load balancing in the presence of general service distributions. We introduce a state representation in terms of interacting measure-valued processes, derive a propagation of chaos result, and obtain PDE approximations to the dynamics that shed insight on the performance of these networks. We also discuss how our mathematical framework can also be used to study models of grain growth arising in materials

MS-We-D-44 13:30–15:30 VIP2-1

Mathematics of Information and Low Dimensional Models - Part II of III

For Part 1, see MS-Tu-E-44

For Part 3, see MS-We-E-44

Organizer: Blanchard, Jeffrey Grinnell College

Abstract: This min-symposium considers a variety of ill-posed inverse problems associated with information theory, signal processing, and image processing. By exploiting low dimensional structure, such as in compressed sensing and low rank matrix completion, tractable algorithms permit construction of accurate approximate solutions and low dimensional representations. The mini-symposium will include state-of-the-art work on algorithms, theoretical analysis, and relationships with high dimensional geometry from researchers at all stages of their careers.
Notes to ICIAM Committee: - Jared Tanner (Oxford) is a co-organizer of this symposium but does not have a pin. - This symposium is sponsored by the SIAM SIAG on Linear Algebra.

▶ MS-We-D-44-1 13:30–14:00

Multiscale Geometric Methods for Statistical Learning and Data in High-Dimensions

Maggioni, Mauro Duke Univ.
Liao, Wenjing Duke Univ. & SAMSI

Abstract: We discuss a family of algorithms for analyzing various new and classical problems in the analysis of high-dimensional data sets. These methods rely on the idea of performing suitable multiscale geometric decompositions of the data, and exploiting such a decomposition to perform a variety of tasks in signal processing and statistical learning. In particular, we discuss the problem of dictionary learning, in Euclidean and metric spaces, and their applications in statistical signal processing.

▶ MS-We-D-44-2 14:00–14:30

Low-dimensional Quantized Representations of Signals and Their Distances.

Boufounos, Petros Mitsubishi Electric Research Laboratories

Abstract: Recently developed low-dimensional quantized representations, such as universal embeddings have proven very powerful in coding signals for cloud computing and big-data applications. This talk explores how such representations provide rate-efficient, low-latency, and low-complexity transmission for inference over communication channels. Such embeddings can also be used in coding signals when side information about the signal is available at the receiver, thus enabling low-complexity, efficient compression methods. We demonstrate results in image compression and retrieval applications.

▶ MS-We-D-44-3 14:30–15:00

Does ℓ_p-minimization Outperform ℓ_1-minimization?

Maleki, Arian Columbia Univ.

Abstract: In many application areas ranging from bioinformatics to imaging we are faced with the following question: Can we recover a sparse vector $x_o \in \mathbb{R}^N$ from its undersampled set of noisy observations $y \in \mathbb{R}^n$, $y = Ax_o + w$. This talk presents an accurate analysis of a class of recovery algorithms known as ℓ_p-regularized least squares for different values of $0 \leq p \leq 1$, under the asymptotic settings.

▶ MS-We-D-44-4 15:00–15:30

Metric Learning with Rank and Sparsity Constraints

Bah, Bubacarr Univ. of Texas at Austin

Abstract: Choosing a distance preserving metric is fundamental to many signal processing algorithms, such as k-means, nearest neighbor searches, compressive sensing, etc. In virtually all these applications, the efficiency of the signal processing algorithm depends on how fast we can evaluate the learned metric. Moreover, storing the chosen metric can create space bottlenecks in high dimensional signal processing problems. As a result, we consider data dependent metric learning with rank as well as sparsity constraints. We propose a new fast non-convex algorithm and empirically demonstrate its performance on various datasets.

MS-We-D-45 13:30–15:30 213A

Complex Networked Systems: modelling and dynamics

Organizer: Lu, Wenlian Fudan Univ.

Abstract: The theory of complex networked systems provided a powerful tool to model and analyze complex systems in science, engineering, biology, etc., since a mathematical term 'graph' is used to describe the interactions between individuals in complex systems. The last few decades have witness the great growth of research in this field, which afterwards enriches our understandings on the complexity of system. However, there is still a gap between the theoretical methods and results in complex networked system and applications in real-world complex systems in terms of terminology and communi-

cation.
The aim of this mini-symposium is to bring researchers from the mathematical sciences together with scientists from engineering, biology, and computer science, to study problems arising from modelling and analysis of complex dynamical systems on networks using mathematical methods. The scope of this mini-symposium are twofold: The theoretical part includes but not be limited by the following: modelling of complex systems by networks, dynamics of complex networked systems; delays in complex networks; the application part includes but not be limited by the following: cybernsecurity on networks; intelligent computation on networks; biological networks. The specific issues that will be discussed in detail at the minisymposium are: whether and how the emerging important problems arising in real-world complex systems can be answered by the present results in network science; whether and how these questions lead to new issues and orients in network science. In view of the broad range of backgrounds of the audience, we are specifically inviting speakers who will present the state-of-art of the scope of complex networked dynamical systems, and furthermore aim to bridge the gaps between the different scientific communities represented at the conference.

▶MS-We-D-45-1 13:30–14:00
Complexity and Network Sciences Supporting the Emerging Science of Cyber Security: Challenges and Exciting Research Opportunities
Xu, Shouhuai Univ. of Texas at San Antonio

Abstract: We see the dawn of Science of Cyber Security, which is the holy-grail challenge that computer/information/network/cyber security researchers have confronted with. In this talk, I will present the novel framework of Cybersecurity Dynamics, which is a promising candidate to serve as the foundation for Science of Cyber Security. I will discuss a unique set of inherent technical barriers, which I hope will serve as a call to action to the Complexity and Network Sciences communities.

▶MS-We-D-45-2 14:00–14:30
Utilization of Data in Complex Networked Systems by Data Assimilation
Lu, Wenlian Fudan Univ.

Abstract: How to utilize "big" data in modelling complex systems by complex networks is a challenge in both network science and data science. Data assimilation may be a promising method to solve this problem due to the occurrence of "big data" and powerful computers. In this talk, I will introduce the basic ideas and techniques of data assimilation. By the neuronal network example, I discuss the prospective of application of data assimilation in complex networks.

▶MS-We-D-45-3 14:30–15:00
Generalized Halanay Inequalities with Applications to Dynamical Networks with Time Delays
Liu, Bo Xidian Univ.

Abstract: In this report, we will provide a series of generalization of the classical Halanay inequality under more general conditions,we will also demonstrate how these generalizations can be used to the analysis of dynamical behaviors of networks with time delays.

▶MS-We-D-45-4 15:00–15:30
Time Delays and Spatio-temporal Patterns on Networks
Atay, Fatihcan M. Max Planck Inst. for Mathematics in the Sci.

Abstract: We will study dynamical patterns on networks arising from coupling delays. The motivation comes from recent interest in chimera states, which were originally observed in ring configurations under symmetric coupling conditions. We shall present a systematic method for searching for nontrivial patterns in networks based on symmetry analysis and bifurcation theory. We will give several examples of novel dynamics and their stability analysis. Particular emphasis will be devoted to patterns combining synchrony and stationary states.

MS-We-D-46 13:30–15:30 306B
Inverse Problems for Image Reconstruction and Processing - Part I of IV
For Part 2, see MS-We-E-46
For Part 3, see MS-Th-BC-46
For Part 4, see MS-Th-D-46
Organizer: Wei, Suhua Inst. of Applied Physics & Computational Mathematics
Organizer: Nikolova, Mila CMLA, CNRS - ENS Cachan
Organizer: Tai, Xue-Cheng Department of Mathematics, Univ. of Bergen
Organizer: Shi, Yuying North China Electric Power Univ.
Abstract: Many image reconstruction tasks amount to solve ill-posed inverse problems. Indeed, measurement devices typically cannot record all the information needed to recover the sought-after object; furthermore, the operators that model these devices are seldom accurate and data are corrupted by various perturbations. A common approach to find an approximate to the unknown object is regularization. The key points are the correct choices of the data fidelity term and the regularization term, as well as the trade-off between these terms. This is a challenging problem since the optimal solutions of the whole functional should correctly reflect the knowledge on the data-production process and the priors on the unknown object. The optimal solutions usually cannot be computed explicitly and iterative schemes are used. This symposium focus on imaging inverse problems' mathematical models, numerical algorithms, theoretical analysis and various applications, especially, applied to CT reconstruction and some processing techniques for images.

▶MS-We-D-46-1 13:30–14:00
Combining Models is An Open Problem
Nikolova, Mila CMLA, CNRS - ENS Cachan

Abstract: Many imaging tasks amount to solve inverse problems. They are typically solved by minimizing an objective that accounts for the models of the recording device and the sought-after image. The common approach is to take a weighted combination: however it appears that the solution deviates from both models. Our talk focuses on the ways how these models can be used jointly so that all available information is used more efficiently.

▶MS-We-D-46-2 14:00–14:30
A Fast Combined Algorithm for Blind Image Restoration
Shi, Yuying North China Electric Power Univ.

Abstract: The blind image restoration problem is not an easy problem to solve for its complexity and difficulty. In this paper, we propose a new algorithm to simultaneously recover the blurring kernel and the original image, which combines split Bregman technique, fast Fourier transform and spectral decomposition technology to accelerate the computation of blind image restoration problem. Numerical results demonstrate that the proposed algorithm is is efficient and robust.

▶MS-We-D-46-3 14:30–15:00
Total Variation Regularisation as A Discrete Gradient Flow
Schönlieb, Carola-Bibiane Univ. of Cambridge

Abstract: In this talk we discuss the application of discrete gradient approaches for the solution of total variation regularised problems. We will show that the discrete gradient approach offers guaranteed energy decrease in every step, and could be particularily interesting for large-scale data as its computation may reduce to the solution of a sequence of 1D problems. This is joint work with Volker Grimm, Robert MacLachlan, David McLaren, and Reinout Quispel.

▶MS-We-D-46-4 15:00–15:30
Preconditioned Alternating Direction Method of Multipliers for Non-Smooth Regularized Problem
SUN, HONGPENG Short Term Visiting Scholar of IAPCM

Abstract: ADMM is a popular first order method. However, it suffers from solving linear subproblems in various applications. We give a preconditioned ADMM method by writing ADMM as a new kind of proximal point method, and prove the weak convergence in infinite dimensional space. Various efficient preconditioners could be used in preconditioned ADMM and any finite preconditioned iterations could guarantee the convergence of the solutions. This talk is based on joint work with Prof. Kristian Bredies.

MS-We-D-47 13:30–15:30 108
Recent progress in modeling and simulation of multiphase thin-film type problems
Organizer: Peschka, Dirk Weierstrass Inst.
Organizer: Wang, Li Univ. of California Los Angeles (UCLA)
Abstract: Thin-film type equations have important applications, e.g. in coating flows, food processing, solar cells. Recently research has focussed on the inclusion of more challenging physics of multiphase systems. This minisymposium features corresponding research including additional surfactant transport, suspension flows, flows over liquid substrates. Another major issue is the thermodynamically consistent statement of such models. Problems are presented from an applied perspective and their modeling, numerics and analysis are discussed. Identifying common mathematical problems inherent to systems of thin-film type problems and successful solution strategies will support industrial applications and the fundamental understanding of such problems.

▶MS-We-D-47-1 13:30–14:00
Droplets on Liquids and Their Long Way into Equilibrium

Peschka, Dirk — Weierstrass Inst.

Abstract: Dewetting from a liquid substrate is in many respects very similar to dewetting from a solid substrate, except that it has a much richer structure. We present an in-depth comparison of dewetting morphologies (droplets, rims, ⋯) measured by atomic force microscopy in recent experiments with the corresponding predictions from solving thin-film models. Furthermore, we present a framework how to numerically treat contact-line motion with a sharp triple-junction and naturally impose all boundary conditions.

▶ MS-We-D-47-2 — 14:00–14:30

Coupled Molecular Dynamics and Continuum Modelling of Super-Spreading Surfactants

Smith, Ed — Imperial College London

Abstract: The bulk behaviour of super-spreading surfactants is well modelled by the thin-film equations. However, an essential feature of the spreading mechanism, surfactant absorption at the three-phase contact line, is difficult to recreate using continuum models. Molecular dynamics can explicitly model this contact-line deposition but is limited to small system sizes. A coupled approach is proposed; combining thin-film equations for the bulk behaviour and molecular detail at the contact line.

▶ MS-We-D-47-3 — 14:30–15:00

Thin Film Evolution Equations for Complex Fluids - Extensions Based on A Gradient Dynamics Formulation

Wilczek, Markus — Inst. for Theoretical Physics, Univ. of Muenster
Gurevich, Svetlana — Inst. for Theoretical Physics, Univ. of Muenster
Koepf, Michael — Ecole Normale Superieure
Tewes, Walter — Inst. for Theoretical Physics, Univ. of Muenster
Todorova, Desislava — Max Planck Inst. for Dynamics & Self-Organization
Thiele, Uwe — Univ. of Muenster

Abstract: After reviewing experiments involving thin films of suspensions and solutions, we propose ways to construct gradient dynamical models for liquid films of suspensions and solutions, as well as for films covered by insoluble surfactants. The gradient dynamics is based on a free energy that accounts for wettability and capillarity. We propose extensions of basic hydrodynamic models and apply them to dewetting and dip-coating problems.

▶ MS-We-D-47-4 — 15:00–15:30

Shock Dynamics for Suspension Flow with Gravity

Wong, Jeffrey — Univ. of California, Los Angeles

Abstract: Gravity-driven thin film flow of a suspension of particles down an incline can be described by a system of conservation law to the leading order. Solutions to this system display shocks with rich structures. In this talk, we will analyze different shock structures and how they relate to the experimental observations. Then we will add higher order regularization effects such as surface tension, which lead to more physical solutions.

MS-We-D-48 — 13:30–15:30 — 212B

Analysis and control of multi-agent systems

Organizer: Liu, Zhixin — AMSS, Chinese Acad. of Sci.

Abstract: Recently, the investigation of multi-agent systems (MAS) has generated great interest in various fields, including physics, biology, computer science, and social science. An important issue in the study of MAS is to understand how locally interacting agents lead to the behavior of the overall system. In this minisymposium, we focus on the analysis and control of MAS. On one hand, we present how to design the distributed control law for each agent such that the system exhibits the expected behavior; On the other hand, we introduce how to intervene in the MAS without changing the existing interactions between agents such that the system reaches the desired states. We also present analysis of the dynamical behavior of MAS.

▶ MS-We-D-48-1 — 13:30–14:00

Cooperative Output Regulation of Multi-agent Systems Coupled by Dynamic Edges

Xiang, Ji — College of Electrical Engineering, Zhejiang Univ.

Abstract: This talk investigates a new class of linear multi-agent systems, in which nodes are coupled by dynamic edges in the sense that each edge has a dynamic system attached. The outputs of the node dynamic systems are inputs of the edge dynamic systems. Several cooperative output regulation problem are posed, including output synchronization, output cooperation and master-slave output cooperation. A simulation example on the cooperative current control of an electrical network illustrates the potential applications.

▶ MS-We-D-48-2 — 14:00–14:30

Distributed Adaptive Control for Synchronization in Directed Multi-agent Networks: Key Network Structure and Control

Yu, Wenwu — Southeast Univ.

Abstract: The dynamics of a complex network is generally very complicated due to the self-dynamics of the node and their interactions. Many existing conditions for reaching certain desirable dynamics in a complex network require global information of the network, for example the spectrum of its Laplacian matrix. A challenging problem is how the network structure affects the network dynamics in a distributed way especially for directed networks, which is still unclear today. In this talk, we will investigate the impact of the network structure for synchronization on an undirected complex network, a second-order multi-agent system with undirected topology, and a general directed complex network. We will also develop a scheme to change the weights in a local manner to achieve a desired behavior. In particular, network synchronization is investigated, for which some distributed adaptive laws are designed on the coupling weights for reaching synchronization.

▶ MS-We-D-48-3 — 14:30–15:00

Design Distributed Consensus Protocols for Linear Multi-Agent Systems

Li, Zhongkui — Peking Univ.

Abstract: Consensus control of multi-agent systems has received compelling attention. Due to the large size of agents, the spatial distribution of actuators, limited sensing or communication capability, consensus protocols of multi-agent systems should be distributed, depending on local information of neighboring agents. The purpose of this talk is to present our recent results on designing distributed adaptive consensus protocols for linear multi-agent systems, which can be constructed and implemented in a fully distributed fashion.

▶ MS-We-D-48-4 — 15:00–15:30

Analysis and Intervention of Multi-agent Systems with Large Population

Liu, Zhixin — AMSS, Chinese Acad. of Sci.

Abstract: In the investigation of multi-agent systems (MAS), a central issue is to understand how local interactions between agents lead to collective behavior of the system. We introduced a random framework and some mathematical tools such as multi-array martingale theorem and estimation of spectral gap of random geometric graphs, to study the synchronization of a basic class of MAS with large population. Meanwhile, I present some quantitative results on how we intervene in MAS such that the system exhibits the expected behavior.

MS-We-D-49 — 13:30–15:30 — 107

Game Theory and Hierarchical Systems

Organizer: TCCT — Technical Committee on Control Theory, CAA

Abstract: Game theory is a study of strategic decision making. Specifically, it is "the study of mathematical models of conflict and cooperation between intelligent rational decision-makers". Hierarchical theory is a new and promising area of general systems theory. This theory deals basically with the decomposition of a system into subsystems forming a hierarchical structure and is, therefore, on method of dealing with complexity. The minisymposium aim to present the highest standard researches in game theory and hierarchical systems study, including 1) study of multi-player pursuit evasion game with one superior evader; 2) team problem research of mean field models with Markov jump parameters and coupled tracking-type indices; 3) analysis of inverse stackelberg public goods game with multiple leaders, followers, or levels; 4) the design of approximate simulation-based hierarchical control on nonlinear systems.

▶ MS-We-D-49-1 — 13:30–14:00

Multi-player Pursuit Evasion Game with One Superior Evader

Peng, Zhihong — Beijing Inst. of Tech.

Abstract: This paper discusses a multi-player pursuit evasion game with one superior evader, who moves faster than the pursuers.Through theoretical analysis, we find an analytical expression of non-escape angle of the evader and the minimum number of the pursuers required. We provide the strategies for the pursuers (evader) to maintain and shrink (destroy) the encirclement corresponding to three different movement patterns of the evader. Finally, we verify the correctness of the theories proposed in this paper.

▶ MS-We-D-49-2 — 14:00–14:30

Team Decision Problem for Markov Jump Mean Field Models

Wang, Bingchang — Shandong Univ.

Abstract: This talk is on the team problem of mean field models with Markov jump parameters and coupled tracking-type indices. Due to random parameters, the population aggregate effect is a stochastic process dependent on Markov jump parameters instead of a deterministic function. We achieve control synthesis by the parametric approach and the state space augmentation. By constructing stochastic Lyapunov functions, we show that the closed-loop

system is uniformly stable, and distributed strategies are asymptotically team-optimal.

▶ MS-We-D-49-3 14:30–15:00

Inverse Stackelberg Public Goods Game with General Hierarchical Structures

Mu, Yifen Acad. of Mathematics & Sys. Sci., Chinese Acad. of Sci.

Abstract: In this presentation we will formalize the inverse Stackelberg Public Goods game in discrete and continuous case with multiple leaders, followers, or levels. We will investigate the equilibrium and outcome of such games and compare them with the case in Nash equilibrium. Related important and interesting questions such as incentive controllability and fairness will also be studied.

▶ MS-We-D-49-4 15:00–15:30

Hierarchical Control Design of Nonlinear Systems Based on Approximate Simulation

Tang, Yutao Beijing Univ. of Posts & Telecommunications
Hong, Yiguang Acad. of Mathematics & Sys. Sci.

Abstract: Hierarchical control for nonlinear systems is discussed using approximate simulation relation in this paper. An approximate bound is obtained under a modified approximate simulation function at first. The abstraction and interface construction problem is solved for a class of nonlinear systems, especially those in the lower triangular form.

MS-We-D-50 13:30–15:30 207

Network dynamics induced by different graphical structures

Organizer: Chen, Yao Beijing Jiaotong Univ.

Abstract: The dynamics of coupled agents is a very intriguing topic recent years as it uncovers the emergent behavior of the complex systems via the collaboration of some very simple subsystems, and it also can be applied in explaining many complex social and economical phenomenons and guiding the designing of some useful distributed algorithms.

One critical issue in the study of coupled agent dynamics is how the graphical structure among the agents affect the global collective behavior. A typical example is that the connectivity of the graph structure guarantees the freedom of information flow between any two nodes, which is usually required in the analysis of coupled agent dynamics. However, there do exist some other typical examples in which the graphical connectivity can be weakened or should be enhanced in order to guarantee the global collective behavior.

The four speakers of this session will center around how the graphical structure influences the the dynamics which built on it, specifically, several special kinds of graphical structure will be considered and the corresponding dynamics will be intensively investigated.

▶ MS-We-D-50-1 13:30–14:00

Asynchronous Implementation Problem of Distributed Coordination Algorithm

Chen, Yao Beijing Jiaotong Univ.

Abstract: Given a networked consensus protocol with each node updated by the average of its neighbors, it is proved that if all the nodes share a global clock and update synchronously, then the connectivity of the network guarantees the convergence of the protocol. However, if each node has an independent clock, the connectivity alone cannot guarantee the consensus. We propose a novel structure, called partial scrambling graph, and discusses its connection with the asynchronous implementation problem.

▶ MS-We-D-50-2 14:00–14:30

Distributed Finite-time Control for Multi-agent Systems with Double-integrator Nonlinear Dynamics

Yu, Zhao Peking Univ.

Abstract: This paper investigates the distributed finite-time consensus tracking problem for a group of autonomous agents modeled by multiple non-identical second-order nonlinear systems. First, a distributed finite-time protocol is proposed based on the relative position and relative velocity measurements. Then, a new observer-based algorithm is designed to solve the finite-time consensus tracking problem without using relative velocity measurements. The main contribution of this paper is that the finite settling time can be theoretically estimated.

▶ MS-We-D-50-3 14:30–15:00

Stationary and Dynamic Consensus of Second-order Multi-agent Systems with Markov Jumping Input Delays

Bo, Hou Tsinghua Univ.

Abstract: This paper investigates the consensus problem of second-order multi-agent systems which are subject to Markov jumping input delays. A unified framework is established to address both the stationary and dynamic consensus issues in sampled-data settings. We first derive the sufficient conditions for consensus in terms of matrix inequalities. Thereafter, a cone complementarity linearization (CCL) based algorithm and its simplified implementation alternative are proposed for the delay-dependent switching controller design.

▶ MS-We-D-50-4 15:00–15:30

Synchronization of A Class of Small-World Networks via Drivingly Coupled Scheme

Zhu, Henghui Chinese Acad. of Sci.

Abstract: Synchronization is a ubiquitous phenomenon in nature. This paper aims at further investigates the synchronization of a class of small-world networks via drivingly coupled scheme. In detail, based on the Master Stability Method, we further discuss the distributions of eigenvalues λ2 and λn of coupling matrixes for realizing the synchronization of small-world networks via a drivingly coupled scheme. It indicates that the distributions of eigenvalues λ2 and λn are largely

MS-We-D-51 13:30–15:30 209A

Collective dynamics of online social systems - Part I of II

For Part 2, see MS-We-E-51

Organizer: Jianguo, Liu Univ. of Shanghai for Sci. & Tech.

Abstract: Billions of online user's behavior data provide valuable opportunity to analyze the collective behavior patterns of online users, interest migration patterns, measuring online user reputation, designing personalized recommendation algorithms, online link prediction, as well as other new challenges. This Minisymposia will introduce the pioneer progress of online user behavior analysis scientists from China, including the statistics properties of online user behavior, online information dissemination, interest measurements, and personalized recommendation algorithms, which would help researchers catch up the current situation of this research direction.

▶ MS-We-D-51-1 13:30–14:00

Collective Behaviors Analysis of Online User Preference

Jianguo, Liu Univ. of Shanghai for Sci. & Tech.

Abstract: Detecting the evolution properties of online user preference is of significance for deeply understanding online collective behaivors. In this talk, we will present advanced progresses of our group for collective behavior analysis, including the local memory effect and evolution dynamics of online user preference, generated by the online rating and selecting behaviors, the correlation between the user taste and the trust formation, the node importance identification method and so on.

▶ MS-We-D-51-2 14:00–14:30

Epidemic Dynamics on Information-driven Adaptive Networks

ZHANG, ZI-Ke Alibaba Research Center for Complexity Sci., Hangzhou Normal Univ.

Abstract: In this work, we propose an information-driven adaptive network. For the information-driven adaptive process, the susceptiblei ndividuals who have realized the existence of the disease would break the links to their infected neighbors to prevent the epidemic from further spreading. Concentrating on the infected density distribution, we find four types of dynamical phenomena. In addition, we present a full local bifurcation diagram to illustrate the evolution among these dynamical behaviors.

▶ MS-We-D-51-3 14:30–15:00

Empirical Studies on the Network of Social Groups

Han, Xiao-Pu Hangzhou Normal Univ.

Abstract: In this paper, we analyze a comprehensive dataset obtained from Tencent QQ. Specically, we analyze three derivative networks involving groups and their members the hypergraph of groups. Our results uncover interesting behaviors on the growth of user groups, the interactions between groups, and their relationship with member age and gender. These findings lead to insights which are difficult to obtain in social networks based on personal contacts.

▶ MS-We-D-51-4 15:00–15:30

Inferring Parent-child Links in Online Social Networks

Xu, Xiaoke Dalian Nationalities Univ.

Abstract: In this study, we are interested to how to infer a user's parent or child links based on the user's ego network structure. Our results show that they are not evidently strong ties. The tie strengths of parent-child links are not as strong as we expect, which leads parent-child links difficult to be distinguished. Taking the user's profile information into account, such as age and gender, we can improve the prediction accuracy for parent-child links.

MS-We-D-52 13:30–15:30 212A
Neural Networks and Optimization with Applications

Organizer: Liu, Qingshan — Huazhong Univ. of Sci. & Tech.
Organizer: Li, Guocheng — Beijing Information Sci. & Tech. Univ.
Organizer: Zeng, Zhigang — Huazhong Univ. of Sci. & Tech.

Abstract: This minisymposium offers a meeting opportunity for academics and engineering researchers belonging to the communities of Complex Networks, Neural Networks, Applied Mathematics and Automatic Control to discuss new areas of neural networks and applications. The aim of this minisymposium is to provide a forum for the presentation of the latest new results and future research directions on the optimization, mathematical modeling and applications. The minisymposium will become an international forum for researchers to summarize the most recent developments and ideas in the field, with a special emphasis given to the theoretical and observational results obtained within the last few years.

▶ MS-We-D-52-1 13:30–14:00
Neural Network for Constrained Nonsmooth Optimization Using Tikhonov Regularization
Qin, Sitian — Harbin Inst. of Tech. at Weihai

Abstract: This paper presents a one-layer neural network to solve nonsmooth convex optimization problems based on the Tikhonov regularization method. It is proved that for any initial point, the state of the proposed neural network is globally convergent to the unique optimal solution of the related strongly convex optimization problems. Compared with the existing neural networks, the proposed neural network has lower model complexity and does not need penalty parameters.

▶ MS-We-D-52-2 14:00–14:30
Neural Network for Solving Constrained Convex Optimization Problems with Global Attractivity
Bian, Wei — Harbin Inst. of Tech.

Abstract: In this paper, we propose a neural network modeled by a differential inclusion to solve a class of nonsmooth convex optimization problems. By the regularization item, without any estimatione on the exact penalty parameters, the solution of proposed network is convergent to the optimal solution set of optimization problem. Moreover, when the feasible region satisfies another condition, the solution of proposed network converges to the feasible region in finite time and it is global attrattive.

▶ MS-We-D-52-3 14:30–15:00
Recurrent Convolutional Neural Network for Object Recognition
Hu, Xiaolin — Tsinghua Univ.

Abstract: Inspired by the biological neural networks in the brain where recurrent connections are abundant, we propose a recurrent CNN (RCNN) for object recognition. The idea is to incorporate recurrent connections in the convolution layers of CNN, which results in a dynamic system. With fewer trainable parameters, RCNN outperforms the state-of-the-art models on four popular object recognition datasets.

▶ MS-We-D-52-4 15:00–15:30
Real Time Model Predictive Control Based on Neurodynamics
Yan, Zheng — Huawei Technologies

Abstract: Model predictive control (MPC) requires real time solutions to, generally nonconvex, constrained optimization problems to obtain optimal control signals. Numerical optimization may not be competent for MPC applications due to the stringent requirements on time and optimality. Neurodynamic optimization based on recurrent neural networks emerges as a promising approach to real time optimization. In this talk, MPC problems are first formulated as sequential dynamic optimization problems, then neurodynamic approaches will be designed and customized.

MS-We-D-53 13:30–15:30 311B
Analytical Pricing Methods for Path-Dependent Options

Organizer: Ludkovski, Mike — UC Santa Barbara
Organizer: Leung, Tim — Columbia Univ.
Organizer: Cai, Ning — Hong Kong Univ. of Sci. & Tech.

Abstract: This minisymposium will explore new developments related to valuation of complex financial contracts, especially those with path-dependent features, such as Asian and Callable contracts.

▶ MS-We-D-53-1 13:30–14:00
Investor Behavior and Valuation of Turbo Warrant
Yang, Xuewei — Nanjing Univ.

Abstract: We examine how investors valuate turbo warrant, which are essentially barrier options. Investors treat turbo warrant like lotteries in that they prefer turbo warrant with low prices, high volatilities, and high skewness. Our analysis highlights the importance of investor behavior in pricing of turbo warrant.

▶ MS-We-D-53-2 14:00–14:30
Pricing Path-dependent Options with Regime Switching
Song, Yingda — Univ. of Sci. & Tech. of China
Cai, Ning — Hong Kong Univ. of Sci. & Tech.

Abstract: We propose a general approach to pricing path-dependent options such as barrier options and lookback options under regime-switching models, where different regimes may follow different processes. Numerical results indicate that our method is accurate and efficient. This is joint work with Ning Cai and Steven Kou.

▶ MS-We-D-53-3 14:30–15:00
Analytical Pricing of Asian Options under A Class of Option Pricing Models
Cai, Ning — Hong Kong Univ. of Sci. & Tech.

Abstract: A unified framework is proposed for pricing both continuously and discretely monitored Asian options under Markov processes. Numerical experiments show that our pricing method performs well under a wide range of popular Markov process models, including the CIR model, the CEV model, Merton's jump diffusion model, the double-exponential jump diffusion model, the variance gamma model, and the CGMY model.

▶ MS-We-D-53-4 15:00–15:30
Closed-form Expansions of Discretely Monitored Asian Options in Diffusion Models
Cai, Ning — Hong Kong Univ. of Sci. & Tech.
Li, Chenxu — Peking Univ.
Shi, Chao — Univ. of International Business & Economics

Abstract: We propose a closed-form asymptotic expansion approach to pricing discretely monitored Asian options in diffusion models. We explicitly calculate not only the first several expansion terms but also any general expansion term in a systematic way. Besides, the convergence of the expansion is proved rigorously under some regularity conditions. Numerical experiments suggest that the closed-form expansion formula with only a few terms is accurate, fast, and easy to implement for a broad range of models.

MS-We-D-54 13:30–15:30 VIP1-2
Selected topics in mathematics of finance

Organizer: Stettner, Lukasz — Inst. of Mathematics Polish Acad. of Sci.

Abstract: The aim of this symposium is to present various important aspects in mathematics of finance. The session shall consists of four lectures devoted market with transaction costs (so called shadow price), pricing of various types of contracts: electricity American call options, multipersons contracts based on multiperiod multi-player stopping games (so called redistribution games), dividend paying securities using dynamic acceptability indices. Mathematics of finance, in particular risk theory is one of challenges of modern apllied mathematics. The minisymposium will be devoted to study pricing on various markets under uncertainty and friction. In the case of markets with proportional transaction costs we are interested to find a price (which is either a function of our current position or a random variable depending on our initial position), under which the optimal value and strategy are the same as in the case of transaction costs. Call options on electricity due to specific properties of product require special treatment. Games are used to design and evaluate financial contracts involving multiple parties. These games are shown to be weakly unilaterally competitive, and sufficient conditions are given for the existence of optimal equilibria, individual values and coalition values. Another aspect is an arbitrage free theoretical framework for modeling bid and ask prices of dividend paying securities in a discrete time setup using theory of dynamic acceptability indices.

▶ MS-We-D-54-1 13:30–14:00
American Contracts for Power System Balancing
Palczewski, Jan — Univ. of Leeds

Abstract: We study utilisation of storage for balancing of power systems. This is formulated as repeated issuance of American-type real options on physical delivery/consumption of power. Using methods of optimal stopping we derive analytically optimal strategies for management of the installed storage and assess its profitability for power system balancing. We depart from the usual monetary description of the market in favour of modelling physical imbalance between supply and demand.

▶ MS-We-D-54-2 14:00–14:30
Construction of Shadow Price
Stettner, Lukasz — Inst. of Mathematics Polish Acad. of Sci.

Abstract: Shadow price is constructed for discrete time model with finite horizon with general utility function and general transaction costs. It is the price on market without transaction costs such that optimal value of the functional is the same as on the market with proportional transaction costs. To construct shadow price we introduce so called weak shadow price, which is the price depending on our financial position. Result is based on joint paper with T. Rogala.

▶ MS-We-D-54-3 14:30–15:00

Arbitrage Pricing of Multi-Person Game Contingent Claims

Rutkowski, Marek Univ. of Sydney

Abstract: A novel class of multi-player competitive stochastic game in discrete-time with an affine specification of redistribution of payoffs at exercise is introduced. We identify conditions under which the optimal equilibria and the value for the game exist. We introduce a class of financial contracts involving several parties by extending the concept of the two-person game option due to Kiefer (2000). We provide conditions under which a multi-person game contingent claim admits an arbitrage price.

▶ MS-We-D-54-4 15:00–15:30

Dynamic Conic Finance via Backward Stochastic Difference Equations

Bielecki, Tomasz Illinois Inst. of Tech.

Abstract: We present an arbitrage free framework for modeling bid and ask prices of dividend paying securities in discrete time using theory of dynamic acceptability indices given in terms of solutions of backward stochastic difference. We introduce pricing operators that are defined in terms of dynamic acceptability indices. We define bid and ask prices for underlying securities and then for derivatives in this market. We discuss related hedging issues in terms of control problems for g-expectations.

MS-We-D-55 13:30–15:40 106

Fluid-structure interaction problems in biological and physical systems

Organizer: Lim, Sookkyung Univ. of Cincinnati

Abstract: The interplay between fluid and elastic structures plays an important role in many biological and physical systems. This Mini-symposium will highlight recent developments in modeling, simulation, and methods for a wide range of fluid-structure interaction problems. The problems include flexible-channel flow, DNA transport, sperm motility, and efficient methods of elastic rod dynamics.

▶ MS-We-D-55-1 13:30–14:00

Modeling Sperm Motility Using A Kirchhoff Rod Model

Olson, Sarah WPI

Abstract: Sperm flagella have been observed to propagate different waves of bending, depending on the fluid environment. In this talk, we will discuss modeling aspects of the relevant fluid environment and chemical concentrations, relating emergent waveforms and interactions to current experiments. The sperm flagellum is represented as a Kirchhoff rod and a regularized Stokes formulation will be used to solve for the local fluid flow. Results will be shown to describe emergent waveforms and swimming speeds.

▶ MS-We-D-55-2 14:00–14:30

Electro-hydrodynamic Effect on DNA Dynamics During Transport

Lim, Sookkyung Univ. of Cincinnati

Abstract: We present computer simulations of DNA dynamics under electric field by using a stochastic version of the generalized immersed boundary method. Our simulations show that DNA molecule in a fluid in the presence of counterions and electric field has a tendency to undergo compression, and the amount of compression depends on the ionic strength and the electric field intensity. This is a joint work with David Swigon (University of Pittsburgh, USA) and Yongsam Kim(Chung-Ang University,Korea).

▶ MS-We-D-55-3 14:30–15:00

Self-excited Oscillations of Flexible-channel Flow with Fixed Upstream Flux

Xu, Feng The Univ. of Manchester

Abstract: To understand onset of self-excited oscillations in a collapsible-tube flow driven by fixed upstream flux, we consider flow in a finite-length planar channel, where a segment of one wall is replaced by a tensioned membrane. We demonstrate how oscillations are driven by divergent instabilities when the membrane has similar length to the rigid segment of channel downstream of the membrane or a 1:1 resonant interaction when the downstream segment is much longer than the membrane.

▶ CP-We-D-55-4 15:00–15:20

Non Homogeneous Boundary Value Problems for the Stationary Navier-Stokes Equations in 2-d Symmetric Semi-infinite Outlet

Chipot, Michel Univ. of Zurich

Abstract: We would like to present existence results for the stationary non homogeneous Navier-Stokes problem in symmetric domains having a semi-infinite outlet. We assume for this Leray problem the so called general outflow condition. (Joint work with K. Kaulakyte, K. Pileckas and W. Xue)

▶ CP-We-D-55-5 15:20–15:40

A Spectral Finite Difference Method for Analysis of A Fluid-Lubricated Herringbone Grooves Journal Bearing in A Special Case of Rectangle Groove

Jun, Liu Tochigi R&D center, Keihin-corp, Japan

Abstract: A spectral difference method is applied to get numerical solutions for a fluid-lubricated herringbone grooved journal bearing, and an inexpedience which Fourier series does not converge at jump points of the film profile in special case of rectangle groove is challenged to solve.

MS-We-D-56 13:30–15:30 403

Modeling, Applications, Numerical Methods, and Mathematical Analysis of Fractional Partial Differential Equations II - Part II of IV

For Part 1, see MS-Tu-E-56
For Part 3, see MS-We-E-56
For Part 4, see MS-Th-BC-56

Organizer: Karniadakis, George Brown Univ.

Organizer: Wang, Hong Univ. of South Carolina

Abstract: Fractional Partial Differential Equations (FPDEs) are emerging as a new powerful tool for modeling many difficult complex systems, i.e., systems with overlapping microscopic and macroscopic scales or systems with long-range time memory and long-range spatial interactions. They offer a new way of accessing the mesoscale using the continuum formulation and hence extending the continuum description for multiscale modeling of viscoelastic materials, control of autonomous vehicles, transitional and turbulent flows, wave propagation in porous media, electric transmission lines, and speech signals. FPDEs raise modeling, computational, mathematical, and numerical difficulties that have not been encountered in the context of integer-order partial differential equations. The aim of this minisymposium is to cover the recent development in mathematical and numerical analysis, computational algorithms, and applications in the context of FPDEs and related nonlocal problems.

▶ MS-We-D-56-1 13:30–14:00

Spectral Method for Substantial Fractional Differential Equations

Huang, Can Xiamen Univ.

Zhimin, Zhang Beijing Computational Sci. Research Center, & Wayne State Univ.

Abstract: A non-polynomial spectral Petrov-Galerkin method and associated collocation method for substantial FDEs are proposed, analyzed, and tested. We extend the generalized Laguerre polynomials to form our basis. Our PG method results in a diagonal and well-conditioned linear systems for model equations. In the meantime, we construct explicit fractional collocation matrices for them. Moreover, the proposed method allows us to adjust a parameter in basis selection according to different given data to maximize the convergence rate.

▶ MS-We-D-56-2 14:00–14:30

Moving Finite Element Methods for A System of Semi-linear Fractional Diffusion Equations

Ma, Jingtang Southwestern Univ. of Finance & Economics

Abstract: We will present moving mesh finite element methods for a system of semi-linear fractional diffusion equations. The system of fractional diffusion equations may arise in competitive predator-prey models by replacing the second-order derivative in the spatial variables with a fractional derivative of order less than two. Moving finite element methods are developed to solve the system of fractional diffusion equations and the convergence rates of the methods are proved.

▶ MS-We-D-56-3 14:30–15:00

Optimal Error Estimates of Spectral Galerkin and Collocation Methods for Fractional Differential Equations

Zhang, Zhongqiang Worcester Polytechnic Inst.

Karniadakis, George Brown Univ.

Zeng, Fanhai Brown Univ.

Abstract: We present optimal error estimates for spectral Galerkin methods and spectral collocation methods for linear fractional differential equations with initial value or boundary values on a finite interval. We also develop Laguerre spectral Petrov-Galerkin methods and collocation methods for fractional equations on the half line. Numerical results confirm the error estimates.

▶ MS-We-D-56-4 15:00–15:30

Modeling, Applications, Numerical Methods, and Mathematical Analysis of

Fractional Partial Differential Equations II—Fast Laplace Transform for Fractional Diffusion Equations

SUN, Hai-wei Univ. of Macau

Abstract: The Laplace transform with hyperbolic contour is exploited to solve space-fractional diffusion equations. By making use of the Toeplitzlike structure of spatial discretized matrices and the relevant properties, the regions that the spectra of resulting matrices lie in are derived. Suitable parameters in the hyperbolic contour are selected based on these regions to solve the fractional diffusion equations. Numerical experiments are provided to demonstrate the efficiency of our contour integral methods.

MS-We-D-57 13:30–15:30 402A

Advances in Numerical Methods for Porous Media Flow - Part III of IV

For Part 1, see MS-Tu-D-57
For Part 2, see MS-Tu-E-57
For Part 4, see MS-We-E-57

Organizer: Wang, Hong Univ. of South Carolina
Organizer: Sun, Shuyu King Abdullah Univ. of Sci. & Tech.
Organizer: Rui, Hongxing Department of Mathematics, Shandong Univ.

Abstract: Porous media flow has wide applications in many areas, including environmental, energy, biological and engineering applications. They lead to strongly coupled transport processes also with nonlinear chemical reactions, which are computationally challenging, for it demands high accuracy and local mass conservation. Porous media manifest dramatically differently at different spatial and temporal scales. Heterogeneity, anisotropy, and discontinuity of medium properties require special treatment. The aim of this minisymposium is to bring together researchers in the aforementioned field to highlight the current developments, to exchange the latest research ideas, and to promote further collaborations in the community.

▶ MS-We-D-57-1 13:30–14:00

Iterative Methods for Multiphysics Including Flow and Geomechanics in Fractured Porous Media

Kumar, Kundan Uni of Bergen
Wheeler, Mary F UT-Austin

Abstract: Fractures play an important role in determining the flow profile and at the same time are vulnerable regions for the mechanical deformations. We consider an iterative scheme for solving a coupled mechanics and flow problem in a fractured poroelastic medium. For the flow problem, we use newly developed multipoint flux mixed method discretization techniques and comment on the extensions to multiphase flows.

▶ MS-We-D-57-2 14:00–14:30

Numerical Methods for Darcy-Forchheimer Flow in Porous Media

Rui, Hongxing Department of Mathematics, Shandong Univ.

Abstract: Darcy Forchheimer model is a kind of nonlinear model to describe flow which can not be modelled by Darcy's law in porous media. In this talk we will present some cell-centered finite difference methods based on the lowest order mixed elements to non-Darcy (Darcy-Forchheimer) flow problems. We will present the approximate schemes, existence and uniqueness analysis, error estimate and numerical examples.

▶ MS-We-D-57-3 14:30–15:00

TWO-PHASE FLUID SIMULATION USING A DIFFUSE INTERFACE MODEL WITH PENG – ROBINSON EQUATION OF STATE

Qiao, Zhonghua The Hong Kong Polytechnic Univ.
Sun, Shuyu King Abdullah Univ. of Sci. & Tech.

Abstract: Two-phase fluid systems are simulated using a diffusive interface model with the Peng – Robinson equation of state (EOS), a widely used realistic EOS for hydrocarbon fluid in the petroleum industry. Some energy stable numerical schemes are developed to solve the resulted partial differential equation. Our proposed algorithms are able to solve successfully the spatially heterogeneous two-phase systems with the Peng – Robinson EOS in multiple spatial dimensions, the first time in the literature.

▶ MS-We-D-57-4 15:00–15:30

From Coupling Stokes-Cahn-Hilliard Equations to Darcy's Law for Two-phase Fluid Flow in Porous Medium by Volume Averaging

Chen, Jie Xi'an Jiaotong Universitty
Sun, Shuyu King Abdullah Univ. of Sci. & Tech.
Wang, Xiaoping Hong Kong Univ. of Sci. & Tech.

Abstract: A technique of local volume averaging is applied to a two-phase fluid mixture system and general equations are obtained which depict mass and momentum transport in porous media. Starting from coupling Stokes-Cahn-Hilliard equations for incompressible two-phase fluid flow, the averaging is performed without significantly idealizing either the porous medium or the fluid mechanical relations. The resulting equations are generalized Darcy's law for two-phase flow with medium parameters resulted from the averaging procedure.

MS-We-D-58 13:30–16:00 401

Numerical Methods for Multi-physics Problems - Part II of III

For Part 1, see MS-Tu-E-58
For Part 3, see MS-We-E-58

Organizer: Bazilevs, Yuri Univ. of California, San Diego
Organizer: Xu, Jinchao PKU,and The Pennsylvania State Univ.
Organizer: Zhang, Shuo Inst. of Computational Mathematics, Chinese Acad. of Sci.

Abstract: Most systems targeted by mathematical modeling in modern science and engineering are multi-physical and multi-scale. These models involve complex coupled nonlinear systems of PDEs built from different physical processes at different scales. Developing robust, efficient, and practical numerical algorithms that can tackle these complex models is one central task of modern computational sciences and also a challenging one. This minisymposium will gather together experts from around the world in the related fields in industrial and applied mathematics to exchange ideas regarding the development of robust and efficient numerical schemes that preserve the key physics of these models, and to study the development of fast and efficient linear and nonlinear solvers that are scalable and optimal.

▶ MS-We-D-58-1 13:30–14:00

Comparison of Turbulence Modeling Approaches in the Context of Fluid-structure Interaction

Schaefer, Michael TU Darmstadt

Abstract: Fluid-structure interaction phenomena play an important role in many technical applications. In most cases the involved fluid flows are turbulent. We present investigations concerning the influence of the turbulence modeling on the prediction quality of fluid-structure interaction simulations. The comparative study involves RANS, LES, hybrid DNS-RANS, and hybrid LES-RANS approaches as well as experimental results. Aspects of numerical efficiency and accuracy are discussed for representative test cases.

▶ MS-We-D-58-2 14:00–14:30

Parallel Adaptive Mesh Refinement and Coarsening: Algorithms and Implementation

Zhang, Lin-bo Acad. of Mathematics & Sys. Sci., Chinese Acad. of Sci.

Abstract: The newest vertex bisection scheme for conforming triangular meshes has been successfully used in many adaptive finite element computations. But due to the complexity of the algorithms, its scalable parallel implementations are still very few. In this talk we will present parallel local mesh refinement and coarsening algorithms and their implementations in the parallel adaptive finite element toolbox PHG (`http://lsec.cc.ac.cn/phg/index_en.htm`), and show timing results of these algorithms in adaptive finite element computations.

▶ MS-We-D-58-3 14:30–15:00

Space-time Trace FEM for Incompressible Flows with Moving Interfaces

Reusken, Arnold IGPM, RWTH Aachen Univ.

Abstract: We consider a sharp interface model for a flow problem with two different immiscible incompressible newtonian phases (fluid-fluid or fluid-gas). This fluid dynamics model may be coupled with a model for mass transport between the phases and a model for transport of surfactants on the interface. In recent years so-called trace finite element techniques have been developed for this type of multi-physics problems. In this presentation we treat space-time variants of this trace FEM technique.

▶ MS-We-D-58-4 15:00–15:30

Quantifying the Influence of Conformational Uncertainty in Biomolecular Solvation

Huan, Lei Pacific Northwest Natl Laboratory
Yang, Xiu Pacific Northwest Natl Laboratory
Bin, Zheng Pacific Northwest National Laboratory
Lin, Guang Purdue Univ.
Baker, Nathan Pacific Northwest Natl Laboratory

Abstract: Biomolecules exhibit conformation fluctuations near equilibrium states, inducing uncertainty in various biological properties. We have developed a general method to quantify this uncertainty using a generalized polynomial chaos expansion on collective variables identified using the active subspace method. The method is demonstrated on solvation properties and shown to yield a more accurate response surface than standard sparse grid collocation methods. Our framework is generalizable and can be used to

investigate uncertainty in numerous biomolecular properties.

▶ MS-We-D-58-5 15:30–16:00

High Order EXtended Finite Element Methods for Interface Problems

Wang, Fei — Pennsylvania State Univ.
Xu, Jinchao — PKU,and The Pennsylvania State Univ.
Zhang, Shuo — Inst. of Computational Mathematics, Chinese Acad. of Sci.
Xiao, Yuanming — Nanjing Univ.

Abstract: For subdomain coupled multi-physics problems, the most difficult part is dealing with an interface, which separates two phases of matter. The extended finite element method (XFEM) has shown its potential in a variety of applications that involve non-smooth solutions near interface. We consider high order XFEM with DG schemes to solve an elliptic interface problem. We show the optimal convergence rate for any order XFE space if the solution satisfies curtain regularity in each sub-domain.

MS-We-D-59 13:30–15:30 402B

Modeling, Simulation and Analysis of Interface and Defect Problems in Solids - Part III of III

For Part 1, see MS-Tu-D-59
For Part 2, see MS-Tu-E-59

Organizer: Xiang, Yang — Hong Kong Univ. of Sci. & Tech.

Abstract: Interfaces or defects in crystalline materials, such as vacancies, dislocations, cracks, grain boundaries, and surfaces, play important roles in the mechanical, electronic, and plastic properties of these materials. The complexity of modeling microstructures of these defects and their evolution at various length and time scales presents new challenges for mathematical modeling and analysis. Multiphysics models are required to accurately describe the complicated interactions among various defects involved in the equilibrium and dynamics processes. The speakers in this minisymposium will discuss recent advances in the modeling approaches and new findings obtained in analysis and simulations.

▶ MS-We-D-59-1 13:30–14:00

Efficient Sum-of-exponentials Approximations for the Heat Kernel and Their Applications

Jiang, Shidong — New Jersey Inst. of Tech.

Abstract: In this talk, we show that efficient separated sum-of-exponentials approximations can be constructed for the heat kernel in any dimension. The number of exponentials in the approximation depends only logarithmically on the total number of time steps. When combined with integral equation method to solve the boundary value problems of the heat equation in complex geometries, the resulting algorithms are nearly optimal in computational complexity. The algorithms can also be parallelized in a straightforward manner.

▶ MS-We-D-59-2 14:00–14:30

Construction and Analysis of Atomistic/Continuum Coupling Method

Zhang, Lei — Shanghai Jiao Tong Univ.

Abstract: We discuss the construction of quasi-optimal energy based atomistic/continuum (A/C) coupling methods for crystalline solids with defects, based on tools from numerical analysis. For general multi-body interactions on the 2D triangular lattice (and potentially for 3D lattices), we show that ghost force removal (patch test consistent) A/C methods can be constructed for arbitrary interface geometries. Further improvement can be achieved by using blending mehod and if a good 'predictor' is available.

▶ MS-We-D-59-3 14:30–15:00

Dislocation Climb Formulation for Discrete Dislocation Dynamics

Srolovitz, David J — Univ. of Pennsylvania

Abstract: We derive a Green's function formulation for the climb of curved dislocations and multiple dislocations in three-dimensions. In this new formulation, the dislocation climb velocity is determined from the Peach-Koehler force on dislocations through vacancy diffusion in a non-local manner. We also present a numerical discretization method of this Green's function formulation appropriate for implementation in discrete dislocation dynamics simulations.

▶ MS-We-D-59-4 15:00–15:30

Efficient Algorithms for Transition State Calculations

Gao, Weiguo — Fudan Univ.

Abstract: Transition states (or index-1 saddle points) are fundamental to understanding the reaction dynamics qualitatively. We introduce a locally optimal search direction finding algorithm and an iterative minimizing method for the translation which improve the rotational step by a factor and the translational step a quantitative scale. Numerical experiments demonstrate the efficiency of our proposed algorithms. This is joint work with Jing Leng, Zhi-Pan Liu, Cheng Shang and Xiang Zhou.

IM-We-D-60 13:30–15:30 310

Industrial Mathematics Around the World - Part V of VIII

Activities on Industrial-Mathematics in East Asia and the West Pacific Region (besides China)

For Part 1, see IM-Mo-D-60
For Part 2, see IM-Mo-E-60
For Part 3, see IM-Tu-D-60
For Part 4, see IM-Tu-E-60
For Part 6, see IM-We-E-60
For Part 7, see IM-Th-BC-60
For Part 8, see IM-Th-D-60

Organizer: Cai, Zhijie — Fudan Univ.
Organizer: Chen, Gui-Qiang G. — Univ. of Oxford
Organizer: Huang, Huaxiong — York Univ.
Organizer: LU, Liqiang — Fudan Univ.
Organizer: Ockendon, Hilary — Univ. of Oxford
Organizer: Ockendon, John — Univ. of Oxford
Organizer: Peng, Shige — Shandong Univ.
Organizer: Tan, Yongji — Fudan Univ.
Organizer: Wake, Graeme — Massey Univ.,
Organizer: Zhu, Yichao — The Hong Kong Univ. of Sci. & Tech.
Organizer: CHENG, JIN — Fudan Univ.

Abstract: The aim of this section is to boost the use of mathematics as an industrial resource in China and around the world. It will highlight (i) the global experience in industrial mathematics and (ii) the new mathematical ideas that these activities have created as well as the exploitation of existing technologies to new applications. Participants will come from both academia and industry and, for this purpose, the section is proposed to consist of eight minisymposia. Four of them will overview the identification and solution of industrially-driven mathematical problems and the mechanisms that have evolved to deal with them in different regions: China, other Asia-Pacific countries, Europe and North America. Three of the remaining minisymposia will focus on the problems coming from different industrial sectors: financial industry, petroleum industry and industrial areas in which wave propagation is important. The last minisymposium will involve an open discussion on how the global mathematics community can best respond to the increasing demand from industry for applied and computational mathematics; the agenda will include both the mechanisms for academic / industrial collaboration and the areas where it will be most fruitful.

▶ IM-We-D-60-1 13:30–14:00

Mathematics-for-Industry and Industry-for-Mathematics

Wakayama, Masato — Kyushu Univ.

Abstract: The concept of Mathematics-for-Industry highlights the fact that, in seeking answers to questions raised by real-world problems, one must look for possible solutions in the wild forest of available mathematical knowledge. Sometimes, the relevant mathematics is already there, waiting to be harvested. More often, know mathematics must be adapted and viewed from a new perspective, like sculpturing a figure from a block of wood. Occasionally, and very importantly, the inverse process arises where the application

▶ IM-We-D-60-2 14:00–14:30

The Mathematics in Industry Study Group - Problems Solved

Farrell, Troy — Queensland Univ. of Tech.

Abstract: For 30 years the Mathematics in Industry Study Group (MISG) has brought together applied mathematicians and statisticians from across Australia, New Zealand and around the world to tackle complex technical problems facing businesses and industry. As the Director of the MISG, the speaker will discuss the benefits and outcomes of study groups from the perspective of a selection of the MISG projects that he has been involved with.

▶ IM-We-D-60-3 14:30–15:00

The Dawn of Malaysian Mathematics in Industry

Abdul Aziz, Zainal — Universiti Teknologi Malaysia, Johor Bahru, Malaysia

Abstract: This talk will elaborate on how the Malaysian industries have come to invigorate the synergy of mathematics and industry through the Malaysian Mathematics in Industry Study Groups (MISG 2011 & 2014). Our scenario of pre MISG is a disconnected linkup between industries and mathematics. There is no serious collaboration for the local industries to provide industrial problems and reciprocally no takers from the mathematical community to offer assistance and solutions. Post MISG 2011 & 2014 have seen intensified partnership between local industries and mathematical community beginning to take shape. The establishment of UTM-CIAM at the end 2012 was a spin-off of MISG 2011. This creates a tailor made platform for active linkup particularly via the centre' s flagship study group. The Malaysian MSIGs are organized in cooperation with Oxford Centre for Industrial and Applied Mathematics (OCIAM). These are collaborative problem-solving workshops where applied mathematicians, operational researchers and statisticians tackle real life problems brought by private and public companies. The talk will also summarize the success collaboration in solving specific problems from our national high revenue industries during the Malaysian MISGs.

▶ IM-We-D-60-4 15:00–15:30

Mathematics-in-industry Projects from New Zealand

Sweatman, Winston Massey Univ.

Abstract: Mathematics in Industry Study Groups (MISG) have been held annually in Australia and New Zealand since 1984. During this time a number of New Zealand enterprises have participated. The workshops were in New Zealand for the years 2004, 2005 and 2006 but the industrial participants have also travelled to the meetings in Australia. A number of these enterprises have participated multiple times. The presenter will describe some New Zealand projects he has worked on.

CP-We-D-61 13:30–15:30 101

Computational Science

Chair: Monnuanprang, Peiangpob Phranakon Rajabhat Univ.

Abstract:

▶ CP-We-D-61-1 13:30–13:50

Numerical Method for Euler Equations with Boundary Conditions

Monnuanprang, Peiangpob Phranakon Rajabhat Univ.

Abstract: In this paper present numerical methods for the solution of the Euler equations of an ideal incompressible fluid flow through a bounded domain with inlet, outlet and impermeable parts of the boundary. The plots of flow structure and isobars under some geometries and flow conditions are included. The code can be used to predict flows for three diffrent kinds of boundary conditions on inlet and outlet parts of a channel.

▶ CP-We-D-61-2 13:50–14:10

Efficient Algorithm for Computing Large Scale Systems of Differential Algebraic Equations

Qin, Xiaolin Chengdu Inst. of Computer Applications, Chinese Acad. of Sci.

Abstract: In many mathematical models of physical phenomenons and engineering fields, such as electrical circuits or mechanical multibody systems, which generate the differential algebraic equations (DAEs) systems naturally. In general, the feature of DAEs is a sparse large scale system of fully nonlinear and high index. To make use of its sparsity, this paper provides a simple and efficient algorithm for computing the large scale DAEs system. We exploit the shortest augmenting path algorithm for finding maximum value transversal as well as block triangular forms (BTF). We also present the extended signature matrix method with the block fixed point iteration and its complexity results. Furthermore, a range of nontrivial problems are demonstrated by our algorithm.

▶ CP-We-D-61-3 14:10–14:30

Numerical Study on the Difference Schemes for Radiative Transfer

Hang, Xudeng Inst. of applied physics & compuational mathematics

Abstract: Numerical simulation of radiative Transfer equation is important while difficult. In this paper, we study the behaviors of difference schemes for the discrete ordinates equations of radiative transfer. The performances are compared for the diamond scheme, the step scheme, corner balance schemes and two new schemes. Numerical experiments show different precision and stability behavior. The two new difference schemes show good precision and are more stable than the diamond schemes and the corner balance schemes. We also study the discretization of the material energy equation in the radiaitive transfer equations. Two discretization methods are studied. one is to discretize the neergy equations on cells and the other is to discretize on the sub cells. We propose a way to discretize the equation on the cells which is as precise as the one on sub cells.

▶ CP-We-D-61-4 14:30–14:50

A Monotone Finite Volume Scheme Preserving Fully Positivity for Diffusion Equation

Sheng, Zhiqiang Inst. of Applied Physics & Computational Mathematics

Yuan, Guang-wei Inst. of Applied Physics & Computational Mathematics, Beijing, China

Abstract: In constructing nonlinear monotone finite volume schemes it is required to assume that values of auxiliary unknowns are nonnegative. However, this assumption is not always satisfied if it is required to get high accuracy at the same time. In this paper we propose new methods to eliminate auxiliary unknowns including edge unknowns and vertex unknowns respectively. Edge unknowns are approximated by cell-centered unknowns and vertex unknowns by using the continuity of flux on cell edge. Vertex unknowns are approximated by cell-centered unknowns and edge unknowns. New methods can assure that these weighted coefficients are nonnegative and the sum of these weighted coefficients is one respectively. Numerical results show that a monotone scheme based on new methods of eliminating auxiliary unknowns is more accurate and robust than some existing monotone schemes.

▶ CP-We-D-61-5 14:50–15:10

A Distributive Interoperable Executive Library (DIEL) for System-wide Multi-disciplinary Scientific Computation

Wong, Kwai Univ. of Tennessee

Abstract: We present a novel integrative software platform – the Distributive Interoperable Executive Library (DIEL) - to facilitate the collaboration, exploration, and execution of multi-disciplinary modeling projects suited for a diversified research community on emergent large-scale parallel computing platforms. DIEL is a lightweight software framework allowing users to plug in their own modules or codes and scheduling the workflow and interactions between them. It does so by providing a managing executive, a layer of tools, a number of commonly used I/O libraries, and two set of native communication protocols - a direct space exchange unit (DSU) and a tuple space exchange unit (TSU). These units are designed to facilitate transferring and storing data across the distributed memory space on a large-scale supercomputer, depending on the nature of the simulation using DSU for deterministic type of exchanges or TSU for stochastic type of exchanges.

▶ CP-We-D-61-6 15:10–15:30

An Entropy Stable Central Solver for Hyperbolic Conservation Laws

Naliganahalli Hanumantharayappa, Maruthi Indian Inst. of Sci.

Suswaram, Raghurama Rao, V. Indian Inst. of Sci.

Abstract: In this work, an entropy-stable scheme is presented for hyperbolic conservation laws. An exact discontinuity capturing central solver developed recently, named MOVERS (Method of Optimal Viscosity for Enhanced Resolution of Shocks) of Jaisankar and Rao (J Computat Phys 2009;228:770-798), is designed to capture steady discontinuities exactly by enforcing Rankine-Hugoniot condition directly in the discretization process. This scheme is low dissipative and free of Riemann solvers. however, MOVERS requires entropy fix to avoid non-smoothness at the expansion regions. Here, the entropy conservation equation is used as a guideline to fix the optimal amount of numerical dissipation for smooth regions of the flow and dissipation from MOVERS is used at the discontinuities. This hybrid scheme uses limiter to switch-over from smooth regions to large gradients of the flow. The resulting new scheme is entropy-stable, free of shock instabilities, captures steady discontinuities exactly and yet avoids the usage of entropy fix.

CP-We-D-62 13:30–15:30 102

Fluids

Chair: Selvan, Muthtamil Bharathiar Univ.

Abstract:

▶ CP-We-D-62-1 13:30–13:50

Magnetic Field Effect on Convection in A Lid-driven Cavity Filled with Nanofluids

Selvan, Muthtamil Bharathiar Univ.

Abstract: Investigations of mixed convection of a fluid confined in a cavity with moving wall have applications in problems such as manufacturing solar collectors, optimized thermal designing of buildings, and cooling of electronic devices. A numerical investigation of laminar mixed convection heat transfer in a lid-driven cavity filled with nanofluid under the influence of a magnetic field is executed. A uniform magnetic field is applied in the vertical direction normal to the moving wall. The governing differential equations are discretised by the control volume approach and the coupling between velocity and pressure is solved using the SIMPLE algorithm. A comparison is also presented between the results obtained from the Maxwell and modified Maxwell models. It is found that the average Nusselt number increases linearly with the increase in the solid volume fraction at given Reynolds number. The results show that the heat transfer is generally higher based on the modified Maxwell model.

▶ CP-We-D-62-2 13:50–14:10

Trapped Waves in An Ice-covered Two-layer Fluid

Bora, Swaroop Nandan — Indian Inst. of Tech. Guwahati

Abstract: In this article, trapped mode frequencies, which are embedded in a continuous spectrum, are computed for a pair of horizontal circular cylinders, each of infinite extent along the y-axis are placed in either layer of a two-layer fluid of infinite depth bounded above by a thin ice-cover. A fifth-order boundary condition arising at the ice-cover makes the problem more complex but interesting. Using multipole expansion, an infinite system of homogenous linear equations is obtained with complex-valued coefficients. For a fixed geometrical configuration and density ratio, the existence of trapped modes is examined by numerically by computing the frequencies for which the truncated complex determinant vanishes. When the cylinders are placed in lower layer, the variation of these modes is investigated by varying the depth of upper layer and also the submergence depth. The effect of the variation of ice parameters on the existence of trapped modes is also looked into.

▶ CP-We-D-62-3 14:10–14:30

Sloshing in An Annular Vertical Circular Cylindrical Container in Presence of A Rigid Baffle Inside Fluid Domain

Choudhary, Neelam — Indian Inst. of Tech. Guwahati
Bora, Swaroop Nandan — Indian Inst. of Tech. Guwahati

Abstract: If an annular baffle is attached to the outer cylinder wall in the annular region of a circular cylinder, filled with an ideal liquid, at some depth, the natural frequencies in the cylinder undergo a drastic change. The baffle divides the liquid region into four in each of which boundary value problems are set up. Using matching conditions across the virtual interfaces and setting up a system of linear equations, the natural frequencies are determined.

▶ CP-We-D-62-4 14:30–14:50

PKN Model for A Two-dimensional Hydraulic Fracture: Conservation Laws and Analytical Solutions.

Mason, David — Univ. of the Witwatersrand, Johannesburg

Abstract: Two conservation laws for the nonlinear diffusion equation describing a two-dimensional PKN hydraulic fracture are derived. The first is the elementary conservation law while the second is new. The Lie point symmetry associated with each conserved vector is derived and the solution generated by each symmetry is obtained. The first solution describes a hydraulic fracture evolving with constant volume. The second solution describes the limiting case of fluid extraction in which a jet of fluid escapes from the fracture at the fracture entry.

▶ CP-We-D-62-5 14:50–15:10

Travelling Wave Exact Coherent States in Plane Poiseuille Flow

Wall, D. P. — Nippon Bunri Univ.

Abstract: Three travelling wave exact coherent states in plane Poiseuille flow are obtained by homotopy from solutions to plane Poiseuille flow subject to a spanwise system rotation recently presented by Wall & Nagata (J. Fluid Mech. 727: 533 – 581, 2013). Two of the solutions are asymmetric with respect to the channel centreplane while the third satisfies a half-turn rotational symmetry about a point on this plane. This latter solution can further be continued to a spanwise-localised flow. In addition, one of the asymmetric flows is found to exist down to a Reynolds number of 665, significantly reducing the previous known minimum for channel flow solutions other than the basic state of 806.

▶ CP-We-D-62-6 15:10–15:30

Thin-film Flow in Helical Channels

Arnold, David — The Univ. of Adelaide
Stokes, Yvonne — The Univ. of Adelaide
Green, Edward — Univ. of Adelaide

Abstract: Flows in helical channels have applications ranging from spiral separators used in the mineral processing industry, to spiral microchannels used in lab-on-a-chip technology to separate different types of cells in blood samples. We consider flows of Newtonian fluid in helically wound channels of arbitrary centreline torsion and curvature. The free-surface inherent in such flows means analytical progress is more difficult than in the better-known study of flow in helical pipes. By making the physically realistic assumption that the fluid depth is small relative to the channel width, we are able to find an analytic solution for flow in a channel with rectangular cross-section. This allows us to quantify the effects of the geometric parameters and the fluid flux on the flow. In some parameter regimes we see the emergence of multiple rotating cells of fluid, a novel result that may have important consequences for particle transport.

CP-We-D-63	13:30–15:30	103
Numerical Analysis		

Chair: Abreu, Eduardo — Univ. of Campinas - UNICAMP

Abstract:

▶ CP-We-D-63-1 13:30–13:50

A Conservative Unsplitting Scheme for Nonlinear Balance Laws: Application to Euler System with Stiff Relaxation Source Terms

Abreu, Eduardo — Univ. of Campinas - UNICAMP
Alvarez, Abel — Univ. of Campinas - UNICAMP
Lambert, Wanderson — Federal Univ. Rural of Rio de Janeiro

Abstract: We study traveling wave solutions for Euler systems with relaxation linked to many objectives in mind ranging from mathematical theory to numerics with applications. We developed a cheap unsplitting finite volume scheme that reproduces the same traveling wave asymptotic structure as that of the Euler solutions of the continuous system at the discrete level as well as consistent to solutions for more general Euler equations with gravity and friction found in current literature.

▶ CP-We-D-63-2 13:50–14:10

A NON-ITERATIVE IMPLICIT ALGORITHM FOR THE SOLUTION OF ADVECTION-DIFFUSION EQUATION ON A SPHERE

Skiba, Yuri — National Autonomous Univ. of Mexico

Abstract: A numerical algorithm for solving advection-diffusion equation on a sphere is suggested. The discretization of problem in space is carried out with the finite volume method and the Gauss theorem. The discretization in time is performed with the splitting method and Crank-Nicolson schemes. The numerical algorithm is of second order approximation and unconditionally stable. In the absence of forcing and dissipation, it conserves the total mass and solution norm. The split periodic problems in longitudinal direction are solved with Sherman-Morrison's formula and Thomas's algorithm. The split problems in the latitudinal direction are solved by the bordering method that requires a prior determination of the solution at the poles. The resulting linear systems have tridiagonal matrices and are solved by Thomas's algorithm. The method is direct (without iterations) and rapid in realization. It can also be applied to linear and nonlinear diffusion problems, some elliptic problems and adjoint advection-diffusion problems.

▶ CP-We-D-63-3 14:10–14:30

An Approach to the Construction of Iterative Methods for Solving Nonlinear Differential Equations

Dang, Quang A — Inst. of Information Tech., VAST

Abstract: In this paper we propose an approach to the construction of iterative methods for solving nonlinear differential equations. It is based on an iterative scheme applied to the integral equation with the kernel being the Green function for a linear part of the differential equations. This kernel serves as an efficient Lagrange multiplier in the variational iteration method. A number of examples for initial value problems of first, second and higher orders show that this method is more general and simpler than the variational iteration method, which now is widely and effectively used for nonlinear problems.

▶ CP-We-D-63-4 14:30–14:50

Stability and Temporal Accuracy of Semi-implicit Projection Methods for the Time-Dependent Incompressible Navier-Stokes Equations

Pan, Xiaomin — Yonsei Univ.
Lee, Changhoon — Yonsei Univ., Department of Computational Sci. & Engineering
Kim, Kyoungyoun — Hanbat National Univ., Department of Mechanical Engineering
Choi, Jung-Il — Yonsei Univ., Department of Computational Sci. & Engineering

Abstract: The present study focuses on analyzing the stability property and temporal accuracy of two semi-implicit projection methods such that iterative and fully decoupled methods for solving the time-dependent incompressible Navier-Stokes equations. In the projection methods, the Crank-Nicolson scheme is used for both the convection and diffusion terms, and pressure-velocity decoupling is achieved based on a block LU decomposition. Moreover, the intermediate velocity components are also decoupled in the fully decoupled method. We prove that the two methods are second-order accurate in time. In order to demonstrate the stability property, we consider kinetic energy estimation for fully-discrete Navier-Stokes equations and von Neumann analysis for linearized Navier-Stokes equations. Three types of discrete convection forms are considered in the analytical discussions. Finally, we perform numerical simulations for the well-established benchmark problems and validate the present theoretical assertions.

▶ CP-We-D-63-5 14:50–15:10

Mixed Finite Element Approximations Based on Triangular and Tetrahedral Meshes with Identical High Orders on Primal and Dual Variables

Castro, Douglas Universidade Federal do Tocantins
Devloo, Philippe Universidade Estadual de Campinas
Farias, Agnaldo Universidade Estadual de Campinas
Gomes, Sônia Universidade Estadual de Campinas
De Siqueira, Denise Universidade Tecnologica Federal do Parana

Abstract: We consider the assembly of hierarchical high order Hdiv basis functions for triangular or tetrahedral meshes, which are used for dual (velocity) approximations on mixed finite element formulations. Compatible approximation spaces of type [P(k+1), p(k)] are used, indicating total degree k of the scalar approximations of the primal variable, and maximum total degree k+1 for Hdiv subspaces. Stable approximation spaces of type [P*(k), p(k)] can also be used, with identical convergence rates for primal and dual variables. Hdiv subspaces of type P*(k) are constructed by keeping only those basis functions in P(k+1) whose normal components on element interfaces have total degree at most k. The application of static condensation is also explored, with drastic reduction in matrix dimensions. Global condensed matrices in the [P*(k), p(k)] framework have the sizes as in [P(k), p(k-1)] context, but with gain in approximation order of the primal variable.

▶ CP-We-D-63-6 15:10–15:30

Innovative Weak Galerkin Finite Element Methods with Application in Fluorescence Tomography

Wang, Chunmei Georgia Inst. of Tech.

Abstract: In this paper, a new and efficient numerical algorithm by using weak Galerkin (WG) finite elementmethods is proposed for a fourth order elliptic problem arising from Fluorescence Tomography(FT) model. Fluorescence Tomography is an emerging, in vivo non-invasive 3-D imaging technique which reconstructs images that characterize the distribution of molecules that are tagged by fluorophores. An error estimateof optimal order is derived in an H^2-equivalent norm for the WG finite element solutions. Error estimates in the usual L^2 norm are established, yielding optimal order of convergence for all the WG finite element algorithms except the one corresponding to the lowest order (i.e., piecewise quadratic elements). Some numerical experiments are presented to illustrate the efficiency and accuracy of the numerical scheme.

CP-We-D-64	13:30–15:30	104
Control and Systems Theory		
Chair: Ali, Iftikhar	King Fahd Univ. of Petroleum & Minerals	
Abstract:		

▶ CP-We-D-64-1 13:30–13:50

Numerical Investigation of Compressibility Coefficients of Gas Transport Models in Unconventional Hydrocarbon Reservoirs

Ali, Iftikhar King Fahd Univ. of Petroleum & Minerals

Abstract: Mathematical modelling of the flow mechanism of natural gas through unconventional hydrocarbon reservoirs, such as, shale gas or tight gas, results into nonlinear time-dependent convection-diffusion equations, with highly nonlinear coefficients. These coefficients are unknown and accurate and precise determination of these coefficients play crucial role in the success of the reservoir simulations. In this study, we numerically investigate several compressibility coefficients and determine which of them are most import in describing the pressure distribution in a reservoir.

▶ CP-We-D-64-2 13:50–14:10

Three-Dimensional Simulation and Visualization of Steam Flow and Heat Transfer in Power Plant Condensers

Nedelkovski, Igor Univ. "St. Kliment Ohridski"

Abstract: Description of the three-dimensional procedure for numerical computation and visualization of steam flow in power plant condensers is presented in this paper. The purpose of the present study is to develop an algorithm that can be used to predict the nature of three-dimensional fluid flow and heat transfer in large condensers of power plants. In order to demonstrate the applicability and predictive capability of the proposed method, both the three-dimensional and two-dimensional procedures are applied to simulate velocity, pressure and air mass fraction in experimental condensers. The numerical results obtained are compared with the experimental results of these condensers, as appearing in the relevant literature on numerical simulation.

▶ CP-We-D-64-3 14:10–14:30

Nutrient Uptake by Roots of Crops in Fixed and Variable Soil Volume

Reginato, Juan Carlos Depatment of Physis, Sci. Faculty, National Univ. of Fourth River

Abstract: Nutrient uptake by roots of crops in fixed and variable volume of soil is reviewed. Studied models are the fixed 1D boundary model (Roose and Schnepf, 2008), 3D-architectural models (Dunbabin et al., 2013) and an improved version of our moving 1D-boundary model (Reginato et al., 2000). Moving boundary model is solved by adaptive finite element method. Comparison of predicted cumulative uptake in fixed and variable soil volume versus observed results are shown. For low concentrations the moving boundary produces better predictions particularly for K. For P the moving boundary produces better predictions only at low concentrations being these predictions comparable to the obtained by 3D-dimensional architectural models. Obtained improvements are due to use a generalized formula for the cumulative nutrient uptake, to the use a same dynamics to obtain influxes and the cumulative uptake and, the use of finite element method assuring that only our model satisfies the mass balance.

▶ CP-We-D-64-4 14:30–14:50

A Lattice Hydrodynamic Traffic Flow Model on A Two-dimensional Network

Redhu, Poonam IIT Ropar
Gupta, Arvind Indian Inst. of Tech. Ropar

Abstract: The study of traffic flow is very complex and depends on the interactions of a large number of vehicles on networks which can be studied using multi-dimensional models. In this study, we propose a two-dimensional lattice hydrodynamics model to take into account passing effect. We examine the effect of passing analytically and numerically on traffic network. We have derived the modified Korteweg-de Varies equation from nonlinear analysis to describe the traffic in term of kink-antikink soliton density wave. We describe the traffic flow in term of the jamming transitions occur form the uniform traffic flow, through the chaotic density waves flow, to the kink density flow with an increase in driver's sensitivity. From numerical tests, we investigate the effect of passing constant and observed that no jam region reduces with an increase in the value of passing constant for all possible configurations of vehicles. Numerical predictions agree with theoretical results.

▶ CP-We-D-64-5 14:50–15:10

Active Disturbance Rejection Control Approach to the Stabilization of Euler-Bernoulli Beam with Pointwise Input Disturbance

Zhang, Yu-Long Bejing Inst. of Tech.
Wang, Jun-Min Beijing Inst. of Tech.

Abstract: We consider the stabilization of Euler-Bernoulli beam with pointwise input disturbance. The active disturbance rejection control (ADRC) approach is adopted in this investigation. We estimate the disturbance and cancel it by constructing an extended state observer. It is shown that the closed-loop system is asymptotically stable in the feedback loop with its online estimation.

▶ CP-We-D-64-6 15:10–15:30

A Parallel Tempering-Multicanonical Sampling Approach for Studying the Aggregation of Bead Polymers

Xu, Yuanwei Univ. of Warwick
RODGER, MARK Univ. of Warwick

Abstract: A lattice Monte Carlo model is used to model certain types of protein aggregation in biological membranes. We show that a modified version of parallel tempering that incorporates dynamic weighting fell short of estimating equilibrium expectations reliably. A new sampling scheme which attempts to combine the merits of PT and multicanonical sampling has shown to be very effective. It relies on deriving best estimator for the log density of states from the MBAR estimator.

CP-We-D-65	13:30–15:30	105
Optimization and Operations Research		
Chair: Gu, Lemin	Tongji Univ.	
Abstract:		

▶ CP-We-D-65-1 13:30–13:50

Z-Chebyshev Optimal Approximation and Method

Gu, Lemin Tongji Univ.

Abstract: In discrete data processing,Chebyshev optimal approximation has constituted Minimax approximation (minimizing the maximum absolute error approximation). According to the law of unity and opposites, there must be an approximation called "Mini-mini approximation" (minimizing the minimal absolute error approximation).From the best approximation point of view, the result of "Mini-mini approximation" must be zero, so called "zero-error approximation". Kneading the two together constitute a novel "Z-Minimax approximation (zero-error type of Minimax approximation). In this paper,Z-Minimax approximation is studied,Z-Chebyshev polynomials introduced,the approximation cri-

teria provided,the realization way of solution described, Z-minimax method built, describe the process of "Change Channel" theory presented,and a new growth model PEE model is drawn out. The paper is pointed out that due to the introduction of zero-error, Z-Minimax approximation may overcome some shortcoming of Minimax approximation, also broaden the scope of application. In relation to description of the security issues, the controllability questions, key point's protection, short-term forecasting, large data segmentation have extensive applications. Through 2 application examples, one is Chinese 2000-2013 years of total energy consumption, another is the change of the world's population in half a century(1960-2010), introduces Z-Minimax method.

▶ CP-We-D-65-2 13:50–14:10

Design Decisions System with Different Production Strategies

Tashakori, Laleh Department of engineering, Islamic Azad Univ., Yazd Branch

Abstract: For response and survival in the market, competition is needed and the organizations should be flexible to variations of market. In addition, they ought to utilize their maximum capacity and reduce storage costs. According to the demand of product, choosing the appropriate production strategy can help to achieving these goals. In this paper, we examine the market to identify competitors. Then, we examine different strategies and present a model for selecting production strategy. In this paper, the idea of the algorithm "Knapsack" is used to select production strategy. Moreover, we have attempted to utilize simple numerical method for solving model. The diverse production strategies which we interpret them in this paper are: MTS, MTO, ATO and ETO. Finally, the numerical experiments reveal to show the advantages of the applied mathematical programming model.

▶ CP-We-D-65-3 14:10–14:30

Algorithms for Solving Convex Separable Minimization Problems with Bounded Variables

Stefanov, Stefan South-West Univ. "Neofit Rilski", Blagoevgrad

Abstract: In this paper, minimization problems with a convex separable objective function subject to a convex separable inequality constraint of the form "'less than or equal to" / linear equality constraint / linear inequality constraint of the form "'greater than or equal to", respectively, and bounds on the variables are considered. Such problems arise in both theoretical considerations and in practical problems. For the first and the second problem, a necessary and sufficient condition is proved for a feasible solution to be an optimal solution to the respective problem, and a sufficient condition is proved for a feasible solution to be an optimal solution to the third problem. Algorithms of polynomial complexity for solving the three problems are proposed and convergence of these algorithms is proved. Some particular problems of the considered forms as well as computational results are presented.

▶ CP-We-D-65-4 14:30–14:50

Structured Low Rank Approximation: An Unconstrained Optimization Formulation

Khare, Swanand Indian Inst. of Tech. Kharagpur

Abstract: Structured Low Rank Approximation (SLRA) problem is a well known problem in the field of numerical linear algebra with applications in theoretical computer science, control theory, and image processing. The SLRA problem is the problem of finding the nearest low rank approximation to a given structured matrix preserving structure. Various approaches of computing SLRA are discussed in the literature; for instance total least squares formulation, use of algebraic geometric techniques, and stochastic optimization. All these formulations treat the SLRA problem as a constrained optimization problem. In this talk, we present the SLRA problem as an unconstrained optimization problem on a matrix manifold. We then use second order convergence methods like Newton's method to obtain the minima, namely the nearest SLRA to a given structured matrix. The numerical results are discussed for linearly structured matrices such as Hankel, Sylvester and Toeplitz structure which are of particular interest in aforementioned application areas.

MS-We-D-66 13:30–15:30 VIP4-3

Moving interface and free boundary problems in biology - Part I of II

For Part 2, see MS-We-E-66

Organizer: Ranner, Thomas Univ. of Leeds
Organizer: Venkataraman, Chandrasekhar Univ. of Sussex

Abstract: Moving interface and free boundary problems arise in the modelling of a variety of biological phenomena such as tumor growth, cell motility, population dynamics and pattern formation. The models involve systems of nonlinear PDE and the analysis of such models is at the forefront of current research. Often analytical solutions are unavailable and state-of-the-art numerical methods are required for the simulation of the model equations. The goal of this mini-symposium is to foster the exchange of ideas by bringing together analysts, modellers and experts in scientific computing who share an interest in biological free boundary problems.

▶ MS-We-D-66-1 13:30–14:00

A Hydrodynamic Activ Polar Gel Theory for Cell Motility - Modeling and Numerics

Voigt, Axel TU Dresden

Abstract: We consider a detailed computational study of the motility mechanism due to myosin-actin interactions in 2D cells. We explain the used model, which is formulated in a diffuse interface description, demonstrate thermodynamic consistancy of the overall model (without the active components), consider an adaptive finite element discretization in space and a semi-implicit time discretization for the system of equations and show convergence studies for critical macroscopic parameters.

▶ MS-We-D-66-2 14:00–14:30

FCT-stabilized Finite Element Level-set-based Method for PDEs on Surfaces and Preservation of Area and Volume Constraints for Incompressible Lipid Membranes

Sokolov, Andriy TU Dortmund

Abstract: we discuss the construction of the FCT-stabilized finite element level-set-based method for for reaction-diffusion-convection equations on evolving-in-time surfaces. The level-set methodology is used for an implicit prescription of an evolving surface, and high-order FCT/TVD stabilization methods are incorporated for the numerical treatment of arising convective/advective terms. The whole framework is expanded to the case of numerical simulations of incompressible lipid membranes, where area and volume preservations of a surface are of a big importance.

▶ MS-We-D-66-3 14:30–15:00

Modelling Plant Cell Invasion by the Rice Blast Fungus

Styles, Vanessa Univ. of Sussex

Abstract: We present a mathematical model for plant cell invasion by the rice blast fungus. The model couples an evolution law for the growth of a tumour on the plant leaf to a reaction diffusion system that holds on the surface of the tumour. We derive a finite element approximation to the model and we show some computational results.

▶ MS-We-D-66-4 15:00–15:30

An Unfitted DG Scheme for Coupled Bulk-surface PDEs on Complex Geometries

Westerheide, Sebastian Inst. for Computational & Applied Mathematics, Univ. of Muenster, Germany
Engwer, Christian Inst. for Computational & Applied Mathematics, Univ. of Muenster, Germany

Abstract: We propose a numerical scheme for a class of coupled PDEs on complex-shaped, time-dependent domains and their surfaces, which possibly undergo strong anisotropic deformations and changes in topology. It decouples geometry and computational mesh by using an implicit level set description of the geometrical setup and employing the unfitted DG method, together with a consistent extension for surface PDEs which is inspired by the Eulerian surface FEM. Biological processes yield model problems for numerical experiments.

EM-We-E-01 16:00–18:00 311A

Third Workshop on Hybrid Methodologies for Symbolic-Numeric Computation - Part VI of VIII

For Part 1, see EM-Mo-D-01
For Part 2, see EM-Mo-E-01
For Part 3, see EM-Tu-D-01
For Part 4, see EM-Tu-E-01
For Part 5, see EM-We-D-01
For Part 7, see EM-Th-BC-01
For Part 8, see EM-Th-D-01

Organizer: Giesbrecht, Mark Univ. of Waterloo
Organizer: Kaltofen, Erich North Carolina State Univ.
Organizer: Safey El Din, Mohab Univ. Pierre & Marie Curie
Organizer: Zhi, Lihong Acad. of Mathematics & Sys. Sci.

Abstract: Hybrid symbolic-numeric computation methods, which first appeared some twenty years ago, have gained considerable prominence. Algorithms have been developed that improve numeric robustness (e.g., in quadrature or solving ODE systems) using symbolic techniques prior to, or during, a numerical solution. Likewise, traditionally symbolic algorithms have seen speed improvements from adaptation of numeric methods (e.g., lattice reduc-

tion methods). There is also an emerging approach of characterizing, locating, and solving "interesting nearby problems", wherein one seeks an important event (for example a nontrivial factorization or other useful singularities), that in some measure is close to a given problem (one that might have only imprecisely specified data). Many novel techniques have been developed in these complementary areas, but there is a general belief that a deeper understanding and wider approach will foster future progress. The problems we are interested are driven by applications in computational physics (quadrature of singular integrals), dynamics (symplectic integrators), robotics (global solutions of direct and inverse problems near singular manifolds), control theory (stability of models), and the engineering of large-scale continuous and hybrid discrete-continuous dynamical systems. Emphasis will be given to validated and certified outputs via algebraic and exact techniques, error estimation, interval techniques and optimization strategies.
Our workshop will follow up on the seminal SIAM-MSRI Workshop on Hybrid Methodologies for Symbolic-Numeric Computation held in November 2010 and the Fields Institute Workshop on Hybrid Methodologies for Symbolic-Numeric Computation, November 16-19, 2011 at the University of Waterloo, Canada. We will provide a forum for researchers on all sides of hybrid symbolic-numeric computation.

▶ EM-We-E-01-1 16:00–16:30

Chordal Structure and Polynomial Systems

Parrilo, Pablo Massachusetts Inst. of Tech.

Abstract: Techniques based on chordal structure and bounded treewidth have been extensively studied in linear algebra, graphical models, constraint satisfaction, database theory, and many other areas. It is natural then to analyze to what extent chordality might also help to solve systems of polynomial equations. To this end, we propose a new technique, which we refer to as chordal elimination, that relies in elimination theory and Gröbner bases. By maintaining the graphical structure of the input polynomial system in all computations, chordal elimination can outperform standard Gröbner basis algorithms in many cases. Besides the theoretical developments, in this talk we will illustrate the suitability of our methods in examples arising from graph colorings, cryptography, sensor localization and differential equations. Based on joint work with Diego Cifuentes (MIT).

▶ EM-We-E-01-2 16:30–17:00

Algebraic Boundaries of Convex Sets

Sinn, Rainer Georgia Inst. of Tech.

Abstract: The algebraic boundary of a convex semi-algebraic set is defined by the polynomial vanishing on its boundary. We give a description of this polynomial in terms of convex and projective duality and discuss computational issues as well as applications in optimization and statistics.

▶ EM-We-E-01-3 17:00–17:30

Symbolic-numeric Methods for Linear and Integer Programming

Steffy, Dan Oakland Univ.

Abstract: Linear and integer programming are widely used for solving problems in applied mathematics and operations research. Typical solution techniques, such as the branch-and-cut paradigm, utilize a combination of numerical and discrete algorithms. We will discuss the interplay between the numerical methods and discrete algorithms used within the solution process and see how special attention to numerical accuracy and conditioning at certain points in these algorithms can lead to improved speed and accuracy.

▶ EM-We-E-01-4 17:30–18:00

Problems on Symbolic Computation of Polynomial Equations in Wavelet Analysis

Han, Bin Univ. of Alberta

Abstract: Wavelet analysis is an interdisciplinary area with many successful applications in mathematics and applied sciences. Design of wavelet filter banks plays the key role in wavelet applications and is closely linked to symbolic/numerical solutions of multivariate polynomial equations. We first provide a short introduction to wavelet analysis and then we discuss several problems about solving multivariate polynomial equations arising from wavelet analysis. Suggestions from applied algebraic geometry community to attack these problems are greatly appreciated.

EM-We-E-02 16:00–18:00 309A

Differential Algebra and Related Topics - Part VI of VIII

For Part 1, see EM-Mo-D-02
For Part 2, see EM-Mo-E-02
For Part 3, see EM-Tu-D-02
For Part 4, see EM-Tu-E-02
For Part 5, see EM-We-D-02
For Part 7, see EM-Fr-D-02
For Part 8, see EM-Fr-E-02

Organizer: Feng, Ruyong Acad. of Mathematics & Sys. Sci.,CAS
Organizer: Guo, Li Rutgers Univ. at Newark, USA
Organizer: Gao, Xiao-Shan Acad. of Mathematics & Sys. Sci., Chinese Acad. of Sci.

Abstract: This meeting is to offer an opportunity for participants to present original research , to learn of reserch progress and new developments on differential algebra and related topics, particularly, the applications of differential algebra to control theory, physics, chemistry, biology and so on.

▶ EM-We-E-02-1 16:00–16:30

On the Computation of the Difference-differential Galois Group for A Second-order Linear Difference Equation

Arreche, Carlos North Carolina State Univ.

Abstract: Given a linear difference equation, there is a difference-differential Galois group that encodes the differential-algebraic dependencies among the solutions of the equation. I will describe algorithms to compute the Galois group associated to a second-order linear difference equation over C(x), the field of rational functions over the complex numbers, with respect to the shift automorphism that sends x to x+1. I will also discuss some concrete examples to illustrate these algorithms.

▶ EM-We-E-02-2 16:30–17:00

A Framework for the Study of the Classical Yang-Baxter Equation

Bai, Chengming Chern Inst. of Mathematics, Nankai Univ.

Abstract: In this talk, I introduce a framework for the study of the classical Yang-Baxter equation. It was formed gradually from the study on the unification of the tensor and the operator forms of the classical Yang-Baxter equation with some algebraic structures behind them. Under this framework, we have obtained some results like certain generalizations of the classical Yang-Baxter equation with motivation from the study of integrable systems, some new algebraic structures with an operadic interpretation and some bialgebraic structures.

▶ EM-We-E-02-3 17:00–17:30

A Galoisian Approach to the Irreducibility of Painlevé Equations

Weil, Jacques-Arthur Limoges Univ.

Abstract: This is joint work with Guy Casale. We study the irreducibility of non-linear differential equations by means of the differential Galois group of their variational equations. We show that if the dimension of the Galois group of a variational equation is large enough then the equation must be irreducible. We propose a method to compute this dimension algorithmically via reduced forms. We illustrate this on Painlevé equations.

▶ EM-We-E-02-4 17:30–18:00

On the Integrability of B-type KdV Equations

Mei, Jianqin Dalian Univ. of Tech.

Abstract: The painleve integrability, Lax integrability, bilinear integrability for B-type KdV equation have been explored. The tau function, Backlund transformation, N-soliton solutions and Riemann-theta function solutions have been constructed.

MS-We-E-03 16:00–18:00 306A

Reduced-order modeling in uncertainty quantification and computational fluid dynamics - Part III of III

For Part 1, see MS-Mo-D-32
For Part 2, see MS-Mo-E-32

Organizer: Chen, Peng ETH Zurich (Swiss Federal Inst. of Tech. in Zurich)
Organizer: Quarteroni, Alfio EPFL
Organizer: Rozza, Gianluigi SISSA, International School for Advanced Studies

Abstract: This proposed minisymposium is about the development and application of reduced-order modeling techniques in the fields of uncertainty quantification and computational fluid dynamics for control, optimization and design. Large-scale computing is commonly faced in these fields due to the high computational complexity of solving parametric and/or stochastic systems described by, e.g. partial different equations, which may lead to unaffordable computational burden for real-world application. In order to tackle this

challenge, reduced-order modeling (e.g. RB, POD, EIM, PGD) techniques with the aim of capturing and utilizing the most important features of these systems are particularly in need for real-time and/or many-query computing.
This minisymposium focuses on the development and application of reduced-order modeling techniques in following themes: 1. efficient and reliable a posteriori error estimates for reduced solution and output; 2. forward uncertainty quantification problems, e.g. sensitivity analysis, risk prediction or reliability analysis with scientific and engineering applications; 3. stochastic inverse problems (model calibration, parameter identification) by variational or Bayesian approach; 4. control, optimization and design in computational fluid dynamics possibility under uncertainties.
Reduced-order modeling techniques have undergone fast development during the last decade and become a new frontier in scientific computing. Their increasing popularity is witnessed by many minisymposia at congress and conferences around the world, such as ICIAM, ICOSAHOM, WCCM, SIAM CSE, SIAM UQ, ECCOMAS, ENUMATH. The aim of this minisymposium is to discuss the most recent development of these techniques with emphasis in the field of UQ and CFD and identify new directions and perspectives. For this purpose we have invited 12 speakers with great expertise from several universities around the world, e.g. (MIT, Stanford, Paris VI, EPFL, TU Munich, CAS, Sandia National Laboratories, etc.)

▶ MS-We-E-03-1 16:00–16:30

Different Approaches for the Approximation by Reduced Basis Approximations

Mula, Olga — RWTH Aachen
Maday, Yvon — Laboratoire J.-L. Lions, Univ. Pierre et Marie Curie

Abstract: Accurate approximation of unknown functions with methods with small computational complexity is a general challenge that is still actual even though the computer capacity are explosing to exacomputing! The various approaches differ already by the way the function are characterized. Either we are able to get some pointwise values, or some measurements or outputs, or we know an equation (e.g. a PDE). These definition infer different approximations that we shall present with various applications.

▶ MS-We-E-03-2 16:30–17:00

Stochastic Collocation Methods on Unstructured Meshes and Their Applications to UQ

ZHOU, TAO — AMSS, the Chinese Acad. of Sci.
Narayan, Akil — Univ. of Massachusetts Dartmouth

Abstract: The talk is concerned with the stochastic collocation methods for UQ applications. We will first discuss a general framework of stochastic collocation methods, and then particular attentions are then given to the discrete least-squares approximations. Recent developments will be reviewed.

▶ CP-We-E-03-3 17:00–17:20

Hierarchical Bayesian Learning for Two-Dimensional Turbulent Bottom Gravity Currents

Lin, Jing — Massachusetts Inst. of Tech.
Lolla, Tapovan — Massachusetts Inst. of Tech.
Haley, Patrick — Massachusetts Inst. of Tech.
Lermusiaux, Pierre — MIT

Abstract: Bayesian inference in high-dimensional chaotic dynamical systems, such as turbulent fluid flows, is challenging because of the high computational costs in capturing the multiscale dynamics and integrating over high-dimensional state variables to compute posteriors. To overcome this difficulty, we developed a novel hierarchical Bayesian learning methodology. The methodology propagates uncertainty in a reduced subspace using the dynamically orthogonal (DO) equations, and jointly infers state variables and model parameters by the Gaussian mixture model-DO filter. Based on the evolving statistics and the sequential observations, the underlying models are learned dynamically in a hierarchical Bayesian way. This methodology is applied to a two-dimensional realistic turbulent bottom gravity current. The learning targets include initial and boundary functional data, domain geometry and model parameters. The numerical results indicate the capability and efficiency of our hierarchical Bayesian learning methodology for capturing non-Gaussian statistics and nonlinear dynamics in high-dimensional multiscale ocean flows.

IM-We-E-04 16:00–18:00 308

Mathematics and Algorithms in Computer-Aided Manufacturing, Manufacturing Systems and Numerical Control - Part VI of VI

For Part 1, see IM-Mo-D-04
For Part 2, see IM-Mo-E-04
For Part 3, see IM-Tu-D-04
For Part 4, see IM-Tu-E-04
For Part 5, see IM-We-D-04

Organizer: Li, Hongbo — Acad. of Mathematics & Sys. Sci., Chinese Acad. of Sci.
Organizer: Shpitalni, Moshe — Technion, Israel

Abstract: The fast development of advanced manufacturing technology has witnessed the growing importance of mathematical methods and algorithms, ranging from algebraic geometry, discrete geometry and differential geometry to differential equations, computational mathematics and computer mathematics. Conversely, problems arising from the field of advanced manufacturing have also stimulated the development of such branches in pure and applied mathematics as computational geometry and mathematics mechanization.
Mathematics and Algorithms for Computer-Aided Manufacturing, Engineering and Numerical Control is intended to be an interdisciplinary forum focusing on the interaction between the side of mathematical methods and algorithms, and the other side of computer-aided manufacturing (CAM), computer-aided engineering (CAE) and computer numerical control (CNC). It concentrates on (but is not restricted to) the following topics: tool path planning, multiscale simulation, feature-based process chain with CAM/CNC coupling, interpolation for CNC controllers.
The proposed industrial mini-symposium of 20 talks will provide an excellent platform for the participants to get acquainted with new research results, to exchange new ideas, and to create new collaboration.
To ensure full success of the proposed mini-symposium, we have invited 8 speakers from abroad. All are knowledgeable world experts in their fields, with impressive records of research, publications and awards, as well as solid background of mathematics. The invited speakers are from various countries and represent different aspects in Manufacturing, Manufacturing Systems and Computer Numerical Control.

▶ IM-We-E-04-1 16:00–16:45

Tool Orientation Optimization for 5-axis Machining with C-space Method

Chun-Ming, Yuan — AMSS, CAS
Shen, Li-Yong — Univ. of Chinese Acad. of Sci.

Abstract: Tool orientations are sensitive for 5-axis machining. In this talk, we will propose new methods to compute the C-spaces and to give the smooth tool orientations for sculptured surface.

▶ IM-We-E-04-2 16:45–17:30

Avoiding 5-axis Singularities Using Additional Matrix Transformation

Lixian, Zhang — Acad. of Mathematics & Sys. Sci. Chinese Acad. of Sci.
Wen, Yong — Chinese Acad. of Sci.
Gao, Xiao-Shan — Acad. of Mathematics & Sys. Sci., Chinese Acad. of Sci.
Li, Hongbo — Acad. of Mathematics & Sys. Sci., Chinese Acad. of Sci.

Abstract: In 5-axis machining, the inverse kinematics transformation generates singular positions for which incoherent movements of rotary axes appear. Hence, the machining quality cannot be guaranteed in this area. In this paper, we proposed a method to change the tool path in the machine coordinate by changing the relative configuration between the machine coordinate and the workpiece coordinate so that the tool does not traverse the singular area. Our purpose is illustrated through the example of the machining of a S-shaped workpiece. The experiment shows the efficiency of our method: the machining quality and the dynamic performance of the machine tool are both improved.

▶ IM-We-E-04-3 17:30–18:00

Approximately Proper Reparametrization of Rational Curves and Surfaces

Shen, Li-Yong — Univ. of Chinese Acad. of Sci.

Abstract: Simplifying the rational parametrizations of numerical rational curves and surfaces is a basic problem CAGD. One possible way is to reduce their improper index they have. For given numerical rational curves and surfaces, we first consider the properness of their lattice supports, since the curves and surfaces defined on proper lattice supports are proper with probability one. A new lattice support transformation algorithm is proposed for

improper supports .

MS-We-E-05 16:00–18:00 215
Recent advances in distributed control of multi-robot systems

Organizer: Cheng, Long — Inst. of Automation, Chinese Acad. of Sci.
Organizer: Wang, Hanlei — Beijing Inst. of Control Engineering
Organizer: Zhao, Dongya — China Univ. of Petroleum

Abstract: Recent years have witnessed the rapid development of distributed control of multi-robot systems because the multi-robot system has some distinguished features such as the flexibility, low-cost and high tolerance to disturbances. As the number of robots increases, the centralized organization of multi-robot systems encounters many disadvantages. A promising way is to organize the multi-robot system in a distributed manner. This will bring difficulties in the design of corresponding control approaches. This minisymposia aims at attracting contributions of distributed control of multi-robot systems and provides a forum for researchers in this field.

▶ MS-We-E-05-1 16:00–16:30
Synchronized Control for Multiple Lagrange System
Zhao, Dongya — China Univ. of Petroleum

Abstract: With the advances in production, more and more tasks require cooperation in the mechanical systems. The multiple machineries are required to work in cooperative manner. For high-precision machineries, the moving parts are required to work in coordinated mode. Synchronized control approach is an effective solution for cooperation of mechanical systems. It becomes a hot issue in academia and industry.

▶ MS-We-E-05-2 16:30–17:00
Leader-Follower Flocking Based on Distributed Event-triggered Hybrid Control
Yu, Pian — Wuhan Univ.
Ding, Li — Wuhan Univ.
Liu, Zhiwei — Wuhan Univ.
Guan, Zhihong — Huazhong Univ. of Sci. & Tech.

Abstract: A novel hybrid control algorithm is proposed in this paper to achieve leader-follower flocking in multi-agent systems. The proposed algorithm only use position state continuously while the velocity state is utilized discretely. The sampling instant is governed by a distributed event-triggered mechanism in which neighbors’ velocity is not required to verify the event-triggered condition. It is shown that stable flocking is achieved asymptotically while the connectivity of networks can be preserved for the whole process.

▶ MS-We-E-05-3 17:00–17:30
On the Task-space Consensus of Networked Robotic Systems without Task-space Velocity Measurement
Wang, Hanlei — Beijing Inst. of Control Engineering
Xie, Yongchun — Beijing Inst. of Control Engineering

Abstract: In this paper, we investigate the task-space consensus problem for multiple robotic systems with both the uncertain kinematics and dynamics in the case of existence of constant communication delays. We propose an observer-based adaptive control scheme to achieve the consensus objective without relying on the measurement of task-space velocities. By Lyapunov-like analysis and iBIBO-stability-based analysis, we demonstrate that the task-space positions of the robotic systems converge to the scaled weighted average of their initial values.

▶ MS-We-E-05-4 17:30–18:00
Containment Control of Continuous-time Linear Multi-agent Systems with Aperiodic Sampling
Liu, Huiyang — Univ. of Sci. & Tech. Beijing
Cheng, Long — Inst. of Automation, Chinese Acad. of Sci.

Abstract: In this paper, the containment control problem of continuous-time linear multi-agent systems is investigated. An aperiodic sampled-data based protocol for containment control is induced by using neighboring information with uncertainly time-varying sampling intervals. By using the proposed protocol, the closed-loop multi-agent system is transformed into a discrete-time system with the discrete way. Utilizing properties of Laplacian matrix, the containment control problem is equivalent to a stability problem. The stability analysis is based on the robustness of related discrete-time systems against perturbation caused by the variation of sampling intervals. By using small-gain theorem, sufﬁcient conditions are obtained to guarantee the stability of uncertain discrete-time systems. Furthermore, two special cases are given to illustrate the method proposed in this paper. The theoretical results are veriﬁed by some simulations.

MS-We-E-06 16:00–18:00 201
Analysis of nonsmooth PDE systems with applications to material failure - Part II of II
For Part 1, see MS-We-D-06

Organizer: Knees, Dorothee — Univ. of Kassel
Organizer: Thomas, Marita — Weierstrass Inst. for Applied Analysis & Stochastics (WIAS Berlin)

Abstract: The understanding and modeling of failure processes in solids is a central task in materials sciences. Mathematical models typically result in highly nonlinear, coupled systems of partial differential equations, where additional nonsmooth constraints, as for instance the unidirectionality of evolution processes or the impenetrability of the material, have to be taken into account. This minisymposium intends to discuss recent advances in the mathematical treatment of failure phenomena, and brings together scientists from the fields of modeling, analysis, and numerics. Analytical methods and numerical strategies both for (quasi-)static and rate-dependent, non-smooth failure models will be presented.

▶ MS-We-E-06-1 16:00–16:30
Analysis of Crystalline Defects
Ortner, Christoph — Univ. of Warwick

Abstract: I will present a general framework for the analysis of material defects embedded into a homogeneous crystalline environment. A key result in this framework is a generic regularity estimate that gives qualitatively sharp bounds on the ”defect core”. I will then show examples how this framework can be employed (i) in the analysis of dislocation models, (ii) multi scale simulation, and (iii) to construct atomistic models of material failure.

▶ MS-We-E-06-2 16:30–17:00
Phase-field Approach for Quasi-static Evolutions in Fracture Mechanics
Negri, Matteo — Univ. of Pavia

Abstract: We consider a couple of quasi-static evolutions obtained by sequences of time-discrete incremental minimization problems generated by a locally minimizing movement (w.r.t. H^1 and L^2 norm) and by the alternate minimization scheme. We characterize their time-continuous limits as parametrized BV-evolutions in terms of stationarity and energy balance. We provide then some physical properties in terms of energy release and thermodynamical consistency of the irreversibility constraint.

▶ MS-We-E-06-3 17:00–17:30
An Irreversible Gradient Flow and Its Application to A Crack Propagation Model
Kimura, Masato — Kanazawa Univ.

Abstract: We consider a nonlinear diffusion equation with irreversible property and construct a unique strong solution by using implicit time discretization. A new regularity estimate for the obstacle problem is established and is used in the construction of the strong solution. An application to a crack propagation model is also presented.

▶ MS-We-E-06-4 17:30–18:00
Dynamics of Microstructure: the Example of A Damage Model
Garroni, Adriana — Sapienza, Univ. of Rome

Abstract: Many models in material science (as plasticity, damage, phase transition or fracture), involve non convex energies. This lack of convexity is responsible for the formation of microstructure and represents a serious issue in the study of evolution problems. I will focus on a simple, but yet enough rich, model for elastic brittle damage introduced by Francfort and Marigo in which many of main questions related to evolution of microstructure can be successfully addressed.

MS-We-E-07 16:00–18:00 202A
Uncertainty Quantification for Applications in Earth Sciences - Part I of II
For Part 2, see MS-Th-BC-07

Organizer: Tong, Charles — Lawrence Livermore National Laboratory
Organizer: Duan, Qingyun — Beijing Normal Univ.

Abstract: Accurate prediction and reliable decision-making in earth systems (watershed, groundwater contamination, carbon sequestration, geothermal reservoir, nuclear waste disposal, etc.) are always challenged by uncertainties of conceptual models, parameters, and experimental and field data. Deterministic models of earth systems are traditionally developed on a single, but presumably ”known” geologic structure with ”certain” system properties, and may not provide the credibility and confidence in decision making and system forecasting. For this reason, uncertainty quantification (UQ) has been studied, as a branch from mathematics, statistics, and computer science, and applied in developing robust models and simulations in earth systems.
This mini-symposium is proposed to encompasses theoretical UQ study, com-

putational methodology development, and applications in earth systems. We encourage presentations on the studies of model-form and parametric uncertainties, sensitivity analyses, reduced-order model development, uncertainty reduction, uncertainty propagation, risk assessment, and decision-making. We welcome application studies in climate change, hydrologic systems, subsurface flow and reactive transport, subsurface energy storage, CO2 geological sequestration, and clear waste disposal, environmental remediation, natural hazard prediction, etc.

▶ MS-We-E-07-1 16:00–16:30

UQ-PyL - A GUI Platform for Uncertainty Quantification of Complex Environmental Models

Wang, Chen Beijing Normal Univ.
Duan, Qingyun Beijing Normal Univ.
Tong, Charles Lawrence Livermore National Laboratory
Wei, Gong Beijing Normal Univ.

Abstract: Uncertainty quantification (UQ) is widely used in environmental engineering to propagate and quantify uncertainty. Here we describe a UQ platform called UQ-PyL (Uncertainty Quantification Python Laboratory), a flexible, user-friendly GUI platform designed to quantify uncertainty of complex dynamical models. UQ-PyL integrates different kinds of UQ methods, including experimental design, uncertainty analysis, sensitivity analysis, surrogate modeling and parameter optimization.We illustrate the different functions of UQ-PyL by applying it to the calibration of a hydrological model.

▶ MS-We-E-07-2 16:30–17:00

Multi-Objective Adaptive Surrogate Modeling-Based Optimization for Parameter Estimation of Large Complex Geophysical Models

Wei, Gong Beijing Normal Univ.
Duan, Qingyun Beijing Normal Univ.
Wang, Chen Beijing Normal Univ.

Abstract: Geophysical models usually simulate many processes, and require a multi-objective optimization (MOO) approach to parameter estimation. MOO algorithms usually require a large number of model runs and can be computationally prohibitive for large complex models. To reduce the total number of model runs while maintaining optimization effectiveness, we developed a Multi-Objective Adaptive Surrogate Modeling based Optimization (MO-ASMO) and tested it against the classical NSGA-II algorithm with 10 test functions and a land surface model.

▶ MS-We-E-07-3 17:00–17:30

A Variance-based Decomposition and Global Sensitivity Index Method for Uncertainty Quantification: Application to Retrieved Ice Cloud Properties

Zhao, Chuanfeng Beijing Normal Univ.
Chen, Xiao Lawrence Livermore National Laboratory

Abstract: We present a UQ method for cloud microphysical property retrievals using an empirial orthogonal function with a variance-based sensitivity analysis on the US Atmospheric Radiation Measurement program's remote-sensing measurements. This method enables an objective validation of climate models against cloud retrievals under a rigorous statistical inference framework. Sensitivity analysis provides directions for improving retrieval algorithms and observation strategies. Results will be given for the iced cloud retrievals at ARMS SGP site on March 9, 2000.

▶ MS-We-E-07-4 17:30–18:00

Surrogate-based Uncertainty Analysis and Data-value Assessment for Integrated Surface-water Groundwater Modeling

Zheng, Yi Peking Univ.

Abstract: Probabilistic Collocation Method (PCM) was adopted to analyze the parametric sensitivity and uncertainty of integrated surface water-groundwater (SW-GW) models. Based on PCM, a data-value evaluation approach for integrated SW-GW modeling was also proposed. Through a case study in Zhangye Basin, the approaches' applicability have been demonstrated. The surrogate-based uncertainty analysis and data-value assessment are highly valuable to understanding hydrological processes, improving model calibration, prioritizing data collection activities, as well as to making management decisions.

MS-We-E-08 16:00–18:00 202B

The Ginzburg-Landau Model and Related Topics - Part II of IV

For Part 1, see MS-We-D-08
For Part 3, see MS-Th-BC-08
For Part 4, see MS-Th-D-08

Organizer: Golovaty, Dmitry The Univ. of Akron
Organizer: Giorgi, Tiziana New Mexico State Univ.

Abstract: The focus of the minisymposium is on mathematical problems related to Ginzburg-Landau model with application in physics and materials science including but not limited to: superconductivity, superfluidity, liquid crystals, and polymers. The speakers in this minisymposium will describe their recent research, including the development and structure of singular solutions of the Ginzburg-Landau-type problems and the dynamics of vortex motion. This minisymposium is sponsored by the SIAM Activity Group on Mathematical Aspects of Materials Science (SIAG/MS).

▶ MS-We-E-08-1 16:00–16:30

Exponential Decay of Superconductivity in the Presence of Strong Currents

Almog, Yaniv LSU

Abstract: We study the time-dependent Ginzburg-Landau equations in the presence of strong currents, but weaker than the critical current where the normal state losses its stability. In the large κ limit, we prove that the superconductivity order parameter is exponentially small in a significant part of the domain, and small in the rest of it. Some results in the large domain limit will be presented as well. Joint work with Bernard Helffer and Xingbin Pan

▶ MS-We-E-08-2 16:30–17:00

A Thin-film Limit in the Landau-Lifshitz-Gilbert Equation Relevant for the Formation of Neel Walls

Ignat, Radu Universite Paul Sabatier - Toulouse III

Abstract: We consider an asymptotic regime for 2D ferromagnetic films that is consistent with the formation of transition layers, called Neel walls. We establish compactness of S^2-valued magnetizations in the energetic regime of Neel walls and characterize the set of accumulation points. We prove that Neel walls are asymptotically the unique energy minimizing configurations. We finally study the corresponding dynamical issues, namely the compactness properties of the magnetizations under the flow of the Landau-Lifshitz-Gilbert equation.

▶ MS-We-E-08-3 17:00–17:30

Nonlocal Ginzburg-Landau/Allen-Cahn Models: Analytical and Numerical Studies

YANG, Jiang Penn State Univ.
Du, Qiang Columbia Univ.

Abstract: We present some recent studies of a time-dependent nonlinear nonlocal Ginzburg-Landau/Allen-Cahn equation based on analytical and numerical approaches. We also analyze the convergence of Fourier spectral methods for problems defined on a periodic cell and show that they are asymptotically compatible so as to provide convergent approximations to both the nonlocal model and the local limit. Numerical examples also reveal some interesting phenomena associated with steady state solutions of the nonlocal model.

▶ MS-We-E-08-4 17:30–18:00

Analysis of the Lawrence-Doniach Energy for Layered Superconductors in Magnetic Fields

Peng, Guanying Univ. of Cincinnati
Bauman, Patricia Purdue Univ.

Abstract: We analyze minimizers of the Lawrence-Doniach energy for layered superconductors occupying a bounded generalized cylinder in the three-dimensional space. For a magnetic field perpendicular to the layers in the intermediate regime, we prove an asymptotic formula for the minimum Lawrence-Doniach energy as the reciprocal of the Ginzburg-Landau parameter and the interlayer distance tend to zero. Our formula also describes the minimum three-dimensional anisotropic Ginzburg-Landau energy as the reciprocal of the Ginzburg-Landau parameter tends to zero.

MS-We-E-09 16:00–18:00 203A

Nonlocal problems: modeling, analysis and computation - Part III of III

For Part 1, see MS-Tu-E-09
For Part 2, see MS-We-D-09

Organizer: Lipton, Robert LSU
Organizer: Du, Qiang Columbia Univ.
Organizer: Mengesha, Tadele The Univ. of Tennessee

Abstract: The goal of this minisymposium is to bring together researchers work- ing on problems related to the nonlocal modeling of physical phenomena and their mathematical analysis. The theme is on modeling, analysis and simulation with a focus on nonlocal continuum equations that arise from applications. The session will be multifaceted so as to cover work related nonlocal modeling and computational simulations of models, and analyti- cal and numerical aspects such as well-posedness of nonlocal stationary and evolution equations, regularity of solutions and numerical approximations.
Nonlocal mathematical models arise naturally in many important fields and they are found to be useful where classical (local) models cease to be predic-

tive. Moreover, nonlocal models are suitable for multiscale modeling as they can be effective in capturing the underlying nonsmooth microscale fields. An example is peridynamics, a nonlocal reformulation of the basic equations of motion of continuum mechanics, which is being used to model cracks and discontinuous fields in solid mechanics. Other areas of application include image processing, modeling population aggregation, wave propaga- tion, pattern formation, and porous media flow. In this minisymposium, research works which have produced novel analytical and numerical methods for nonlocal problems will be presented.

▶ MS-We-E-09-1 16:00–16:30

Cohesive Dynamics and Fracture

Lipton, Robert — LSU
Said, Eyad — Louisiana State Univ.

Abstract: We introduce a new nonlocal, nonlinear large deformation cohesive model for describing dynamic fracture. In this peridynamic model the deforming body is split into a process zone exhibiting nonlinear force-strain behavior and a complementary zone exhibiting elastic behavior. We show using energy estimates and Gamma convergence that the length scale of nonlocal interaction controls the size of the process zone. This gives rise to the size effect seen in quasibrittle materials such as polymers.

▶ MS-We-E-09-2 16:30–17:00

A PDE Approach to Numerical Fractional Diffusion

Salgado, Abner — Univ. of Tennessee

Abstract: We study solution techniques for problems involving fractional powers of elliptic operators by realizing them as the Dirichlet to Neumann map of a nonuniformly elliptic problem posed on a semi-infinite cylinder. We derive optimal error estimates for anisotropic discretizations. We explore extensions and applications: a posteriori error analysis and adaptivity, parabolic equations with fractional diffusion and Caputo fractional time derivative and obstacle problems.

▶ MS-We-E-09-3 17:00–17:30

Surface Effect Corrections in Peridynamic Solid Mechanics

Seleson, Pablo — Oak Ridge National Laboratory

Abstract: The peridynamics theory of solid mechanics is a nonlocal generalization of classical continuum mechanics, suitable for material failure and damage simulation. Even though peridynamics enables engineering simulations involving cracks and their propagation, many problems of interest based on systems with free surfaces exhibit undesired surface effects, due to the nonlocal nature of interactions in peridynamics. In this talk, we will analyze the sources of those surface effects and propose a method to correct them.

▶ MS-We-E-09-4 17:30–18:00

Nonlocal Calculus of Variations Involving High Order Nonlocal Operators

Du, Qiang — Columbia Univ.
Tian, Xiaochuan — Columbia Univ.

Abstract: We extend recently developed nonlocal calculus of variations for the basic nonlocal operators to problems that involve high order nonlocal operators. We establish a number of nonlocal integral identities and some embedding inequalities which are extensions of their local counterpart. We discuss their applications to nonlocal beam and plate models.nonlocal operators,

MS-We-E-10 16:00–18:00 206B

Evolutionary game dynamics on complex networks: Modeling, analysis and control

Organizer: Tan, Shaolin — Hunan Univ.

Abstract: Networked games prevail in a wide range of evolutionary collective phenomena on biological, social, and engineering networks. One important and challenging problem is to model, analyze and further intervene in the networked game dynamics. Recently, the above problem has attracted increasing interest in a variety of areas. This mini-symposia mainly focus on the recent advances on modeling, analysis and control in evolutionary game dynamics on complex networks. It also aims at providing a communication platform for applications of evolutionary networked game dynamics.

▶ MS-We-E-10-1 16:00–16:30

An Evolutionary Game Dynamic Approach for Determination of the Structural Conflicts in Signed Networks

Tan, Shaolin — Hunan Univ.

Abstract: Social or biochemical networks can often divide into two opposite alliances in response to structural conflicts between positive (friendly, activating) and negative (hostile, inhibiting) interactions. Yet, the underlying dynamics how the opposite alliances are spontaneously formed to minimize the structural conflicts is still unclear. Here, we report that evolutionary game dynamics provides a felicitous tool to characterize the evolution and formation of alliances in signed networks

▶ MS-We-E-10-2 16:30–17:00

Game-theoretic Analysis of Cooperation Enforcement in Unreliable MANETs

Tang, Changbing — Zhejiang Normal Univ.

Abstract: In this report, we study cooperative packet forwarding in a one-hop unreliable channel which results from loss of packets and noisy observation of transmissions. We propose an indirect reciprocity framework based on evolutionary game theory, and enforce cooperation of packet forwarding strategies in both structured and unstructured MANETs.Furthermore, we analyze the evolutionary dynamics of cooperative strategies and derive the threshold of benefit-to-cost ratio to guarantee the convergence of cooperation.

▶ MS-We-E-10-3 17:00–17:30

Emergence of Cooperation Through Coevolving Time Scale in Spatial Prisoner's Dilemma

Rong, Zhihai — UESTC

Abstract: Game theory has for decades sought to explain why egoistic individuals cooperate even though they, in a short time perspective, would be better off not to. We will introduce the influence of the separation of interaction and strategy-updating time scales on the evolution of cooperation in spatial prisoner’s dilemma game. Through connecting the lifetime of individuals’ strategies with their fitness, the diversity of strategy-selection time scale promotes the maintenance of cooperators in networked systems.

▶ MS-We-E-10-4 17:30–18:00

Evolutionary Game on Multilayer Networks

Zhen, Wang — Kyushu Univ.

Abstract: Besides the structure of interactions within networks, also the interactions between networks are of the outmost importance. We therefore study the outcome of the evolutionary games on multilayer networks that are connected by means of a utility function, which determines how payoffs on networks jointly influence the success of players in each individual network.. To reach this aim, we consider the symmetric, asymmetric utility function and find the symmetric breaking phenomenon and the spontaneous emergence of multilayer network reciprocity. Along this line, the role of partially correlation is investigated and the optimal condition for cooperation is found. Finally, we consider the co-evolution mechanisms of evolutionary games on multilayer networks and find that the optimal cooperation can be attributed to individual self-organization trait. We hope that this framework can shed more light to solving social dilemma.

MS-We-E-11 16:00–18:00 203B

Nonlinear Eigenvalue Problems - Part II of III

For Part 1, see MS-We-D-11
For Part 3, see MS-Th-BC-11

Organizer: Kressner, Daniel — EPFL
Organizer: Su, Yangfeng — Fudan Univ.

Abstract: Eigenvalue problems that are nonlinear in the eigenvalue parameter regularly appear in the analysis of vibrations and frequency-dependent material properties. It is not uncommon to find that model reduction techniques turn linear into nonlinear eigenvalue problems (NEP). Current research directions for NEPs include efficient and reliable algorithms for problems of small size, memory-efficient and robust algorithms for large-scale problems, as well as structure-preserving algorithms for structured NEPs. This MS aims to give an overview of state-of-the-art developments on the analysis, algorithms, and applications.

▶ MS-We-E-11-1 16:00–16:30

On Spectral Analysis and A Novel Algorithm for Transmission Eigenvalue Problems

Lin, Wen-Wei — National Chiao Tung Univ.

Abstract: In this talk, we focus on the computation of some smallest positive real eigenpairs for interior transmission eigenvalue problems. Based on continuous finite elements, we derive a symmetric quadratic eigenvalue problem (QEP) to eliminate nonphysical zeros while preserve all nonzero ones. We then transform the QEP to parameterized symmetric definite generalized eigenvalue problems and develop a novel secant-type iteration. Numerical experiments show that the proposed method can find those desired eigenpairs accurately, efficiently, and robustly.

▶ MS-We-E-11-2 16:30–17:00

Nonlinear Eigenvalue Problems and Contour Integrals

Kravanja, Peter — Katholieke Universiteit Leuven

Abstract: Nonlinear eigenvalue problems involving analytic matrix functions can be solved via a numerical method related to the Sakurai-Sugiura method as well as Polizzi's FEAST algorithm for generalized eigenvalue problems. This method is based on contour integrals. These are approximated numerically by a quadrature formula, which corresponds to a filter function. In this talk the properties of such a filter function as well as its implications on the nonlinear eigenvalue approximation problem will be investigated.

▶ MS-We-E-11-3 17:00–17:30

Solving the Quadratic Eigenvalue Problem with Low-Rank Damping

LU, DING — Fudan Univ.
Bai, Zhaojun — Univ. of California, Davis
Su, Yangfeng — Fudan Univ.

Abstract: We propose a Pade Approximate Linearization (PAL) technique to solve the quadratic eigenvalue problem (QEP) with low-rank damping. The PAL technique leads to a linear eigenvalue problem of dimension n+m*r, which is substantially smaller than the dimension 2n by standard linearization scheme, where n is the dimension of the QEP, r and m are the rank of the damping matrix and Pade approximant order, respectively. Efficiency of this approach will be shown by numerical examples.

MS-We-E-12 16:00–18:00 208B

Mathematical modeling and statistical analysis of biological systems

Organizer: Wang, Pei — Henan Univ.
Organizer: Lu, Jinhu — Acad. of Mathematics & Sys. Sci., Chinese Acad. of Sci.

Abstract: Biological networks are typical real-world complex networks. Gene regulatory networks, protein-protein interaction networks, signal transduction networks are all typical biological networks. Biological networks can be explored through mathematical modeling and statistical analysis. Based on the underlying biochemical reactions in biological networks, one can establish differential equation models to describe the evolution the system, the functional characteristics of some biological circuits and so on. Further based on the complex network theory and statistical method, some more information can be mined from complex biological networks, such as explaining the topological organization of biological networks, clarifying the evolutionary mechanism of some frequently appeared biological circuits, constructing new measures to weigh the importance of nodes in biological networks. The related investigations can help us to understand the organization and functional principle of complex biological networks, which have potential implications in the artificial design and reengineering of some biological networks. Through this Mini-symposia, we expect to provide a platform for researchers to exchange idea and information on mathematical modeling and statistical analysis of biological networks.

▶ MS-We-E-12-1 16:00–16:30

Cooperative Design of Networked Observers for Stabilizing Continuous-LTI Plants

Liu, Kexin — Chinese Acad. of Sci.
Zhu, Henghui — Chinese Acad. of Sci.
Lu, Jinhu — Acad. of Mathematics & Sys. Sci., Chinese Acad. of Sci.

Abstract: This paper aims at developing a unified framework for cooperative design of networked observers to stabilize LTI plants. Apart from the traditional centralized design of MIMO system, the proposed cooperative design approach only utilizes the local information of each sensor. To four kinds of network, we obtain the conditions for the existence of the parameters that lead to the stabilization of the LTI plant. The numerical simulation is given to validate the theoretical analysis.

▶ MS-We-E-12-2 16:30–17:00

Statistical Analysis of Several Typical Biological Networks

Wang, Pei — Henan Univ.
Lu, Jinhu — Acad. of Mathematics & Sys. Sci., Chinese Acad. of Sci.

Abstract: Based on online databases and literatures, we construct several real-world biological networks. Through multivariate statistical analysis, we propose some new measures to weight the importance of nodes in networks. Further based on the duplication-divergence model, we investigate the evolution of structurally important nodes, and clarify the evolutionary mechanisms of network motifs in bio-molecular networks. The related investigations have potential real-world implications in networked medicine and so on.

▶ MS-We-E-12-3 17:00–17:30

Reconstructing Dynamic PPI Networks by Integrating Multiple Biological Data Sources

CHEN, BOLIN — Northwestern Polytechnical Univeristy

Abstract: Real cellular systems are dynamic. Many dynamic protein-protein interaction (PPI) network reconstruction methods have mainly been focused on only globally co-expressed gene pairs for stable interactions. However, numerous locally co-expressed or time-lag co-expressed gene pairs also reveal insightful information about transient interactions. In this study, a novel multiple data integration method is proposed to identify those transient interactions and a dynamic PPI network reconstruction method is introduced by using both transient interactions and stable interactions.

▶ MS-We-E-12-4 17:30–18:00

Metapopulation Synchrony

Liu, Zhiguang — Henan Univ.

Abstract: Spatial synchrony and asynchrony have been detected across a wide range of taxa and regions. Spatial synchrony can increase extinction risk and undermines metapopulation persistence. Therefore, identifying key drivers of spatial synchrony is of crucial importance for successful conservation management and pest/disease control. This report introduces the existing results and development trend about metapopulation synchrony, and some of our works in this area.

MS-We-E-13 16:00–18:00 VIP3-2

Progress in hyperbolic problems and applications - Part I of VI

For Part 2, see MS-Th-BC-13
For Part 3, see MS-Th-D-13
For Part 4, see MS-Th-E-13
For Part 5, see MS-Fr-D-13
For Part 6, see MS-Fr-E-13

Organizer: Wang, Ying — Univ. of Oklahoma
Organizer: Tesdall, Allen — City Univ. of New York, College of Staten Island

Abstract: Hyperbolic conservation laws form the basis for the mathematical modeling of many physical systems, and describe a wide range of wave propagation and fluid flow phenomena, including shock waves in nonlinear situations. For one dimensional systems with small data, a well-posedness theory of entropy weak solutions is well known. Analysis in several space dimensions, however, remains an enormous challenge. In this minisymposium, recent results in the theory and numerical analysis of hyperbolic problems will be presented. A variety of computational techniques, including finite volume, finite element, spectral, WENO, and discontinuous Galerkin methods, will be represented.

▶ MS-We-E-13-1 16:00–16:30

Shock Formation for Compressible Euler Equations

Pan, Ronghua — Georgia Inst. of Tech.

Abstract: We present our recent progress on finite time shock formation for compressible Euler Equations with large smooth initial data away from vacuum. These results, alight with classical results of Lax, John, Liu, Li-Zhou-Kong for small data, offer more complete picture to this classical problem. This talk is based on joint work with G. Chen and S. Zhu.

▶ MS-We-E-13-2 16:30–17:00

Numerical Methods for Optimal Control Problems Governed by Nonlinear Hyperbolic Systems of PDEs

Kurganov, Alexander — Tulane Univ.

Abstract: I will present a new numerical method for solving tracking-type optimal control problems subject to hyperbolic conservation laws. Our approach is based on the formal optimality system and requires numerical solutions of the nonlinear hyperbolic system forward in time and a corresponding nonconservative linear adjoint system backward in time. We use the central-upwind scheme for the forward problem, while the backward problem is solved using a second-order Roe-type upwind finite-difference scheme.

▶ MS-We-E-13-3 17:00–17:30

Neutral and Inertial Particles in Strained Turbulence

Lee, Chung-min — California State Univ. Long Beach

Abstract: Turbulence enhances transportation and mixing of particles. We study the turbulent flows and particles within the flow using a direct numerical simulation. In this talk we discuss the accelerations of neutral and inertial particles in axisymmetric expansion turbulence. We will show the acceleration variances compared with the rapid distortion theory prediction, and the probability density functions for particles with different Stokes numbers and in flows with various strain rates and Reynolds numbers.

MS-We-E-14 16:00–18:00 111

Eigenvalues of partial differential operators and their applications - Part I of III

For Part 2, see MS-Th-BC-14
For Part 3, see MS-Th-D-14

Organizer: Kao, Chiu-Yen Clarmeont McKenna College
Organizer: Osting, Braxton Univ. of Utah

Abstract: Eigenvalues and eigenfunctions are fundamental to the understanding of the dynamics and properties of solutions to partial differential equations. This minisymposium features the latest progress on numerical and theoretical approaches for solving linear and nonlinear eigenvalue problems, eigenvalue optimization, and their applications in several different and important scientific areas including mechanical vibration, optimal conductivity, photonic crystals, and shape classification and recognition.

▶ MS-We-E-14-1 16:00–16:30

Tangent Method with A Nonequivalence Deflation for Solving Nonlinear Eigenvalue Problems Arising in Three Dimensional Maxwell Equations

Huang, Tsung-Ming National Taiwan Normal Univ.
Lin, Wen-Wei National Chiao Tung Univ.
Mehrmann, Volker TU Berlin

Abstract: For solving the large-scale nonlinear eigenvalue problem (NLEP) $Ax = \lambda B(\lambda)x$, we develop a tangent iterative method with a novel nonequivalence low-rank deflation to compute a target eigenpair. The multiplicity of the zero eigenvalue of NLEP is huge and the desired eigenvalues are cluster and near to zero eigenvalue. Numerical results illustrate that our proposed method is robust even for the case of computing many eigenvalues in very large problems.

▶ MS-We-E-14-2 16:30–17:00

Fundamental Limits to the Optical Response of Metals

Miller, Owen MIT

Abstract: We present shape-independent limits to the optical response of metals and more general lossy media. From the optical theorem and energy positivity, we bound absorption and scattering, LDOS, and near-field heat transfer. We present examples of structures that reach the various bounds, and examples where all known designs fall far short. We also show how the limits arise from volume integral equations, where each response function has a sum rule over "eigen-materials."

▶ MS-We-E-14-3 17:00–17:30

Scattering Resonances for Photonic Structures and Schrodinger Operators

Lin, Junshan Department of Mathematics & Statistics, Auburn Univ.

Abstract: Resonances are important in the study of transient phenomena associated with the wave equation, especially in understanding the large time behavior of the solution to the wave equation when radiation losses are small. In this talk, I will present our recent studies on the scattering resonances for finite photonic structures and Schrodinger operators with a potential of finite-thickness barrier. Several ongoing works along this research direction will also be highlighted.

▶ MS-We-E-14-4 17:30–18:00

Numerical Shape Optimization of P-laplacian Eigenvalues

Antunes, Pedro Univ. of Lisbon

Abstract: We develop a numerical method for solving shape optimization problems involving p-laplacian eigenvalues. The eigenvalue problem is solved using an adaptive procedure with radial basis functions, while the optimization is performed with Hadamard shape derivatives. Several examples illustrate the performance of the method.

MS-We-E-15 16:00–18:00 213B

Task-oriented social network data mining

Organizer: Xuan, Qi Zhejiang Univ. of Tech.
Organizer: ZHANG, ZI-Ke Alibaba Research Center for Complexity Sci., Hangzhou Normal Univ.

Abstract: Task-Oriented Networks are communities of people who are virtually organized around and working on a common goal, or task. In addition to the social networks, there is a typical wealth of other data about these communities, e.g. records of their technical contribution. Examples of such communities are Electronic Commerce, Open Source Software (OSS) projects, Wikipedia, StackExchange, etc., where people cooperate to do business, create software, share knowledge, and provide quick and high-quality answers for different kinds of questions, respectively. These communities provide extremely large and diverse real data, which enable us to study the online cooperative behaviors comprehensively. For example, in the Electronic Commerce systems, individuals can not only make acquaintance and interact with their friends, but also accelerate marketing goods via the social channel, thus social marketing is relevant topic in the area of social networks; In OSS projects, developers contribute to large software of complex structure, so as to form the complex task networks, and meanwhile they communicate with each other to coordinate their work, so as to form the complex social network. It is being proven that the complex software structure, task network and the higher level social network have some impacts on the quality of software and the work efficiency of developers. In this Minisymposium, we will invite several experts in Electronic Commerce, Social Network, and Software Engineering to present their work on data mining in such task-oriented networks, and hope to provide some useful insights for the network research.

▶ MS-We-E-15-1 16:00–16:30

Information Transmission and Prediction on Social Networks

ZHANG, ZI-Ke Alibaba Research Center for Complexity Sci., Hangzhou Normal Univ.

Abstract: Nowadays, social networking oriented tools have been widely applied to various scenarios. One of the significant applicaitons is the e-commerce systems, in which individuals can not only make acquaintance and interact with friends, but also can accelerate marketing goods via the social channel. Therefore, social marketing and relavent topics will be discussed in this session.

▶ MS-We-E-15-2 16:30–17:00

Task-oriented Social Networks in Open Source Software Projects

Xuan, Qi Zhejiang Univ. of Tech.

Abstract: Open source software (OSS) projects combine social and technical networks in a unique way. In this presentation, we will introduce the three-level structure of OSS projects and several developer behavioral patterns, such as synchronous collaboration and focus shifting pattern. We will also associate these behavioral patterns to the code contribution of developers, which may provide some insights for the improvement of software structure and task assignments in the future.

▶ MS-We-E-15-3 17:00–17:30

Construction and Application of Software Networks in Software Engineering

Pan, Weifeng Zhejiang Gongshang Univ.

Abstract: In recent years, researchers from the software engineering community proposed to use complex networks in software, software networks, to represent software structure. Based on software networks, they introduced the complex network theory to study the software static structure, with characterizing the software structure as its focus and supporting software engineering practices as its objectives. In this Minisymposium, I will present our primary work on the application of software networks to software measurement, regression test case prioritization and software refactoring.

▶ MS-We-E-15-4 17:30–18:00

Social Commerce and Business Intelligence Techniques

Wei, Qiang Tsinghua Univ.

Abstract: The incorporation of social networking brings new opportunities and challenges for e-commerce and makes social commerce one of the emerging hot topics for both academicians and practitioners. Due to its typical big data characteristics, business intelligences techniques play an important role. In this paper, several novel business intelligence methods are introduced, e.g., internet ads title enhancement with feature extraction in social online reviews, online review helpfulness prediction/estimation with social trust network structure information, etc.

MS-We-E-16 16:00–18:30 205A

Lie Symmetries, Solutions and Conservation laws of nonlinear differential equations - Part II of III

For Part 1, see MS-We-D-16
For Part 3, see MS-Th-BC-16

Organizer: Khalique, Chaudry Masood North-West Univ., Mafikeng Campus
Organizer: Zhang, Lijun Zhejiang Sci-Tech Univ.

Abstract: This mini-symposium is devoted to all research areas that are related to nonlinear differential equations and their applications in science and engineering. The main focus of this mini-symposium is on the Lie symmetry analysis, conservation laws and their applications to ordinary and partial differential equations. These differential equations could originate from mathematical models of diverse disciplines such as architecture, chemical kinetics, civil engineering, ecology, economics, engineering, fluid mechanics, biology and finance. Other approaches in finding exact solutions to nonlinear differential equations will also be discussed. This includes, but not limited to, asymptotic analysis methodologies, bifurcation theory, inverse scattering transform techniques, the Hirota method, the Adomian decomposition method, and oth-

ers.

▶ MS-We-E-16-1 16:00–16:30

Noether's theorem and its inverse problem of nonholonomic systems with fractional derivatives

Jing-Li, Fu — Zhejiang Sci-Tech Univ.

Abstract: In this paper, the Noether symmetry and the Noether inverse the problems of nonholonimic systems with fractional derivatives are studied. Basic on the quasi-invariance of Hamilton action under the infinitesimal group of transformations without the time variable and the general transformations of time-reparametrization, then the fractional Noether theorem of nonholonomic system are established respectively. Further, the fractional Noether inverse problems are firstly presented for the nonholonomic system. An example is designed to illustrate the application of the results.

▶ MS-We-E-16-2 16:30–17:00

Application of Lie Symmetry and Symmetry Solving Approach to Electrical Networks with Dissipation

YU, Xie — Zhejiang Sci. Tech. Univ.
Jing-Li, Fu — Zhejiang Sci-Tech Univ.

Abstract: The Lie symmetry and symmetry solving approach to electrical networks with dissipation are studied. The Lagrange-Maxwell equations of electrical networks with dissipation are established by using Kirchhoff's laws. The definition and the theorem of Lie symmetry, the expression of the Noether conserved quantity deduced directly from the Lie symmetry for electrical networks with dissipation are obtained. Moreover, a new symmetry solving approach of differential equations for electrical networks with dissipation is presented. An example is designed to illustrate the application of the results.

▶ MS-We-E-16-3 17:00–17:30

Symmetry Analysis and Conservation Laws for A Generalized Coupled Hyperbolic System

Khalique, Chaudry Masood — North-West Univ., Mafikeng Campus

Abstract: We carry out the Noether symmetry classification of a generalized coupled hyperbolic system. In addition conservation laws for several cases which admit Noether point symmetries are established for the generalized system under consideration.

▶ MS-We-E-16-4 17:30–18:00

Conservation Laws of A Semilinear Radial Wave System

Muatjetjeja, Ben — North-West Univ.

Abstract: In this talk we perform Noether symmetry classification of a semilinear radial wave system. It is shown that four main cases arise with respect to the standard Lagrangian. Moreover, conservation laws are derived for the cases which admit Noether point symmetries.

▶ MS-We-E-16-5 18:00–18:30

Conservation Laws of Partial Differential Equations and Their Connections to Symmetries

Anco, Stephen — Brock Univ.

Abstract: This talk presents a modern approach to finding conservation laws and symmetries for general PDE systems. As a main result, a kind of generalization of Noether's theorem to non-variational PDE systems will be shown, which provides a general algorithmic method to find all conservation laws for any given PDE system (whether or not it has a variational structure). A recent formula of Ibragimov will be shown to be a special case of this method. Examples from nonlinear diffusion, nonlinear waves, integrable systems will be used to illustrate the ideas.

MS-We-E-17 16:00–18:00 205B

Singular limits in mathematical physics - Part I of V

For Part 2, see MS-Th-BC-17
For Part 3, see MS-Th-D-17
For Part 4, see MS-Th-E-17
For Part 5, see MS-Fr-D-17

Organizer: Cheng, Bin — Univ. of Surrey
Organizer: Secchi, Paolo — Univ. of Brescia
Organizer: Ju, Qiangchang — Inst. of Applied Physics & Computational Mathematics (IAPCM)
Organizer: Jiang, Ning — Tsinghua Univ., Beijing

Abstract: This minisymposium will address recent advances in analytical and numerical studies of singular limits of multiscale physical models as certain parameters approach zero or infinity. It shall cover such areas as incompressible and fast rotating limits in fluid dynamics, hydrodynamical limits of complex fluid and kinetic models, and relaxations. The singular nature of these models makes it challenging to rigorously justify and quantify their limits and to numerically simulate them in a way consistent with theory. Novel techniques and results in partial differential equations, stochastic differential equations and numerical analysis will be discussed.

▶ MS-We-E-17-1 16:00–16:30

Critical Thresholds in Flocking Dynamics with Large Number of Agents

Tadmor, Eitan — Univ. of Maryland

Abstract: We discuss the flocking dynamics of agent-based models. When the number of agents is large, one encounters a kinetic and hydrodynamics descriptions. The hydrodynamic description consists of pressureless Euler equations driven by non-local alignment forces. We assert that "smooth solutions must flock" which raises the question of global regularity. We study the critical threshold for global regularity of such systems. The results are extended to the case when additional pairwise attractive or repulsive interaction forces are present.

▶ MS-We-E-17-2 16:30–17:00

Scattering Theory for the Boltzmann Equation and the Arrow of Time

Levermore, C. David — Univ. of Maryland

Abstract: We develop a scattering theory for a class of eternal solutions to the Boltzmann equation posed over all space. In three spatial dimensions each of these solutions has thirteen conserved quantities. There is a unique minimizer of the Boltzmann entropy with the same thirteen conserved values. This minimizer is not the asymptotic state of our eternal solutions as time goes to minus or plus infinity.

▶ MS-We-E-17-3 17:00–17:30

First Order Aggregation Models

Sun, Weiran — Simon Fraser Univ.

Abstract: We will study the approach of first-order macroscopic aggregation equations with alignment and interaction from the kinetic equations.

▶ MS-We-E-17-4 17:30–18:00

A Multiscale Kinetic Scheme for Vlasov Poisson Equations

Guoxi, Ni — Inst. of applied physics & computational mathematics

Abstract: We propose a multiscale kinetic scheme for Vlasov Poisson equations. Usually the Vlasov Poisson system solved by splitting scheme which solve the transport and source terms seperately,our scheme is able to accurately approximate the solution in both kinetic and diffusion regimes,the key point is the unsplitting treatment of the transport and source terms in the evaluation of local solution of the distribution function. It is asymptotic preserving when thethe mean free path is small.

MS-We-E-18 16:00–18:00 209B

Recent Advances in Stochastic Approximation for Uncertainty Quantification: Analysis and Computation - Part I of II

For Part 2, see MS-Th-BC-18

Organizer: Archibald, Rick — Oak Ridge National Laboratory
Organizer: Webster, Clayton — Oak Ridge National Laboratory
Organizer: Zhang, Guannan — Oak Ridge National Laboratory

Abstract: This mini-symposium focuses on the fundamental problem of how to accurately approximate solutions of both forward and inverse complex systems with random inputs. Predicting the behavior of complex phenomena relies on constructing solutions in terms of high dimensional spaces, particularly in the case when the input data are affected by large amounts of uncertainties. The resulting explosion in computational effort is a symptom of the curse of dimensionality. This mini-symposium aims at exploring recent advances in high-dimensional approximation, sparse polynomial approximation, multilevel methods, model calibration and data-driven reduced order modeling.

▶ MS-We-E-18-1 16:00–16:30

Reconstruction of Partially Sampled Fourier Data Using Sparse Polynomial Annihilation Sparsifying Transform

Archibald, Rick — Oak Ridge National Laboratory

Abstract: Data of piecewise smooth images are sometimes acquired as Fourier samples. Standard reconstruction techniques need to deal with the uncertainty in measurement and corruption of samples. Filtering can improve the rate of convergence away from discontinuities and can help with measurement error. We will discuss a high-order reconstruction method that is capable of handling measurement uncertainty and corruption. We use the polynomial annihilation edge detection method to generate a sparsifying transform for partially sampled Fourier

▶ MS-We-E-18-2 16:30–17:00

Efficient Calibration for Imperfect Computer Models

Tuo, Rui — Chinese Acad. of Sci.

Wu, Jeff — Georgia Inst. of Tech.

Abstract: Many computer models contain unknown parameters which need to be estimated using physical observations. Tuo and Wu (2014) shows that the calibration method based on Gaussian process models proposed by Kennedy and O' Hagan (2001) may lead to unreasonable estimate for imperfect computer models. In this work, we extend their study to calibration problems with stochastic physical data. We propose a novel method, called the L2 calibration, and show its semiparametric efficiency. The conventional method

▶MS-We-E-18-3 17:00–17:30

Gaussian Process Emulators in Bayesian Inverse Problems

Teckentrup, Aretha — Univ. of Warwick
Stuart, Andrew — Univ. of Warwick

Abstract: We consider the approximation by Gaussian Process emulators of the posterior distribution in Bayesian inverse problems.

▶MS-We-E-18-4 17:30–18:00

Dimension Independent Likelihood Informed MCMC

Law, Kody — ORNL
Cui, Tiangang — MIT
Marzouk, Youssef — Massachusetts Inst. of Tech.

Abstract: This talk concerns function-space MCMC methods for sampling the posterior distribution arising from Bayesian inverse problems. A general class of operator-weighted proposal distributions are introduced, which are dimension(and covariance)-independent, and may include local gradient information. These proposals can utilize Hessian information to identify a subspace in which the posterior measure concentrates, and adaptively scale the proposal distribution according to the posterior covariance in this space. Their high level of efficiency is demonstrated numerically on examples.

MS-We-E-19 16:00–18:00 307B

Women in Applied Mathematics: Recent Advances in Modeling, Numerical Algorithms, and Applications - Part I of IV

For Part 2, see MS-Th-BC-19
For Part 3, see MS-Th-D-19
For Part 4, see MS-Th-E-19

Organizer: Li, Fengyan — Rensselaer Polytechnic Inst.
Organizer: Cheng, Juan — Inst. of Applied Physics & Computational Mathematics

Abstract: This mini-symposium aims at bringing women mathematicians to share recent progress and to inspire new ideas in applied mathematics. Talks may address modeling, theoretical and computational aspects of numerical methods, as well as various applications arising from biomedical problems, fluid dynamics, electromagnetism, rarefied gas dynamics, and constrained optimal control problems etc. Besides the scientific aspects, the fourth part of this mini-symposium is a career panel session, which is to create a platform for women mathematicians at different stages with different career paths to network, to exchange experiences and advices in career advancement, and to discuss challenges and strategies for a successful career.

▶MS-We-E-19-1 16:00–16:30

Symmetry-preserving Lagrangian Schemes for Compressible Fluid Flow in Two-dimensional Cylindrical Coordinates

Cheng, Juan — Inst. of Applied Physics & Computational Mathematics

Abstract: In this talk, we develop a second order cell-centered Lagrangian scheme for solving compressible Euler equations in cylindrical coordinates, based on the control volume discretizations, which is designed to have uniformly second order accuracy and capability to preserve one-dimensional spherical symmetry in a two-dimensional cylindrical geometry when computed on an equal-angle-zoned initial grid. The scheme maintains several good properties such as conservation for mass, momentum and total energy, and the geometric conservation law.

▶MS-We-E-19-2 16:30–17:00

Difference Potentials Method for Interface/Composite Domain Problems

Epshteyn, Yekaterina — Univ. of Utah

Abstract: Designing numerical methods with high-order accuracy for problems with interfaces (for example, models for composite materials or fluids, etc), as well as models in irregular domains is crucial to many physical and biological applications. We will discuss recently developed efficient numerical schemes based on the idea of the Difference Potentials for elliptic and parabolic composite domain/interface problems. Numerical experiments to illustrate high-order accuracy and the robustness of the developed methods will be presented as well.

▶MS-We-E-19-3 17:00–17:30

Is Normalized Line Search Rule Really Suitable for Finding Multiple Solutions of Semilinear PDEs?

Xie, Ziqing — Hunan Normal Univ., China

Abstract: Inspired by the work in Zhou and Li (SISC , 2001,2002) and the line search rules in optimization theory in R^n aiming at the global convergence, in this talk we propose a modified Local Minimax Method (LMM) based on a normalized Goldstein line search rule to find multiple minimax-type solutions.The feasibility of our approach is provided and its corresponding convergence is proven. the numerical results indicate that our approach is efficient.

▶MS-We-E-19-4 17:30–18:00

A Simple and Efficient Metaheuristic to Solve the Weighted Set Covering Problem

Lu, Yun — Kutztown Univ. of PA

Abstract: A new metaheuristic based on the relationship between teachers and learners has recently been proposed by Rao, Savsani and Vakharia (2011). This metaheuristic is designed to solve continuous nonlinear optimization problems. It has been shown to be an efficient and effective approach for solving various structural and mechanical design problems. It is of particular interest because it is a population-based metaheuristic that requires no parameter fine-tuning other than determining the size of the population and convergence criteria. In this paper, we adapt this metaheuristic, designed for continuous problems, to solve the weighted set covering problem. Empirical results demonstrate the competitiveness of this approach both in terms of solution quality and execution time. The advantage to this approach is its relative simplicity.

MS-We-E-20 16:00–18:00 210B

Theory, Computation, and Application of Transmission Eigenvalues - Part II of III

For Part 1, see MS-We-D-20
For Part 3, see MS-Th-BC-20

Organizer: Sun, Jiguang — Michigan Technological Univ.
Organizer: Cakoni, Fioralba — Univ. of Delaware

Abstract: Transmission eigenvalue problem is a new research area arising from the inverse scattering theory of inhomogeneous media. The problem is non-selfadjoint, non-standard and not covered by any classical partial differential equation. Since 2007, the problem received significant attention including a special issue of transmission eigenvalues of Inverse Problems. This mini symposium will bring top researchers from America, Europe, and Asia to present the recent advances of the theory, computation, and applications of transmission eigenvalues. It will also be a great chances for these researchers to exchange new ideas and discuss the future development for the transmission eigenvalue problem.

▶MS-We-E-20-1 16:00–16:30

Error Estimates of the Finite Element Method for Interior Transmission Problems

Wu, Xinming — Fudan Univ.

Abstract: The interior transmission problem (ITP) plays an important role in the investigation of the inverse scattering problem. In this paper we propose the finite element method for solving the ITP. Based on the T-coercivity, we derive both priori error estimate and a posteriori error estimate of the finite element approximation. Numerical experiments are also included to illustrate the accuracy of the finite element method.

▶MS-We-E-20-2 16:30–17:00

Boundary Integral Equations for the Transmission Eigenvalue Problem for Maxwell's Equations

Cakoni, Fioralba — Univ. of Delaware
Haddar, Houssem — Ecole Polytechnique/INRIA
Meng, Shixu — Univ. of Delaware/Ecole Polytechnique

Abstract: We consider the transmission eigenvalue problem for Maxwell's equations corresponding to non-magnetic inhomogeneities with contrast in electric permittivity that changes sign inside its support. We formulate the transmission eigenvalue problem as an equivalent homogeneous system of boundary integral equation. Under the assumption that the contrast is constant near the boundary of the support of the inhomogeneity, we prove that the set of transmission eigenvalues is discrete with positive infinity as the only accumulation point.

▶MS-We-E-20-3 17:00–17:30

A Recursive Integral Method for Transmission Eigenvalues

Sun, Jiguang — Michigan Technological Univ.

Zhang, Ruming Michigan Technological Univ.

Abstract: Recently, a new eigenvalue problem, called transmission eigenvalue problem, has attracted many researchers. The problem arose in the inverse scattering theory for inhomogeneous media and has importance in a variety of inverse problems in target identification and nondestructive testing. Since the problem is non-selfadjoint and nonlinear, it is very challenging to develop effective numerical methods for it. In this paper, using continuous finite elements, we propose a recursive integral method to compute several transmission eigenvalues.

▶MS-We-E-20-4 17:30–18:00

The Multigrid Method for Transmission Eigenvalue Problems

Xie, Hehu Acad. of Mathematics & Sys. Sci., Chinese Acad. of Sci.

Abstract: In the lecture, we will propose a type of multigrid method for sovling transmission eigenvalue problems. In this method, the solution of transmission eigenvalue problem is transformed to a series of solution of boundary value problems and a very small scale transmission eigenvalue on the coarsest finite element space. Since the high efficiency of the multigrid method for boundary value problems, the proposed multigrid method can improve the overall efficiency of transmission eigenvalue problem solving.

MS-We-E-21 16:00–18:30 309B

Minisymposium on discontinuous Galerkin method: recent development and applications - Part IV of VIII

For Part 1, see MS-Tu-D-21
For Part 2, see MS-Tu-E-21
For Part 3, see MS-We-D-21
For Part 5, see MS-Th-BC-21
For Part 6, see MS-Th-D-21
For Part 7, see MS-Th-E-21
For Part 8, see MS-Fr-D-21

Organizer: Xu, Yan Univ. of Sci. & Tech. of China
Organizer: Shu, Chi-Wang Brown Univ.

Abstract: Over the last few years, discontinuous Galerkin (DG) methods have found their way into the main stream of computational sciences and are now being successfully applied in almost all areas of natural sciences and engineering. The aim of this minisymposium is to present the most recent developments in the design and theoretical analysis of DG methods, and to discuss relevant issues related to the practical implementation and applications of these methods. Topics include: theoretical aspects and numerical analysis of discontinuous Galerkin methods, non-linear problems, and applications. Particular emphasis will be given to applications coming from fluid dynamics, solid mechanics and kinetic theory.

▶MS-We-E-21-1 16:00–16:30

Discontinuous Galerkin Method for Free Surface Flows That Develop Singularities

Van Der Vegt, Jacobus Univ. of Twente
Medvedeva, Tatyana Univ. of Twente

Abstract: In this presentation we will discuss a new discontinuous Galerkin method, combined with a diagonally implicit Runge-Kutta method, to solve a system of strongly nonlinear third order partial differential equations modeling the flow and droplet formation of thin liquid jets. A key feature of these equations is the occurrence of singularities that present severe numerical difficulties, both in the DG discretization and in the solution of the algebraic equations resulting from the DIRK method.

▶MS-We-E-21-2 16:30–17:00

Local Discontinuous Galerkin Method for Parabolic Equations with Blow-up Solutions

Yang, Yang Michigan Technological Univ.

Abstract: We apply the local discontinuous Galerkin method for parabolic equations with blow-up solutions. The model yield positive exact solutions and are commonly used in biology and combustion. In our work, we apply the positivity-preserving technique to the scheme, and construct high-order approximations. Numerical experiments will be given to demonstrate that high-order schemes yield better numerical blow-up time and accurate blow-up sets.

▶MS-We-E-21-3 17:00–17:30

An HDG Method for the P-Laplacian

Shen, Jiguang Univ. of Minnesota, Twin Cities

Abstract: We propose a hybridizable Discontinuous Galerkin (HDG) method for the p-Laplacian equation. The approximations to u, ∇u, $|\nabla u|^{p-2}|\nabla u$ exhibit optimal order of convergence in L^1 and L^p norms, when solution is sufficiently regular. We rewrite our scheme into minimization problems and solve them with preconditioned gradient descent type algorithms, which demonstrate mesh independent, polynomial degree independent convergence rate. Numerical results for non-smooth solutions are displayed to show the benefit of hybridization.

▶MS-We-E-21-4 17:30–18:00

Discontinuous Galerkin Solutions for the Electromagnetic Waves in Metallic Nanostructures

Xu, Liwei Chongqing Univ.

Abstract: In this talk, we introduce a hydrodynamic model describing the propagation of electromagnetic waves in metamaterial. A discontinuous Galerkin method has been designed for the solution of the model. Several numerical solutions, including the second and third harmonics generation, are reproduced using the method and the model.

▶MS-We-E-21-5 18:00–18:30

Multiscale Hybridizable DG Methods for Flows in in Heterogeneous Media

Shi, Ke Texas A&M Univ.

Abstract: In this talk, we will review a recently introduced finite element method: multiscale hybridizable Discontinuous Galerkin (HDG) method. We motivate with Darcy flow in porous media to illustrate the main features of the multiscale HDG method. Both theoretical and numerical results will be presented. Finally, we will discuss the current work on other problems such as Brinkman flow, linear elasticity.

MS-We-E-22 16:00–18:00 206A

Evolution of Cooperation on Complex Networks

Organizer: Rong, Zhihai UESTC
Organizer: Wang, Wen-Xu School of Sys. Sci., Beijing Normal Univ.
Organizer: Chi, Liping College of Physical Sci. & Tech., Central China Normal Univ.

Abstract: Cooperative behaviors are ubiquitous from nature to human society. Game theory provides a powerful theoretical framework to understand the evolution of cooperation. The network reciprocity, as an efficient mechanism to support the evolution of cooperation in population, has attracted considerable attention from various fields of discipline, such as mathematics, physics, biology, sociology as well as engineering. Understanding the interaction between cooperative behaviors of individuals and underlying complex organization structure of population has become a hot topic of interdisciplinary areas. The aim of this Minisymposium is to bring together researchers working in the area of game theory with complex networks. We will introduce the recent results around evolution of cooperation on complex networks, and discuss potential application of game theory in social network.

▶MS-We-E-22-1 16:00–16:30

Influence of Time Slices on Temporal Networks

Chi, Liping College of Physical Sci. & Tech., Central China Normal Univ.

Abstract: The topological structure properties of temporal network can be used to characterize complex system with time-varying interactions. Temporal network is composed of a series of contacts. The topological structure enters through aggregating the contacts within a certain time interval. Our goal is to investigate the influences of time-slices on both the structural and the dynamical properties of temporal networks.

▶MS-We-E-22-2 16:30–17:00

Evolutionary Dynamics on Heterogeneous Networks

Zhang, Boyu Beijing Normal Univ.

Abstract: Recent studies have revealed that graph heterogeneity can considerably affect evolutionary processes. In this talk, we introduce the evolutionary dynamics and the evolutionarily stable strategy (ESS) conditions for 2×2 games on heterogeneous graphs based on "birth-death" (BD), "death-birth" (DB) and "pairwise comparison" (PC) updatings. We show that graph heterogeneity does not change the evolutionary results of BD and DB updating, but promotes cooperation under PC updating.

▶MS-We-E-22-3 17:00–17:30

Revisiting the reduced learning and teaching ability of players to the evolution of cooperation in prisoner's dilemma game

Zhi-xi, Wu Lanzhou Univ.

Abstract: We investigate the evolution of cooperation in spatial prisoner's dilemma games with the reduced learning or teaching ability of the players. By using extensive MC simulations, we show that cooperation can be always facilitated in both schemes of synchronous and asynchronous strategy updating provided that the teaching ability of the players is reduced. By contrast, cooperation is only promoted in the case of synchronous strategy updating, if otherwise reduced learning ability is considered.

▶ MS-We-E-22-4 17:30–18:00

Probabilistic Sharing Solves the Problem of Costly Punishment

Chen, Xiaojie Univ. of Electronic Sci. & Tech. of China

Abstract: Cooperators that refuse to participate in sanctioning defectors create the second-order free-rider problem. Such cooperators will not be punished because they contribute to the public good, but they also eschew the costs associated with punishing defectors. Altruistic punishers—those that cooperate and punish—are at a disadvantage, and it is puzzling how such behavior has evolved. In this talk, I will show how the consideration of probabilistic sanctioning solves the problem of costly punishment.

MS-We-E-23 16:00–18:00 208A

Pedestrian Dynamics: Modeling, Analysis and Intervention

Organizer: Wang, Lin Shanghai Jiao Tong Univ.
Organizer: Dong, Hairong State Key Laboratory of Rail Traffic Control & Safety, Beijing Jiaotong Univ.
Organizer: Wang, Jinhuan Hebei Univ. of Tech.

Abstract: Over the past years, pedestrian dynamics has attracted much attention in several discourses, such as transport studies, urban planning and architecture. With increasing technological sophistication, substantial experimental efforts have revealed quantitative details of pedestrian interactions, which have led to a deeper understanding of how collective behavior emerges from individual interactions. In this mini-symposium, we will focus on modeling, analysis and intervention of pedestrian dynamics. We will first present a new optimization-based collision avoidance model for pedestrian dynamics, and then discus how do small group behaviors impact on pedestrian evacuation, thirdly propose some intervention strategies for crowd panic, and finally from a theoretical perspective , study the averaging-based consensus of multi-agent systems under switching topologies.

▶ MS-We-E-23-1 16:00–16:30

Averaging-Based Consensus of High-Order Linear Multi-Agent Systems under Switching Topologies

Ni, Wei Nanchang Univ.

Abstract: The averaging theory is a fundamental tool to investigate the stability of time-varying systems. The application of averaging theory to the field of consensus control of multi-agent systems under switching topology has just started, and there are many important issues to be solved. In this talk, we provide some averaging-based consensus control algorithms and corresponding convergence analysis for high-order liner multi-agent systems under switching topology.

▶ MS-We-E-23-2 16:30–17:00

Small Group Behaviors and Their Impacts on Pedestrian Evacuation Based on the Modified Social Force Model

Wang, Jinhuan Hebei Univ. of Tech.
Zhang, Lei Hebei Univ. of Tech.
Li, Nan Hebei Univ. of Tech.

Abstract: A modified social force model is proposed to simulate the impacts of small group behaviors on pedestrian evacuation. We define an exponential formulation of the group attractive force among the small group. Simulation results show that the small group behaviors will cause negative effects on pedestrian evacuation. The panic case is further considered, under which the agents crowd together and the evacuation efficiency becomes lower.

▶ MS-We-E-23-3 17:00–17:30

Analysis and Intervention on Crowd Panic via Modified Social Force Model

Cao, Lei Shanghai Jiao Tong Univ.
Wang, Lin Shanghai Jiao Tong Univ.

Abstract: In this paper, we modify the classical social force model to be more realistic in the emergent situations, and use it to investigate the crowd panic under full vision and limited vision. We study the effects of different pedestrian behaviors on the crowd evacuation, and find that following the wall is always a better strategy. Furthermore, we intervene in the crowd panic by deploying information sources.

▶ MS-We-E-23-4 17:30–18:00

A New Optimization-based Collision Avoidance Model for Pedestrian Dynamics

Wang, Qianling Beijing Jiaotong Univ.
Dong, Hairong State Key Laboratory of Rail Traffic Control & Safety, Beijing Jiaotong Univ.
Chen, Yao Beijing Jiaotong Univ.

Abstract: This paper proposes an optimization-based collision avoidance model for pedestrian dynamics. In this model, the behaviors of pedestrians are governed by their desired walking direction and speed. By combining the critical factors of pedestrian movement, such as positions of the exit and velocities of the neighbors, the choice of desired velocity has been rendered to a discrete optimization problem. The new model is verified by comparing with the fundamental diagram and actual data.

MS-We-E-24 16:00–18:00 211

Recent Advances in Numerical Approximation of Singular Solutions - Part III of III

For Part 1, see MS-Tu-E-24
For Part 2, see MS-We-D-24

Organizer: Li, Hengguang Wayne State Univ.
Organizer: Nistor, Victor Pennsylvania State Univ. & U. Lorraine
Organizer: Ovall, Jeffrey Portland State Univ.

Abstract: In this mini-symposium, we will mainly discuss new developments and open questions concerning the approximation of singular solutions of partial differential equations. The scope of the mini-symposium includes but is not limited to: a-priori estimates of the equation, sharp numerical error analysis, novel discretizations, and effective numerical solvers. We hope to bring together both recognized experts and junior researchers with common interest but diverse backgrounds and knowledge, thereby bringing in a wide range of expertise for extensive discussions and communications.

▶ MS-We-E-24-1 16:00–16:30

Analysis of Numerical Methods for the Monge-Ampere Equation

Awanou, Gerard Univ. of Illinois at Chicago

Abstract: The Monge-Ampère equation is a nonlinear partial differential equation with a geometric theory due to Aleksandrov. Solutions of the Monge-Ampère equation are in general not smooth, and hence difficult to compute with standard discretizations. I will review a large class of methods proposed so far, from the point of view of structure preserving discretizations. I will discuss how this new point leads to an analysis of the theoretical convergence properties of the methods.

▶ MS-We-E-24-2 16:30–17:00

Double Layer Potentials on Polygonal Domains

Qiao, Yu Shaanxi Normal Univ.
Li, Hengguang Wayne State Univ.

Abstract: The method of layer potentials is one of the classical approaches to solving boundary problems for Laplace's equations. In this talk, let Ω be a bounded polygonal domain in two-dimensional plane. We study the double layer potential operator K associated to Ω and the Laplace operator Δ, and obtain Fredholm property for K on some weighted Sobolev spaces associated to $\partial\Omega$. If possible, numerical methods will be discussed.

▶ MS-We-E-24-3 17:00–17:30

On the Conditioning of the Generalized Finite Element Method (GFEM) and Its Effect on Iterative Solvers

Banerjee, Uday Syracuse Univ.

Abstract: The conditioning of GFEM could be worse than the standard FEM. We will show that if the angle between the underlying piecewise linear FE space and the enrichment space is uniformly bounded away from zero, the conditioning of GFEM is not worse than the FEM. GFEM with this property is called the SGFEM. The angle affects the performance of the iterative method to solve the linear system. We illuminate the results through an Interface problem.

▶ MS-We-E-24-4 17:30–18:00

Finite Element Approximations of Singular Solutions in the W^1_p Norm

Li, Hengguang Wayne State Univ.

Abstract: Consider elliptic equations on 2D polygonal domains with singular solutions due to the non-smoothness of the boundary. We first establish the stability of the finite element solution in the W^1_p norm on a class of graded meshes. Then, we give regularity requirements in weighed Sobolev/Holder spaces on the given data and specific parameter-selection criteria for graded meshes, such that the resulting numerical approximation achieves the optimal convergence rate in W^1_p. Numerical results are provided.

MS-We-E-25 16:00–18:30 210A

Numerical Methods for Stochastic PDE and Uncertainty Quantification - Part III of IV

For Part 1, see MS-Tu-E-25
For Part 2, see MS-We-D-25
For Part 4, see MS-Th-BC-25

Organizer: ZHOU, TAO AMSS, the Chinese Acad. of Sci.
Organizer: Yu, Xijun Inst. of Applied Physics & Computational Mathematics
Organizer: Xiu, Dongbin Univ. of Utah

Abstract: Efficient solution strategy for stochastic partial differential equations (SPDE) has been a classical topic, as many physical phenomena are inherently random. The topic has received an increasing amount of attention in recent years, driven by the need for uncertainty quantification (UQ). In UQ, even deterministic systems need to be modeled as random because of the uncertainty in the system inputs. Stochastic problems become more challenging to solve, as they often reside in high dimensional random space. The purpose of this mini-symposium is to gather researchers from mathematics and computer science and engineering to interchange the latest advances in simulation techniques for SPDE and UQ. The focus will be on efficient algorithms for practical systems, particularly those arising from multidisciplinary problems.

▶ MS-We-E-25-1 16:00–16:30

Dealing with Uncertainty in Space Awareness Problems

Hesthaven, Jan EPFL

Abstract: We shall discuss treatment of uncertainty in space awareness problems, illustrated by orbiting satellites. We discuss the elements of the models, sources of uncertainty, the development low dimensional reduced models, various examples on collision detection and, time permitting, object identification under uncertainty.

▶ MS-We-E-25-2 16:30–17:00

Local Polynomial Chaos Expansion for Linear Stochastic PDE with High Dimensional Random Inputs

Zhu, Xueyu Univ. of Utah
Xiu, Dongbin Univ. of Utah

Abstract: We present a localized polynomial chaos expansion for PDE with high dimensional random inputs. The method employs a domain decomposition technique to approximate the problem locally. The subdomain problems are solved independently and in much lower random dimensions. Accurate global solution can then be obtained by enforcing the correct statistical dependence. We present its theoretical foundation, along with examples to demonstrate its ability to handle very high dimensional stochastic PDE.

▶ MS-We-E-25-3 17:00–17:30

Transport Map Accelerated Markov Chain Monte Carlo

Marzouk, Youssef Massachusetts Inst. of Tech.

Abstract: We present a new approach for efficiently characterizing complex probability distributions, using a combination of optimal transport maps and Metropolis corrections. We use continuous transportation to transform typical Metropolis proposal mechanisms into non-Gaussian proposal distributions. Our approach adaptively constructs a Knothe-Rosenblatt rearrangement using information from previous MCMC states, via the solution of convex and separable optimization problems. We discuss the construction of transport maps in high dimensions and demonstrate order-of-magnitude speedups over standard MCMC.

▶ MS-We-E-25-4 17:30–18:00

Sparse Interpolation via L^1 Minimization and Its Applications in UQ

ZHOU, TAO AMSS, the Chinese Acad. of Sci.

Abstract: The talk is concerned with sparse interpolation by means of l^1 minimization. Some basic approximation results for sparse interpolation will be presented, and the design of interpolation points will also be discussed. We will finally present some applications of the sparse interpolation methods for parametric uncertainty quatification.

▶ MS-We-E-25-5 18:00–18:30

Response-Excitation Joint PDF Theory and Applications

Karniadakis, George Brown Univ.

Abstract: TBA

MS-We-E-26 16:00–18:30 110

Recent advances in modeling, analysis, and methodology for interface and free boundary problems and applications - Part IV of V

For Part 1, see MS-Mo-D-57
For Part 2, see MS-Mo-E-57
For Part 3, see MS-We-D-26
For Part 5, see MS-Th-BC-26

Organizer: Li, Zhilin North Carolina State Univ.
Organizer: Lai, Ming-Chih National Chiao Tung Univ.

Abstract: In recent years, there is increasing interest in the development and application of advanced computational techniques for interface problems, problem with free boundary and moving interface, fluid-structure interactions driven by applications in physiology, fluid mechanics, material sciences, porous media flow, and biology. There are also many numerical approaches developed in recent years. The aim of this mini-symposium is to bring together scientists in the field to exchange their recent research discoveries and future directions, to stimulate novel ideas, and to nurture collaborations. The focus would be on Cartesian grid method such as the immersed boundary/interface methods, the level set methods, fluid-structure interactions, and applications.

▶ MS-We-E-26-1 16:00–16:25

Recent Progress for Cell Based Particle Method for Moving Interface Problem

Zhao, Hongkai UC Irvine

Abstract: We present our recent work on combing cell based particle method with volume of fluid method for computational modeling of moving interface problems. The key advantage of our method is the ability for accurate computation of geometric quantities, such as curvature, as well as mass conversation and topological stability. As an extension of the grid based particle method, the interface is sampled quasi-uniformly by meshless points, which allows controlled topological and easy grid adaptivity.

▶ MS-We-E-26-2 16:25–16:50

Numerical Renormalization Group Methods for Asymptotically Self-similar Dynamics

Lee, Long Univ. of Wyoming

Abstract: We present a numerical method for studying long-term behavior of a class of partial different equations (PDE) that model several physical phenomena, including a free-boundary problem of viscus gravity-driven flow in porous media. The numerical renormalization group (RG) procedure introduced in this talk captures asymptotically self-similar dynamics of physical systems. The iteration of the RG transformation renders a detailed picture of the asymptotics, including scaling exponents, profile functions and pre-factors. We illustrate the effectiveness of the RG procedure on some well-known nonlinear PDE, including cases where nonlinear effects are asymptotically irrelevant or neutral. This work is joined with G. A. Braga and F. Furtado.

▶ MS-We-E-26-3 16:50–17:15

An Immersed Interface Method for Axisymmetric Electrohydrodynamic Simulations in Stokes and Navier-Stokes Flows

Young, Yuan-Nan New Jersey Inst. of Tech.

Abstract: A numerical scheme based on the immersed interface method (IIM) is developed to simulate the dynamics of an axisymmetric viscous drop under an electric field. In this work, the IIM is used to solve both the fluid velocity field and the electric potential field. Detailed numerical studies on the numerical scheme show a second-order convergence. Moreover, our numerical scheme is validated by comparing against previous relevant results.

▶ MS-We-E-26-4 17:15–17:40

A Moment of Fluid Method for Simulating the Impact and Freezing of Supercooled Liquid Droplets on Solid Surfaces.

Sussman, Mark Florida State Univ.

Abstract: The impact of supercooled large droplets (SLDs) on aircraft wings can lead to splatter in which fragments can freeze downstream of the wing leading edge, avoiding freezing prevention devices. A numerical method is presented that takes into account effect of air on droplet(s), droplet splashing, contact line dynamics, and freezing. There are 4 materials air, liquid, ice, and solid which lends itself to the moment-of-fluid representation. This is work with Prof. Yongsheng Lian, UofL, KY.

▶ MS-We-E-26-5 17:40–18:05

Computations of the Initial Value Problem for Hydroelastic Waves

Siegel, Michael NJIT

Abstract: The hydroelastic problem describes the evolution of a thin elastic membrane in potential flow. It arises in many applications, including the dynamics of flapping flags and ice sheets in the ocean. An efficient, nonstiff boundary integral method for the 3D hydroelastic problem is presented. The

stiffness is removed by a small-scale decomposition, following prior work on 2D interfacial flow with surface tension. A convergence proof for a version the numerical method will be discussed.

▶ MS-We-E-26-6 18:05–18:30

Wrinkling Dynamics of Vesicles in Stokes Fluids

Li, Shuwang Illinois Inst. of Tech.

Abstract: We consider the wrinkling dynamics of a vesicle in Stokes flow. We first perform linear analysis and simulations to investigate the deterministic wrinkling dynamics, then include thermal fluctuations to study the stochastic wrinkling dynamics. Preliminary results show (1) negative surface tension introduces wrinkles on the membrane surface; (2) thermal fluctuations break the geometric symmetry of the vesicle and excite higher order odd mode wrinkles. This is a joint work with Kai Liu and John Lowengrub.

MS-We-E-27 16:00–18:00 407

Decoupling methods for multi-physics and multi-scale problems - Part III of VIII

For Part 1, see MS-Tu-E-27
For Part 2, see MS-We-D-27
For Part 4, see MS-Th-BC-27
For Part 5, see MS-Th-D-27
For Part 6, see MS-Th-E-27
For Part 7, see MS-Fr-D-27
For Part 8, see MS-Fr-E-27

Organizer: He, Xiaoming Missouri Univ. of Sci. & Tech.
Organizer: Xu, Xuejun Inst. of Computational Mathematics, AMSS, CAS

Abstract: The inherent multi-physics and multi-scale features of many real world problems accentuate the importance to develop efficient and stable numerical methods for the relevant PDEs, especially the decoupling methods. Although great efforts have been made for solving these problems, many practical and analytical challenges remain to be solved. This mini-symposium intends to create a forum for junior and senior researchers from different fields to discuss recent advances on the decoupling methods for multi-physics and multi-scale problems with their applications.

▶ MS-We-E-27-1 16:00–16:30

Computations of Some Optimal Control Problems for Stochastic Partial Differential Equations

Lee, Hyung-Chun Ajou Univ.

Abstract: n this talk, we propose some numerical methods for solving optimal control problems for elliptic partial differential equations with random coefficients and forcing terms. These input data are assumed to be dependent on a finite number of random variables. We set up three different kind of problems and prove existence of optimal solution and derive an optimality system. In the methods, we use a Galerkin approximation in physical space and a sparse grid collocation in

▶ MS-We-E-27-2 16:30–17:00

PHASE-FIELD MODELING AND SIMULATION OF THE ZONE MELTING PURIFICATION PROCESS∗

Wang, Xiaoping Hong Kong Univ. of Sci. & Tech.

Abstract: Zone melting is an efficient purification method that is widely used in the manufacture of semiconductors. In this paper, we propose a variational phase-field model to model the zone melting process. We present our numerical results for the zone melting process and show the feasibility of our model by comparing with the experimental results.

▶ MS-We-E-27-3 17:00–17:30

Higher Order Finite Element Methods for A Class of Interface Problems

Guzman, Johnny Brown Univ.

Abstract: We present higher-order piecewise continuous finite element methods for solving a class of interface problems in two dimensions. The method is based on correction terms added to the right-hand side in the standard variational formulation of the problem. We prove optimal error estimates of the methods on general quasi-uniform and shape regular meshes in maximum norms. In addition, we apply the method to a Stokes interface problem, adding correction terms for the velocity and the

▶ MS-We-E-27-4 17:30–18:00

Decoupling and Monolithic Approches for Fluid-structure Interaction (FSI) Problems

Lee, Hyesuk Clemson Univeristy

Abstract: Simulating fluid-structure interactions is challenging due to the tight coupling between the solid and fluid substructures in a moving domain. Explicit and implicit decoupling methods often either fail or require relaxation when densities of the two materials are close. In this talk both monolithic and decoupling approaches are considered for analytical and numerical studies of FSI problems where a fluid is governed by a Newtonian or non-Newtonian model. An optimization based method which allows FSI problems to be stably decoupled is discussed and numerical results are presented.

MS-We-E-28 16:00–18:05 109

Numerical Analysis for Forward-Backward Stochastic Differential Equations and Related Problems - Part I of II

For Part 2, see MS-Th-BC-28

Organizer: Zhao, Weidong Shandong Univ.
Organizer: ZHOU, TAO AMSS, the Chinese Acad. of Sci.

Abstract: Backward stochastic differential equations (BSDE's) were first introduced by J.M. Bismut in 1973 and generalized to the nonlinear form by Pardoux and Peng in 1990. Since then, BSDEs and coupled FBSDEs have been widely studied and used in connection with partial differential equations, stochastic optimal control theory, nonlinear filtering and mathematical finance. The numerical analysis of FBSDEs is more complicated than that of classical SDEs, so that there are many interesting and challenging open problems. The mini-symposium aims at exploring efforts related to numerical analysis for F-BSDEs and related problems such as SPDEs, nonlocal diffusions, nonlinear filtering, stochastic optimal control, mathematical finance, etc.

▶ MS-We-E-28-1 16:00–16:25

Regression Monte-Carlo with Adaptive Approximation Selection Applied to BSDE-FBSDE

Gobet, Emmanuel Ecole Polytechnique

Abstract: We design regression schemes for decoupled FBSDE, using a selection point of view, taking the best estimator among a family, accounting automatically for the regularity of the unknown solution. Tight error estimates are given. This is a joint work with Laurent Zwald.

▶ MS-We-E-28-2 16:25–16:50

Layer Methods for Stochastic Navier-Stokes Equations Using Simplest Characteristics

Tretyakov, Michael Univ. of Nottingham

Abstract: We propose and study a layer method for stochastic Navier-Stokes equations (SNSE) with spatial periodic boundary conditions and additive noise. The method is constructed using conditional probabilistic representations of solutions to SNSE and exploiting ideas of the weak sense numerical integration of stochastic differential equations. We prove some convergence results for the proposed method. Results of numerical experiments on two model problems are presented. The talk is based on a joint paper with G.N. Milstein.

▶ MS-We-E-28-3 16:50–17:15

Monotone Schemes for Fully Nonlinear Parabolic Path Dependent PDEs

Zhang, Jianfeng Univ. of Southern California

Abstract: We extend the results of the seminal work Barles and Souganidis (1991) to path dependent case. Based on the recently developed viscosity theory of path dependent PDEs, we show that a monotone scheme converges to the unique viscosity solution of the (fully nonlinear) parabolic path dependent PDE. Moreover, in the case that the solution is smooth, we obtain the rate of convergence of our scheme.

▶ MS-We-E-28-4 17:15–17:40

Numerical Solution of Backward Stochastic Differential Equations with Jumps for A Class of Nonlocal Diffusion Problems

Zhang, Guannan Oak Ridge National Laboratory
Zhao, Weidong Shandong Univ.
Webster, Clayton Oak Ridge National Laboratory

Abstract: We propose a novel numerical approach for linear nonlocal diffusion equations with integrable kernels, based on the relationship between the backward Kolmogorov equation and a class of backward stochastic differential equations (BSDEs) driven by Levy processes with jumps. The nonlocal diffusion problem under consideration is converted into a BSDE, for which numerical schemes are developed and applied directly.

▶ MS-We-E-28-5 17:40–18:05

Numerical Scheme for Regular Semilinear Stochastic PDEs via Backward Doubly Stochastic Differential Equations

Mnif, Mohamed Ecole Nationale d'Ingenieurs de Tunis

Abstract: TBA

MS-We-E-29 16:00–18:00 305
High Order Numerical Methods for PDEs - Hybrid Methods - Part III of III
For Part 1, see MS-Tu-E-29
For Part 2, see MS-We-D-29

Organizer: Jung, Jae-Hun SUNY at Buffalo
Organizer: Don, Wai Sun Ocean Univ. of China/Brown Univ.
Organizer: Ling, Leevan Hong Kong Baptist Univ.
Organizer: Yoon, Jungho Ewha W. Univ.

Abstract: In this mini-symposium, we gather together researchers in the areas of high order numerical approximation methods for PDEs and Images and their applications. The mini-symposium will present recent progress in high-order methods including ENO/WENO methods, spectral methods, discontinuous Galerkin methods, and radial basis function methods. Particularly we are interested in the recent development of the hybrid methods that combine the different high order methods in a single frame. The proposed mini-symposium will gain a significant attention since it will provide a valuable opportunity for researchers from different areas to investigate the idea of hybridization of their methods.

▶ MS-We-E-29-1 16:00–16:30
WENO-Z+: Improving the Numerical Dissipation of WENO Schemes
Borges, Rafael UERJ

Abstract: WENO schemes based on the WENO-Z weight formula are less dissipative than (and as stable as) the classical WENO scheme. The improvement offered by WENO-Z near critical points of the solution is particularly remarkable. We discuss the main reason for this improvement —contrary to common belief, it is not linked to the order of accuracy at critical points —and present a modified WENO-Z scheme, which improves the results near critical points even further.

▶ MS-We-E-29-2 16:30–17:00
A New Adaptive Weighted Essentially Non-oscillatory WENO-θ Scheme for Hyperbolic Conservation Laws
Nguyen, Thien Binh Ulsan National Inst. of Sci. & Tech. (UNIST)
Jung, Chang-Yeol UNIST

Abstract: A new adaptive WENO-θ scheme is proposed. Depending on the smoothness of the large stencil used in the reconstruction procedure, a parameter θ is set adaptively to switch the scheme between a 5th-order upwind and 6th-order central approximation. A new set of smoothness indicators for both the sub-stencils and the large one is introduced. These are constructed symmetrically around x_j in Taylor expansions. Numerical results show that WENO-θ substantially improves other comparing WENO schemes.

▶ MS-We-E-29-3 17:00–17:30
Adaptive RBF ENO and WENO Finite Volume Methods for Hyperbolic Problems
Guo, Jingyang SUNY at Buffalo
Jung, Jae-Hun SUNY at Buffalo

Abstract: Adaptive ENO and WENO methods are proposed based on the radial basis function (RBF) interpolation replacing the polynomial interpolation. The free parameter provided by RBF interpolation is determined by canceling the leading error term. To achieve essentially non-oscillatory property, RBF-ENO is reduced into ENO scheme. A monotone polynomial method is proposed to determine non-smooth regions. Numerical examples show that the algorithm improves the order of convergence and provides a sharper solution profile near discontinuity.

▶ MS-We-E-29-4 17:30–18:00
Optimized Schwarz Methods for Radial Basis Function Methods
Kwok, Felix Hong Kong Baptist Univ.

Abstract: Radial basis function (RBF) methods for PDEs remain challenging computationally because they produce matrix problems that are dense and ill conditioned as the number of nodes increases. In this talk, we consider preconditioning the problem using an optimized Schwarz method, which is known to have superior convergence properties to classical additive Schwarz methods. We study the convergence of this new method by comparing it with additive Schwarz and other known preconditioners for RBF methods.

MS-We-E-30 16:00–18:00 VIP2-2
Numerical approaches in optimization with PDE constraints: recent progress and future challenges - Part II of VII
For Part 1, see MS-We-D-30
For Part 3, see MS-Th-BC-30
For Part 4, see MS-Th-D-30
For Part 5, see MS-Th-E-30
For Part 6, see MS-Fr-D-30
For Part 7, see MS-Fr-E-30

Organizer: Yan, Ningning Chinese Acad. of Sci.
Organizer: Hinze, Michael Universität Hamburg

Abstract: The numerical treatment of optimization problems with PDE constraints is a very active field of mathematical research with great importance for many practical applications. To achieve further progress in this field of research, the development of tailored discretization techniques, adaptive approaches, and model order reduction methods has to be intertwined with the design of structure exploiting optimization algorithms in function space.
This minisymposium covers mathematical research in PDE constrained optimization ranging from numerical analysis and adaptive concepts over algorithm design to the tailored treatment of optimization applications with PDE constraints. It thereby forms a platform and fair for the exchange of ideas among young researchers and leading experts in the field, and for fostering and extending international collaborations between research groups in the field.

▶ MS-We-E-30-1 16:00–16:30
Modelling Transboundary Industrial Stochastic Pollution by Differential Games and Computation
Zhang, Shuhua Tianjin Univ. of Finance & Economics

Abstract: In this talk, a differential game model of transboundary pollution with emission permits trading is presented. We make use of stochastic optimal control theory to derive the value function for the noncooperative and cooperative games and propose a fitted finite volume method to solve it. The optimal emission paths, which maximize the region's discounted stream of net revenue, are obtained. Several examples are presented to illustrate the results and the efficiency of the method.

▶ MS-We-E-30-2 16:30–17:00
PDE Constrained Optimization with Pointwise Gradient Constraints
Wollner, Winnifried Univ. of Hamburg

Abstract: In this talk, we will review several recent result in PDE constrained optimization with pointwise constraints on the gradient of the state. This includes barrier and penalty methods in a function space setting to eliminate the constraint on the gradient. Convergence of such methods is discussed. Further, we will consider the discretization of such problems in particular for non smooth domains, where the control to state mapping does not assert the gradient to be Lipschitz.

▶ MS-We-E-30-3 17:00–17:30
Parareal in Time Algorithm for the Optimal Control of Evolution Equations
Gong, Wei Chinese Acad. of Sci.
Yan, Ningning Chinese Acad. of Sci.
Lu, Xiliang Wuhan Univ.

Abstract: A parareal in time algorithm is proposed to solve the optimal control problems of evolution equations. This method is to solve the first order optimality system by a time domain decomposition technique and has a comparable error estimate with that of the parareal algorithm for the initial value problems. This method can also be extended to the optimal control problems with control constraints and nonlinear governing equation.

MS-We-E-31 16:00–18:00 405
Integration, Approximation and Discrepancy - Part II of III
For Part 1, see MS-We-D-31
For Part 3, see MS-Th-BC-31

Organizer: Ullrich, Mario Johannes Kepler Univ.
Organizer: Gnewuch, Michael Christian-Albrechts-Universität zu Kiel

Abstract: Numerical methods for high dimensional integration and approximation play a crucial role in a number of applications. This session brings together experts from the areas of integration, approximation, discrepancy theory, information-based complexity, potential theory, and partial differential equations (PDE) to discuss numerical methods for these types of problems. In this context, well distributed point sets are important. The generation of good point sets for various problems as well as bounds for their discrepancy and integration error will be covered in the minisymposium. Particular emphasis is given to the dependence of the results on the dimension. Approximation of functions is intimately related with the integration problem and the proposed

minisymposium should stimulate the exchange between both communities.

▶ MS-We-E-31-1 16:00–16:30

L_p-discrepancy of Higher Order Digital Sequences

Markhasin, Lev — Univ. of Stuttgart

Abstract: Higher order digital sequences as proposed by Dick are constructions of infinite sequences with very well distribution modulo one. Dick and Pillichshammer proved that for order at least 3 they satisfy optimal upper bound for the L_2-discrepancy. We show that even for order at least 2 digital sequences satisfy optimal bounds for the L_p-discrepancy.

▶ MS-We-E-31-2 16:30–17:00

Linear Versus Non-linear Approximation in the Average Case Setting

Plaskota, Leszek — Univ. of Warsaw, Inst. of Applied Mathematics & Mechanics

Abstract: We compare the average errors of linear and non-linear approximations assuming that the coefficients in an orthogonal expansion are scaled i.i.d. random variables. We show that generally n-term non-linear approximation can be much better than linear approximation. On the other hand, if the scaling parameters decrease no faster than polynomially then the average error of non-linear approximations does not converge to zero faster than that of linear approximations, as $n \to \infty$.

▶ MS-We-E-31-3 17:00–17:30

An Implementation of the Multivariate Decomposition Method

Gilbert, Alexander — The Univ. of New South Wales
Kuo, Frances — Univ. of New South Wales

Abstract: This talk is on implementing the Multivariate Decomposition Method (MDM) for approximating integrals over the infinite-dimensional unit cube, see “The multivariate decomposition method for infinite-dimensional integration’’ by Kuo, Nuyens, Plaskota, Sloan and Wasilkowski. Loosely, by decomposing an infinite-dimensional function into a sum of finite-dimensional functions it’ s integral can be approximated by summing over separate cubature rules applied to each term in the decomposition. We focus on truncating this sum and explicitly constructing the cubature rules.

▶ MS-We-E-31-4 17:30–18:00

Quasi-Polynomial Tractability for Standard Information

Wozniakowski, Henryk — Columbia Univ. & Univ. of Warsaw

Abstract: QPT (quasi-polynomial tractability) is well understood for for linear multivariate problems in various settings when linear information is used. We present current results for QPT in the case of standard information. This will allow us to compare the power of linear and standard information for QPT. The talk is based on joint work with Erich Novak.

MS-We-E-32 16:00–18:00 307A

Structured-mesh methods for interface problems. - Part III of VIII

For Part 1, see MS-Tu-E-32
For Part 2, see MS-We-D-32
For Part 4, see MS-Th-BC-32
For Part 5, see MS-Th-D-32
For Part 6, see MS-Th-E-32
For Part 7, see MS-Fr-D-32
For Part 8, see MS-Fr-E-32

Organizer: Chen, Huanzhen — College of Mathematical Sci. Shandong Normal Univ.
Organizer: He, Xiaoming — Missouri Univ. of Sci. & Tech.
Organizer: KWAK, Do Young — Korea Advanced Inst. of Sci. & Tech.
Organizer: Zhang, Xu — Purdue Univ.

Abstract: In many real world applications it is more convenient or efficient to utilize structured meshes for solving different types of interface problems. Since the structured meshes may not fit the non-trivial interfaces, special methods need to be developed to deal with the difficulties arising from the interface problems in order to solve them on these meshes. Therefore, great efforts have been made for solving interface problems and tracing the moving interfaces based on structured meshes in the past decades. This mini-symposium intends to create a forum for researchers from different fields to discuss recent advances on the structured-mesh numerical methods for interface problems and their applications.

▶ MS-We-E-32-1 16:00–16:30

Dissipation Sand Dispersion Errors of Discontinuous Galerkin Method and Its Application to Level Set Equations

Yan, Jue — iowa state Univ.

Abstract: The discontinuous Galerkin (DG) method is known to provide high resolution properties, especially when applying after long time run. In this talk, we consider analyzing the error behavior of the DG method with P2 quadratic polynomial approximations, the dissipation error is on the order of 5 and the dispersion error is on the order of 6. The part of the error that grows linearly in time is on the order of 6. When solving interface problems in a complex incompressible flow, the DG method is shown to dramatically improve the mass conservation property of the level set method. Numerical examples demonstrate the high order accuracy of the scheme and the high resolution property especially when the interface undergoes large topological changes.

▶ MS-We-E-32-2 16:30–17:00

A Parallel Solution Approach for Crack Propagation Using Adaptive Mesh Refinement

Heister, Timo — Clemson Univ.

Abstract: We present an algorithm based on the active set strategy to simulate crack propagation using a quasi-static fracture model. The crack is discretized using a phase-field approach, which allows merging and joining of cracks. The non-linear system is discretized using the Finite Element method and solved in a monolithic fashion. We include a new strategy for adaptive mesh refinement. The whole scheme is parallelized and scales to a large number of cores.

▶ MS-We-E-32-3 17:00–17:30

Reliable and Efficient Error Control for An Adaptive Galerkin-characteristic Method for Convection-dominated Diffusion Problems

Cui, Ming — College of Applied Sci., Beijing Univ. of Tech.

Abstract: An efficient and reliable a-posteriori error estimator is developed for a characteristic-Galerkin FEM for time-dependent convection-dominated problems. An adaptive algorithm with variable time and space steps is proposed. It is proved that at each time step this adaptive algorithm is capable of reducing errors below a given tolerance in a finite number of iteration steps. Numerical results are presented to check the theoretical analysis.

▶ MS-We-E-32-4 17:30–18:00

An Adaptive Local Basis for Elliptic Problems with Complicated Discontinuous Coefficients

Sauter, Stefan — Univ. of Zurich
Weymuth, Monika — Univ. of Zurich

Abstract: We will present a generalized finite element method for the discretization of elliptic partial differential equations in heterogenous media. An adaptive local finite element basis (AL basis) on a coarse mesh which does not resolve the matrix of the media is constructed by solving finite dimensional localized problems. This method requires $O(\log(1/H)^(d+1))$ basis functions per mesh point. We will prove that the optimal convergence rates are preserved and give some complexity estimates.

MS-We-E-33 16:00–18:00 406

Mathematical Modelling, Analysis and Computation for Bose-Einstein condensation - Part II of III

For Part 1, see MS-We-D-33
For Part 3, see MS-Th-BC-33

Organizer: Wang, Hanquan — Yunnan Univ. of Finance & Economics

Abstract: Recently, modeling and simulation of Bose-Einstein condensates (BEC) at zero temperature are one of most interesting research topics in physics as well as applied mathematics. At such low temperature, different kinds of BEC can be modeled by the famous Gross-Pitaevskii equation (GPE) or coupled GPEs or nonlocal GPE(s). How to analyze and solve the GPE(s) for understanding the physics of BEC is interested by mathematicians and physicists . In this minisymposium, we aim to discuss the mathematical properties of these nonlinear Schrodinger type models, find solutions to those models both analytically and numerically, do numerical analysis for efficient numerical methods, and show their applications into simulation of BEC and related physics. This minisymposium can be helpful to design efficient numerical methods for nonlinear Schrodinger type equation. It can be also helpful for applied mathematician to share their latest research work with physicists who are working on research of BEC and related physics.

▶ MS-We-E-33-1 16:00–16:30

Spectral Method for Computing Dynamics of Rotating Two-component Bose-Einstein Condensates via Coordinate Transformation

Yanzhi, Zhang — Missouri Univ. of Sci. & Tech.
Tang, Qinglin — INRIA - Univ. of Lorraine

Abstract: In this talk, we present an efficient and accurate numerical method for computing the dynamics of rotating two-component Bose-Einstein condensates which is described by coupled Gross-Pitaevskii equations (CGPEs) with an angular momentum rotation term and an external driving field. By introducing rotating Lagrangian coordinates, we eliminate the angular momentum

rotation term from the CGPEs. Our method has spectral accuracy in all spatial dimensions and moreover it can be easily implemented in practice.

▶ MS-We-E-33-2 16:30–17:00

Optimal Error Estimate of A Symplectic and Energy Conserving Finite Difference Scheme for the Nonlinear Schrödinger Equation

Wang, Tingchun — Nanjing Univ. of Information Sci. & Tech.

Abstract: Up to now, the mathematicians think that the symplectic finite difference schemes for solving nonlinear partial differential equations could not preserve the total energy in the discrete sense. In this talk, we put forward a new viewpoint that the symplectic finite difference scheme of the nonlinear Schrödinger equation can preserve both the total mass and the total energy in the discrete sense, and establish the optimal error estimate in the maximum norm.

▶ MS-We-E-33-3 17:00–17:30

Error Estimates of Numerical Methods for Nonlinear Schrodinger Equation with Wave Operator

Cai, Yongyong — Purdue Univ.
Hanquan, Wang — Yunnan Univ. of Finance & Economics

Abstract: The nonlinear Schroedinger equation (NLS) with wave operator (NLSW) is NLS perturbed by the wave operator with strength described by a dimensionless parameter $\varepsilon \in (0, 1]$. In this talk, I will start with the error analysis of finite difference methods for NLSW and the uniform bounds w.r.t. ε. Then I will show the error analysis of an exponential wave integrator sine pseudospectral method for NLSW, with improved uniform error bounds.

▶ MS-We-E-33-4 17:30–18:00

Bloch Decomposition Based Method for Quantum Dynamics in Periodic Media

HUANG, ZHONGYI — Tsinghua Univ.

Abstract: In this talk, we will give a short review of our Bloch based method for quantum dynamics in heterogeneous media with periodic microstructures. Furthermore, we will also discuss the applications of our method to some physical problems.

MS-We-E-34 16:00–18:00 112

Structure-preserving methods for nonlinear Hamiltonian systems I-III

Organizer: Feng, Bao-Feng — The Univ. of Texas-Pan American
Organizer: Hu, Xing-Biao — Inst. of Computational Mathematics, Chinese Acad. of Sci. (CAS), China
Organizer: Shang, Zaijiu — AMSS, CAS
Organizer: Hong, Jialin — Inst. of Computational Mathematics, Chinese Acad. of Sci. (CAS)

Abstract: During the last 50 years, there has been a wide interest in the study of nonlinear Hamiltonian systems, especially Hamiltonian PDEs. Among which an important class are integrable, in the sense that they can be solved exactly, admit enough number of conservation laws. On the other hand, there have been major advances in the numerical methods of integrable Hamiltonian systems. Symplectic, multi-symplectic and energy-preserving methods have been popular in simulating these equations. Nevertheless, an important question still deserve to be explored is how to appropriately discretize nonlinear Hamiltonian systems and to gain a superior performance for long time simulations while keeping their common features as many as possible. The purpose of this organized minisymposium is to bring together researchers from both integrable system and numerical analysis to discuss recent advances on numerical aspects of nonlinear Hamiltonian systems.

▶ MS-We-E-34-1 16:00–16:30

Noether's Laws for Finite Element Variational Problems

Mansfield, Elizabeth — Univ. of Kent

Abstract: I will show recent work with Tristan Pryer, in which we demonstrate conservation of energy, and linear and angular momenta for variational problems, which is exact for the approximate problem and which converges to the smooth law. I will then show that particle relabelling group symmetry which yields conservation of potential vorticity for shallow water problems, yields an exact "FE-potential vorticity" which converges to the smooth law.

▶ MS-We-E-34-2 16:30–17:00

A Structure-preserving Numerical Integrator Based on the Hodograph Transform for the Short-pulse Equation

Matsuo, Takayasu — Univ. of Tokyo

Abstract: In this talk, we consider the numerical integration of the short pulse equation. For this, Feng et al. (2011) considered an integrable discretization based on hodograph transform, which enables beautiful simulation of loop type solitons. In this talk, we employ the same transform, and then apply an energy-preserving method. As a good consequence of this approach, the curve length in the short pulse equation, which is also an invariant, is preserved.

▶ MS-We-E-34-3 17:00–17:30

Asymmetric Numerical Schemes Based on the Discrete Variational Derivative Method and A Practical Application

Furihata, Daisuke — Osaka Univ.

Abstract: In general, structure-preserving methods for partial differential equations have some mathematically rigorous properties, but the cost to obtain solutions of them are relatively expensive since those methods are the equivalent of systems of nonlinear equations. An asymmetric discrete variational derivative method weaken the nonlinearity and may lower this cost. We introduce this asymmetric method and indicate its practical utility as predictors in the predictor-corrector context.

▶ CP-We-E-34-4 17:30–17:50

Free Boundary Problem in 3D Geometry

Humaloja, Jukka-Pekka — Tampere Univ. of Tech.
Hamalainen, Timo — Tampere Univ. of Tech.
Pohjolainen, Seppo — Tampere Univ. of Tech.

Abstract: We present a numerical method for detecting perfectly conducting objects in a homogeneous medium in 3D. The method is based on minimizing an objective function that depends on Cauchy data given on the surface of a sensor, near which the conducting objects are located. The objective function is derived from Green's second identity with the fundamental solution of the three-dimensional Laplacian. The functional has linear and nonlinear parts, which is utilized in the minimization.

MS-We-E-35 16:00–18:30 408

Monte Carlo Methods for Solving Partial Differential Equations - Part II of III

For Part 1, see MS-We-D-35
For Part 3, see MS-Th-BC-35

Organizer: Mascagni, Michael — Florida State Univ. CS Dept
Organizer: Cai, Wei — Univ. of North Carolina at Charlotte

Abstract: Monte Carlo Methods (MCMs) have been used extensively in diverse computational applications in the sciences, engineering, and finance. This is due to their natural parallelism, data parsimony and locality, and their capability to tackle high dimension problems that are otherwise intractable. In this mini-symposium, we will present several talks that study the use of MCMs to solve partial differential equations (PDEs). These include using the Feynman-Kac formula to develop MCMs for PDEs, using polynomial chaos for solving stochastic PDEs, Monte Carlo linear solvers that arise from PDEs, algorithmic issues of the walk-on-sphere method, fault tolerance in multilevel MCMs, stability analysis of MCMs for mixed type PDEs, estimation of diffusion process sensitivities, as well as the application of MCMs in capacitance calculation of microchip ICs and multi-asset finance options.

▶ MS-We-E-35-1 16:00–16:30

Monte Carlo Simulations for the Structure of Dielectric Spheres

Xu, Zhenli — Shanghai Jiao Tong Univ.

Abstract: We reported a hybrid algorithm for electrostatic energies of charged dielectric spheres. It is composed of method of images, method of moments and FMM, which provides high accuracy for closely compacted spheres. The high speed is ensured by using images thus only a small number of multipoles is needed in the method of moments. This algorithm allows MC simulations for equilibrium structures of dielectric spheres at room temperature, e.g., PMFs of colloids and their self-assembly.

▶ MS-We-E-35-2 16:30–17:00

A Multi-scale Reaction-Potential Monte Carlo Simulation Method of Electrolytes

Xing, Xiangjun — shanghai jiao tong Univ.

Abstract: In this work we present a novel multi-scale Monte Carlo simulation strategy for the electrolytes. We introduce a spherical simulation domain, and then integrate all ions outside the domain to obtain an effective theory for the ions inside. The resulting multi-scale grand canonical Monte Carlo method is not only efficient in terms of computation resources, but also captures correlation effects between ions faithfully.

▶ MS-We-E-35-3 17:00–17:30

The Floating Random Walk Algorithms for Capacitance Extraction Problems in IC and FPD Design

Yu, Wenjian — Tsinghua Univ.

Abstract: The floating random walk (FRW) algorithms for capacitance extraction of metal interconnects in integrated circuits and flat panel display are

presented. The method is scalable to full-chip / full-net extraction task. The techniques for handling structures with multiple dielectrics, the variance reduction techniques based on importance sampling and stratified sampling, and the techniques handling non-Manhattan geometries are discussed. They largely accelerate the computation and extend the application of the random walk method.

▶ MS-We-E-35-4 17:30–18:00

Computational Geometry Problems Arising in Walk on Spheres Monte Carlo Techniques

Mascagni, Michael — Florida State Univ. CS Dept

Abstract: The efficient and popular method known as Walk on Spheres (WoS) is useful for solving a variety of elliptic and parabolic partial differential equations.. The WoS algorithm is efficient, but the computational bottleneck is the computational geometry required to create optimal WoS paths. In this paper we present results on the best computational algorithms for this aspect of WoS.

▶ MS-We-E-35-5 18:00–18:30

Revisit of Monte Carlo Methods on Solving Large-Scale Linear Systems

Ji, Hao — Old Dominion Univ.
Li, Yaohang — Old Dominion Univ.

Abstract: We present an approach of embedding Monte Carlo sampling into the Krylov subspace methods, where the extreme eigenvalues/eigenvectors of the large coefficient matrix can be estimated and continuously refined during the course of iterations via importance sampling to accelerate the convergence of the linear solvers. The resulted Krylov subspace-based solver with Monte Carlo deflation is memory-bounded, matrix pass-efficient, and can be efficiently implemented on CPU-coprocessor architectures.

MS-We-E-36 16:00–18:00 409

Boundary and interior layers: analysis and simulations - Part I of II

For Part 2, see MS-Th-BC-36

Organizer: Shih, Yin-Tzer — National Chung Hsing Univ.
Organizer: HUANG, ZHONGYI — Tsinghua Univ.

Abstract: Recently there are several computational techniques have been successively implemented in dealing with non-smooth solutions for modeling of many physical phenomena such as fluid flows, semiconductor device simulation or in financial models etc. The mini-symposium will be concerned with in cases of where the solution contains deep gradients exhibiting the boundary layers or interior layers. For such problems, standard discretization methods such as a Galerkin finite element method or classical finite difference methods yield inaccurate oscillatory solutions. These layers are characterized by rapid transitions in the solution, and thus are very difficult to capture the solutions accurately without using a large number of unknowns or using fitted meshes in the layer regions. The aim of this minisymposium is to exchange ideas and explore novel techniques for resolving the boundary or interior layers while simulating the non-smooth model problems.

▶ MS-We-E-36-1 16:00–16:30

Some Open Problems in the Numerical Analysis of Singularly Perturbed Differential Equations

Stynes, Martin — Beijing Computational Sci. Research Center

Abstract: Some open problems in the numerical analysis of singularly perturbed differential equations will be discussed. This is joint work with Hans-Goerg Roos.

▶ MS-We-E-36-2 16:30–17:00

An Equation Decomposition Based Tailored Finite Point Method for Fluid Dynamics

HUANG, ZHONGYI — Tsinghua Univ.

Abstract: In this talk, we propose a tailored-finite-point method for Oseen equations in two dimensions based on the equation-decomposition technique. Unlike the usual vorticity-stream function formulation, the velocities are decomposed to irrotational and rotational parts. We only need to solve a system of two elliptic equations which are decoupled in the interior domain. Our scheme satisfies the discrete maximum principle automatically. We also gives ome remarks on more generally incompressible flow.

▶ MS-We-E-36-3 17:00–17:30

Tailored Finite Point Method for Solving One-dimensional Burgers' Equation

Shih, Yin-Tzer — National Chung Hsing Univ.
Lin, Yu-Tuan — Inst. of Mathematics, Academia Sinica
Tsai, Chih-Ching — National Chung Hsing Univ.

Abstract: We propose two versions of tailored finite point (TFP) methods for solving a time-dependent nonlinear Burgers equation. The first scheme implements the Hopf-Cole transformation, and then discretize the problem by the TFP with fourth order approximation on the boundary. In the second scheme we uses some hyperbolic functions to discretize Burgers' equation directly. Numerical results indicate that both schemes are efficient and robust for solving Burgers' equation.

▶ MS-We-E-36-4 17:30–18:00

An Efficient Stabilized Linear Finite Element Method for Solving Reaction-convection-diffusion Equations

Hsieh, Po-Wen — Chung Yuan Christian Univ.
Yang, Suh-Yuh — National Central Univ.

Abstract: We propose an efficient stabilized linear FEM for solving reaction-convection-diffusion equations with arbitrary magnitudes of reaction and diffusion. The key feature of the method is that the test function in the stabilization term is taken in the adjoint-operator-like form. The analysis shows that the method is suitable for a wide range of mesh Peclet and Damkohler numbers. Numerical examples exhibiting boundary or interior layers are given to demonstrate the high performance of the method.

MS-We-E-37 16:00–18:00 301B

Analysis and control of multi-agent systems

Organizer: Liu, Zhixin — AMSS, Chinese Acad. of Sci.

Abstract: Recently, the investigation of multi-agent systems (MAS) has generated great interest in various fields, including physics, biology, computer science, and social science. An important issue in the study of MAS is to understand how locally interacting agents lead to the behavior of the overall system. In this minisymposium, we focus on the analysis and control of MAS. On one hand, we present how to design the distributed control law for each agent such that the system exhibits the expected behavior; On the other hand, we introduce how to intervene in the MAS without changing the existing interactions between agents such that the system reaches the desired states. We also present analysis of the dynamical behavior of MAS.

▶ MS-We-E-37-1 16:00–16:30

Analysis and Intervention of Multi-agent Systems with Large Population

Liu, Zhixin — AMSS, Chinese Acad. of Sci.

Abstract: In the investigation of multi-agent systems (MAS), a central issue is to understand how local interactions between agents lead to collective behavior of the system. We introduced a random framework and some mathematical tools such as multi-array martingale theorem and estimation of spectral gap of random geometric graphs, to study the synchronization of a basic class of MAS with large population. Meanwhile, I present some quantitative results on how we intervene in MAS such that the system exhibits the expected behavior.

▶ MS-We-E-37-2 16:30–17:00

Design Distributed Consensus Protocols for Linear Multi-Agent Systems

Li, Zhongkui — Peking Univ.

Abstract: Consensus control of multi-agent systems has received compelling attention. Due to the large size of agents, the spatial distribution of actuators, limited sensing or communication capability, consensus protocols of multi-agent systems should be distributed, depending on local information of neighboring agents. The purpose of this talk is to present our recent results on designing distributed adaptive consensus protocols for linear multi-agent systems, which can be constructed and implemented in a fully distributed fashion.

▶ MS-We-E-37-3 17:00–17:30

Cooperative Output Regulation of Multi-agent Systems Coupled by Dynamic Edges

Xiang, Ji — College of Electrical Engineering, Zhejiang Univ.

Abstract: This talk investigates a new class of linear multi-agent systems, in which nodes are coupled by dynamic edges in the sense that each edge has a dynamic system attached. The outputs of the node dynamic systems are inputs of the edge dynamic systems. Several cooperative output regulation problem are posed, including output synchronization, output cooperation and master-slave output cooperation. A simulation example on the cooperative current control of an electrical network illustrates the potential applications.

▶ MS-We-E-37-4 17:30–18:00

Distributed Adaptive Control for Synchronization in Directed Multi-agent Networks: Key Network Structure and Control

Yu, Wenwu — Southeast Univ.

Abstract: The dynamics of a complex network is generally very complicated due to the self-dynamics of the node and their interactions. Many existing conditions for reaching certain desirable dynamics in a complex network require

global information of the network, for example the spectrum of its Laplacian matrix. A challenging problem is how the network structure affects the network dynamics in a distributed way especially for directed networks, which is still unclear today. In this talk, we will investigate the impact of the network structure for synchronization on an undirected complex network, a second-order multi-agent system with undirected topology, and a general directed complex network. We will also develop a scheme to change the weights in a local manner to achieve a desired behavior. In particular, network synchronization is investigated, for which some distributed adaptive laws are designed on the coupling weights for reaching synchronization.

MS-We-E-38 16:00–18:00 302A
Analysis and design of hybrid dynamical systems

Organizer: Kang, Yu Univ. of Sci. & Tech. of China

Abstract: Control theory and corresponding technologies have seen their great success in wide areas of applications in real world for many decades. In this minisymposium, several distinct systems are discussed, including the photovoltaic array, service robots for rehabilitation, systems over communication networks, and the remote sensing of exhaust gas of vehicles. Each discussion focuses on one or several aspects of the modelling, identification, sensing or control of such systems, together presenting a fairly comprehensive picture of the state of the art applications of the modern control technologies.

▶ MS-We-E-38-1 16:00–16:30
Time-Varying Control Design for Nonlinear Systems with Unknown Nonlinearities
Liu, Yungang Shandong Univ.

Abstract: This report is devoted to the time-varying control design with prescribed performance for uncertain nonlinear systems. Differently, the systems under investigation are of unknown control directions, and possess inherent nonlinearities with non-parameterizable unknowns. A new time-varying framework is developed to effectively handle the serious unknowns and strong nonlinearities, and to achieve global stabilization and practical tracking with prescribed performance for two representative classes of uncertain nonlinear systems, respectively.

▶ MS-We-E-38-2 16:30–17:00
The Research and Industrialization of Wearable Upper Arm Robotic System for Medical Rehabilitation
Li, Zhijun South China Univ. of Tech.

Abstract: This project will be based on the nerve repair theory, combined with hemiplegia rehabilitation methods commonly used in the clinic, using robot technology, intelligent control theory, computer technology, to develop the wearable arms robot for medical rehabilitation. The project will provide theoretical guidance and practical verification for a new type of medical rehabilitation robot which has independent intellectual property rights and the value on clinical application. This project will improve the medical rehabilitation robot level and its market competitiveness, and change the situation of dependence on imports. The project has important practical significance of accelerating the industrialization of the medical rehabilitation robot.

▶ MS-We-E-38-3 17:00–17:30
Parameter Identification Method of Photovoltaic Array Based on Measured Data
Wang, Bing Hohai Univ.

Abstract: Based on the I-V equation of photovoltaic cell and basic circuit theories, this paper identifies four undetermined coefficients of photovoltaic array, including photo current, negative saturation current, diode ideality factor and the series resistance of cells, via the output characteristics of maximum power point tracking, by using parameter identification method with the known input and output data of photovoltaic. According to the solved I-V equation, it can predict the output power of photovoltaic plant. At last, it verifies the feasibility and accuracy of the proposed method by numerical examples and data simulation.

MS-We-E-39 16:00–18:00 302B
Data-based industrial modelling, control and optimization

Organizer: Ding, Jinliang Northeastern Univ.
Organizer: Han, Honggui Beijing Univ. of Tech. & City Univ. of Hong Kong

Abstract: With application of the automation and information management systems, numerous historical or real-time data related to industrial production operation are stored. Mining of the information (knowledge) hidden in data and investigating data-driven approaches is a challenging problem for modelling, control and optimization of complex industrial processes. The minisymposium aims to present some recent developments in data-based industrial modelling, control and optimization approaches, including 1) plant-wide performance optimization of industrial processes; 2) hierarchical model to predict sludge volume of wastewater treatment; 3) data-driven predictive scheduling for energy system of steel industry; 4) sampled-data synchronization control of chaotic systems with time delays.

▶ MS-We-E-39-1 16:00–16:30
Data-based Multi-objective Plant-wide Performance Optimization of Industrial Processes under Dynamic Environments
Ding, Jinliang Northeastern Univ.

Abstract: In order to guarantee performance in terms of prescribed multi-objective plant-wide production indices, an approach for selecting optimal operational indices for unit processes is proposed using measured data and without knowing dynamical models of the unit process. Techniques from reinforcement learning are used to provide a data-driven optimization technique that guarantees optimal plant-wide process performance. The effectiveness of this automated decision procedure has been demonstrated by implementation on a large mineral processing plant.

▶ MS-We-E-39-2 16:30–17:00
Hierarchical Modeling Approach to Predict Sludge Volume Index of Wastewater Treatment Process
Han, Honggui Beijing Univ. of Tech. & City Univ. of Hong Kong

Abstract: Sludge volume index (SVI) monitoring is a key challenge that will become even more crucial in the years ahead to quantify the sludge bulking. This contribution presents a SVI predicting plant which uses a hierarchical radial basis function neural network (HRBF) to predict SVI in a wastewater treatment process (WWTP). Experimental results show that the HRBF can be used to predict the wastewater quality online. The results demonstrate its effectiveness.

▶ MS-We-E-39-3 17:00–17:30
Data-driven Predictive Scheduling for Energy System of Steel Industry
Zhao, Jun Dalian Univ. of Tech.
Wang, Wei Dalian Univ. of Tech.

Abstract: With the application of automation system based on information technology, a large number of historical or real-time data related to the production scheduling in industry are generated and stored. Mining and making full use of the information (knowledge) implicitly involved in the data will provide scheduling problem with a class of data-driven methods. In this study, a data-driven predictive scheduling approach will be studied, which will be practically attempted to apply to the steel enterprises.

▶ MS-We-E-39-4 17:30–18:00
Sampled-data Synchronization Control of Chaotic Systems with Time Delays
Wu, Zheng-Guang Inst. of Cyber-Sys. & Control, Zhejiang Univ.
Su, Hongye Inst. of Cyber-Sys. & Control, Zhejiang Univ.

Abstract: The problem of sampled-data synchronization control is investigated for chaotic systems with time delays. It is assumed that the sampling periods are variable but bounded. In order to take full advantage of the available information about the actual sampling pattern, a novel Lyapunov functional is proposed, based on which an exponential synchronization criterion is derived by analyzing the corresponding synchronization error systems and the design method of the desired sampled-data controller is also given.

MS-We-E-40 16:00–18:00 303A
Communication and Control for Complex Networked Systems

Organizer: Peng, Chen Shanghai Univ.

Abstract: Networked control systems (NCSs) are a class of complex dynamical systems wherein the distributed system components, such as sensors, controllers and actuators are connected over a communication network. In the past decade, we have already witnessed interesting results in the literature for NCSs. However, many problems such as the necessary communication for NCSs with limited bandwidth, communication and control design under the limited network resources, and the application of NCSs in the real world still require in-depth investigation to reveal the effects of networks on the operation of NCSs and widen their application domains. The goal of this minisymposium is to gather recent event/self-triggered communication and controller design and separation principle for complex networked control systems field obtained by researchers from academia, research labs, and industry. The central theme of the minisymposium will be advanced communication and control design for NCSs with limited network and computational resources. This theme is strongly interdisciplinary, involving competencies from several science fields, such as: communications, control and computing. Therefore, a minisymposium devoted to it will be of high interest both for the academic and industrial communities.

▶MS-We-E-40-1 16:00–16:30
On Designing A Novel Self-triggered Sampling Scheme for Networked Control Systems with Network-induced Delays and Data Dropouts
Peng, Chen Shanghai Univ.

Abstract: A novel self-triggered sampling scheme is proposed for networked control systems with network-induced delays and data dropouts. By using this scheme, the next sampling instant, which does not depend on the continuous measurement of the system state and on-line estimation of an event-triggered condition, can be dynamically determined with respect to the desired performance, the transmitted time-stamped packet, and the allowable number of successive data dropouts and the network-induced delays. Consequently, the sampling interval can be adaptively adjusted. Therefore, the communication burden can be reduced and the energy efficiency can be improved while maintaining the desired performance.

▶MS-We-E-40-2 16:30–17:00
Controller Design and Separation Principle of Networked Control Systems
Li, Hongbo Tsinghua Univ.

Abstract: Communication technology and digital computation have shown remarkable progress in recent years, which facilitates the emergence and development of the so-called networked control systems (NCSs). This talk will present some recent works on the stability analysis and controller synthesis of NCSs with time delays and packet losses, and offer a perspective on separation principle of NCSs.

▶MS-We-E-40-3 17:00–17:30
Distributed Event Triggered Control of Multi-agent Systems with Switching Topologies
Wang, Dong Dalian Univ. of Tech.

Abstract: A switched Lyapunov function method is proposed for distributed event triggered control of multi-agent systems under the switching topology. Although an arbitrary switching topology is obtained, there is a self-Lyapunov function for each topology. This is in fact a multi-Lyapunov function, which reduces the conservatism of common Lyapunov function method.

▶MS-We-E-40-4 17:30–18:00
Event-triggered Control Design of Nonlinear Networked Systems: A Multi-instant Homogenous Matrix Polynomials Approach
Xie, Xiangpeng Nanjing Univ. of Posts & Telecommunications

Abstract: With the rapid development of networking communication technologies, networked control systems have received increasing interest in recent years. Compared with traditional point-to-point control systems, the main advantages of NCSs are low cost, easy maintenance, and increased system flexibility. More recently, much attention has also been paid to event-triggered control design of nonlinear networked systems. This talk will present some recent works on event-triggered control design of nonlinear networked systems via an efficient approach (named as multi-instant homogenous matrix polynomials approach), which could offer a perspective on reducing the conservatism of existing results.

MS-We-E-41 16:00–18:00 303B
Dynamics and Robotic System Control
Organizer: TCCT Technical Committee on Control Theory, CAA

Abstract: Dynamics and robotic Systems have been object of widespread researchin the last decades. Their applications span over service,industrial, military and civil fields and involve missions likeexploration, transportation and mobile manipulation. In spiteof the many advancements in the field of dynamics and robotic systems,several challenging issues are still open.The minisymposium aim to present some methodic, functional, procedural or algorithmic search, find and processing approach of dynamics and roboticsystemcontrol, including: 1)eigenaxis maneuver strategy for flexible spacecrafts; 2)hypersonic vehicle control; 3)the property of selfishness to the robots; 4) neural network for convex optimization.

▶MS-We-E-41-1 16:00–16:30
Modeling, Control and Simulation of Hypersonic Vehicle
Zong, Qun Tianjin Univ.

Abstract: Our research of Hypersonic Vehicle(HSV) modeling is carried out to calculate the complete aerodynamic data and then obtain the 6-DOF model by mechanism analysis and CFD technique. Our research of HSV control is mainly focused on the sliding mode control(SMC) and adaptive backstepping conrol in the cruise and reentry phase. Combining with the 3D scene technique, dSPACE-based real-time simulations are carried out to prove the validity of the controllers.

▶MS-We-E-41-2 16:30–17:00
Eigenaxis Maneuver Strategy with Input Shaping for Three-axis Maneuver of Flexible Spacecrafts
Lu, Pingli Beijing Inst. of Tech.
Liu, Xiangdong Beijing Inst. of Tech.

Abstract: An eigenaxis maneuver strategy of flexible spacecraft with vibration suppression is investigated. The eigenaxis maneuver is realized by sliding mode methodology so that three-axis attitude maneuver can be treated as single-axis attitude motion around the eigenaxis. Then the input shaping technique, which commonly considers cases of single-axis attitude motion, can be utilized to suppress the residual flexible vibration during three-axis maneuver. Finally, the numerical simulation results verify the effectiveness of the proposed strategies.

▶MS-We-E-41-3 17:00–17:30
Let Robots Be Selfish
Xie, Guangming Peking Univ.
Wang, Chen Peking Univ.

Abstract: We present a framework of evolutionary game theory and multi-robot systems by introducing the property of selfishness to the robots. Based on this novel framework, we investigate formation control problems for a group of selfish robots. It is shown that the system performance can be enhanced by evolving the selfishness.

▶MS-We-E-41-4 17:30–18:00
Recurrent Neural Network for Convex Optimization Problems with Application in Robotics
Cheng, Long Inst. of Automation, Chinese Acad. of Sci.

Abstract: In this talk, we introduce a recurrent neural network model which is capable of solving the convex optimization problems. Both the objective function and inequality constraints can be non-smooth. Finally, we give some application examples of recurrent neural networks in the robotic field.

MS-We-E-42 16:00–18:30 301A
Cooperative Control and Multi-Agent Systems II
Organizer: TCCT Technical Committee on Control Theory, CAA

Abstract: Recent advances in sensing, communication and computation technologies have enabled a group of agents, such as robots, to communicate or sense their relative information and to perform tasks in a collaborative fashion. The past few years witnessed rapidly-growing research in cooperative control technology. Multi-agent system (MAS) is a computerized system composed of multiple interacting intelligent agents within an environment. Multi-agent systems can be used to solve problems that are difficult or impossible for an individual agent or a monolithic system to solve. The aim of this minisymposium is to share novel approaches and innovative applications of cooperative control and MAS, including：1) Distributed control of power grids; 2) Measurement and communication uncertainties of cooperative dynamic networks; 3) Stochastic Control with Time Delay; 4) Synchronization of heterogeneous multi-agent systems.

▶MS-We-E-42-1 16:00–16:30
Distributed Control of Electrical Power Networks
Johansson, Karl H. Royal Inst. of Tech.

Abstract: This talk is on some problems of controlling the voltage and frequency in the future power grids, when the controllers have to be distributed to several individual network nodes. We introduce the distributed control problem, and then, describe how to guarantee stability together with a certain level of performance and disturbance attenuation. In particular, the challenges on how to introduce distributed integral action is discussed in some detail.

▶MS-We-E-42-2 16:30–17:00
Stability and Performaces of Consensus Systems with Measurement and Communication Uncertainties
Tao, Li Shanghai Univ.

Abstract: Measurement and communication uncertainties are important factors for the stability and performances of cooperative dynamic networks. We consider the stability and the performances of several consensus systems subject to noises, link failures and encoding-decoding errors. Consensus conditions are established and the quantitative relationship among the performances, the network and control parameters are given.

▶MS-We-E-42-3 17:00–17:30
Distributed Output Tracking of High-Order Uncertain Nonlinear Multi-Agent Systems
Li, Wuquan Ludong Univ.

Abstract: In this report, the problem of distributed output tracking for high-order uncertain nonlinear multi-agent systems is presented. For the case where the graph topology is directed and the leader is the neighbor of only a small portion of followers, distributed tracking control laws are designed. By using the algebra graph theory, it is shown that all the states of the closed-loop system are bounded, and the tracking errors can be tuned to be arbitrarily small.

▶ MS-We-E-42-4 17:30–18:00

Stochastic Control with Transmission Delay

Zhang, Huanshui — Shandong Univ.

Abstract: This paper study stochastic control for systems with transmission delay. A sufficient and necessary stabilizing condition is presented for the s-tochastic system with delayed state. The analytical controller is given in terms of the optimal state prediction and the solution to a coupled nonlinear equation.

▶ MS-We-E-42-5 18:00–18:30

Heterogeneous Multi-Agent Systems: Geometry and Dual Design

Lewis, Frank — Univ. of Texas at Arlington

Abstract: We study the geometry and duality of multiple interacting heterogeneous multi-agent systems where the agent dynamics may not be the same. A geometric theory is given using Kalman observable form decomposition and a characterization of that portion of the leader's dynamics that is hidden within the dynamics of each agent. These new geometric ideas are used to design efficient reduced-order synchronizers. It is shown that the synchronization problem can be approached by two dual methods:

MS-We-E-43 16:00–18:00 VIP4-1

Black-box and derivative-free optimization

Organizer: Zhang, Zaikun — Institut de Recherche en Informatique de Toulouse (IRIT)

Abstract: Black-box optimization problems arise frequently in real-world applications. In these problems, the function values are provided by black-boxes (typically simulations or experiments), and there is no access to derivatives. They have stimulated optimization methods that do not use derivatives, which are commonly referred to as derivative-free optimization methods. This mini-symposium intends to present the latest advances on black-box and derivative-free optimization both in theory (convergence analysis and complexity control) and in practice (software developments and application-s). The talks will be particularly focused on large-scale problems, constrained problems, parallel methods, subspace methods, and randomized methods.

▶ MS-We-E-43-1 16:00–16:30

Using Concurrent Function Evaluations to Identify Local Minima of A Derivative-free Optimization Problem

Larson, Jeffrey — Argonne National Laboratory
Wild, Stefan — Argonne National Laboratory

Abstract: We present software that uses concurrent evaluations of the objective function to identify all of its local minima. The method is based on a multistart algorithm that almost surely finds all local minima of the function while starting only finitely many local optimization runs. We specifically highlight rules in our software that pause local optimization runs to help our method more efficiently search the domain, while not interfering with its underlying theoretical properties.

▶ MS-We-E-43-2 16:30–17:00

Direct Search Based on Probabilistic Descent

Gratton, Serge — Univ. of Toulouse, IRIT-CERFACS joint laboratory
Royer, Clement — Univ. of Toulouse, IRIT-CERFACS joint laboratory
Vicente, Luis Nunes — Univ. of Coimbra
Zhang, Zaikun — Institut de Recherche en Informatique de Toulouse (IRIT)

Abstract: Direct-search methods are a class of derivative-free algorithms based on evaluating the objective function along directions in positive spanning sets. We study a more general framework where the directions are only required to be probabilistic descent, meaning that with a significantly positive probability at least one of them is descent. This framework enjoys almost-sure global convergence and a global rate of 1/sqrt(k) (like in gradient methods) with overwhelmingly high probability.

▶ MS-We-E-43-3 17:00–17:30

A Subspace Decomposition Framework for Nonlinear Optimization

Gratton, Serge — Univ. of Toulouse, IRIT-CERFACS joint laboratory
Vicente, Luis Nunes — Univ. of Coimbra
Zhang, Zaikun — Institut de Recherche en Informatique de Toulouse (IRIT)

Abstract: We present a parallel subspace decomposition framework for nonlinear optimization, which can be regarded as an extension of the domain decomposition method for PDEs. A feature of the framework is that it incorporates the restricted additive Schwarz methodology into the synchronization phase of the algorithm. We establish the global convergence and worst case iteration complexity of the framework, and illustrate how this framework can be applied to design parallel algorithms for derivative-free optimization problems.

MS-We-E-44 16:00–18:00 VIP2-1

Mathematics of Information and Low Dimensional Models - Part III of III

For Part 1, see MS-Tu-E-44
For Part 2, see MS-We-D-44

Organizer: Blanchard, Jeffrey — Grinnell College

Abstract: This min-symposium considers a variety of ill-posed inverse problems associated with information theory, signal processing, and image processing. By exploiting low dimensional structure, such as in compressed sensing and low rank matrix completion, tractable algorithms permit construction of accurate approximate solutions and low dimensional representations. The mini-symposium will include state-of-the-art work on algorithms, theoretical analysis, and relationships with high dimensional geometry from researchers at all stages of their careers.
Notes to ICIAM Committee: - Jared Tanner (Oxford) is a co-organizer of this symposium but does not have a pin. - This symposium is sponsored by the SIAM SIAG on Linear Algebra.

▶ MS-We-E-44-1 16:00–16:30

Theory and Applications of Conic Integral Geometry

Amelunxen, Dennis — City Univ. of Hong Kong

Abstract: Conic integral geometry provides deep insights as well as -exact-formulas for the probabilities of important events such as -success of the compressed sensing method with Gaussian sensing matrices, -a random (GOE) semidefinite program having a solution of rank r, as well as other application-s. We present this theory with an emphasis on new developments such as a central limit theorem (Goldstein et al, 2014), and probability calculus that goes beyond the convex case.

▶ MS-We-E-44-2 16:30–17:00

Rank-One Tensor Updating Algorithms for Tensor Completion

Yang, Yuning — KU Leuven

Abstract: We introduce algorithms for tensor completion which are based on rank-one tensor updating. At each iteration, a rank-one tensor is selected by computing the tensor spectral norm; then the new trial is given by the linear (convex) combination of the current trial and the newly generated rank-one tensor. The weights or stepsizes are updated by greedy strategy, or under the Frank-Wolfe method framework. Experiments are provided to verify the efficiency of the algorithms.

▶ MS-We-E-44-3 17:00–17:30

PCANet: A Simple Deep Learning Baseline for Image Classification?

Ma, Yi — ShanghaiTech Univ.

Abstract: We will discuss a very simple deep network for image classification which comprises only the very basic data processing components: cascaded principal component analysis (PCA), binary hashing, and block-wise histograms. In the proposed architecture, PCA is employed to learn multistage filter banks. It is followed by simple binary hashing and block histograms for indexing and pooling. This architecture is thus named as a PCA network (P-CANet) and can be designed and learned easily and efficiently.

▶ MS-We-E-44-4 17:30–18:00

An Expander Graph Construction and Its Implication for Compressed Sensing

Tanner, Jared — Univ. of Oxford

Abstract: We consider a probabilistic construction of sparse matrices with provable restricted isometry constants (RICS) using l1 norms. Unlike traditional RICs which are based on eigenvalue analysis, these l1-RICs are determined by expansion properties of the adjacency matrix of an expander graph. Implications for compressed sensing are discussed. This work is joint with Bubacarr Bah.

MS-We-E-45 16:00–18:00 213A

Distributed control of networked agent systems

Organizer: Yu, Wenwu — Southeast Univ.
Organizer: Wen, Guanghui — Southeast Univ.

Abstract: Many real large-scale systems can be modeled as networked agent systems, where typical examples include Internet, WWW, smart grids, etc. In the past ten years, distributed control of networked agent systems has received much attention from various fields. Experimental studies indicate that the abundance of embedded computational and sensing resources in networked agent systems enables enhanced operational effectiveness through

cooperative teamwork in real applications. The focus of this mini-symposium will be on new and existing distributed control approaches in networked agent systems.

▶ MS-We-E-45-1 16:00–16:30

Distributed Finite-time Tracking of Multiple Euler-Lagrange Systems without Velocity Measurements

Yu, Zhao Peking Univ.
Wen, Guanghui Southeast Univ.

Abstract: This paper investigates the distributed finite-time tracking problem of networked agents with Euler-Lagrange dynamics. To achieve finite-time tracking, with the aid of second-order sliding-mode observer approach, a new class of finite-time tracking protocols based only on the relative position measurements are developed and employed. It is proved that the multiple agents equipped with the designed protocols cantrack the target location in finite time. The effectiveness of the theoretical results is finally illustrated by numerical simulations.

▶ MS-We-E-45-2 16:30–17:00

Node-to-node Consensus of Multi-agent Systems under Directed Topology

Wen, Guanghui Southeast Univ.
Yu, Wenwu Southeast Univ.

Abstract: Consensus of multi-agent system has recently received considerable attention from various scientific communities due to its potential applications in engineering. In this talk, distributed node-to-node consensus for multi-agent systems with directed topology is introduced and discussed. The multi-agent systems in the present framework consist of two layers, i.e., the leader's layer and the follower's layer, where the coordination goal is to make each follower asymptotically track its corresponding leader by designing some local-information-based protocol. Both theoretical and numerical results on node-to-node consensus of such a multi-agent system will be provided in this talk.

▶ MS-We-E-45-3 17:00–17:30

Convergence Rate of the Consensus of Linear Multi-agent Systems with Communication Noises

Cheng, Long Inst. of Automation, Chinese Acad. of Sci.

Abstract: This study mainly focuses on the convergence rate of the consensus of linear multi-agent systems. It is assumed that each agent is described by the generic linear dynamics, and communication channels are corrupted by additive noises. A time-varying gain is adopted to attenuate the noise effect. It has been found that the convergence rate of the consensus has a strong relationship with the convergence rate of this time-varying gain.

▶ MS-We-E-45-4 17:30–18:00

General Algebraic Connectivity in Consensus of Multi-agent Systems

Yu, Wenwu Southeast Univ.

Abstract: This talk will discuss general algebraic connectivity representing consensus convergence rate in multi-agent systems with directed topologies. First, a new concept, general algebraic connectivity is proposed to study the global consensus problem with first-order dynamics in strongly connected networks and also in a broad class of networks containing spanning trees, for which ideas from algebraic graph theory, matrix theory, and Lyapunov methods are utilized. Based on this result, consensus in multi-agent systems with second-order nonlinear

MS-We-E-46 16:00–18:00 306B

Inverse Problems for Image Reconstruction and Processing - Part II of IV

For Part 1, see MS-We-D-46
For Part 3, see MS-Th-BC-46
For Part 4, see MS-Th-D-46

Organizer: Wei, Suhua Inst. of Applied Physics & Computational Mathematics
Organizer: Nikolova, Mila CMLA, CNRS - ENS Cachan
Organizer: Tai, Xue-Cheng Department of Mathematics, Univ. of Bergen
Organizer: Shi, Yuying North China Electric Power Univ.

Abstract: Many image reconstruction tasks amount to solve ill-posed inverse problems. Indeed, measurement devices typically cannot record all the information needed to recover the sought-after object; furthermore, the operators that model these devices are seldom accurate and data are corrupted by various perturbations. A common approach to find an approximate to the unknown object is regularization. The key points are the correct choices of the data fidelity term and the regularization term, as well as the trade-off between these terms. This is a challenging problem since the optimal solutions of the whole functional should correctly reflect the knowledge on the data-production process and the priors on the unknown object. The optimal solutions usually cannot be computed explicitly and iterative schemes are used. This symposium focus on imaging inverse problems' mathematical models, numerical algorithms, theoretical analysis and various applications, especially, applied to CT reconstruction and some processing techniques for images.

▶ MS-We-E-46-1 16:00–16:30

Domain Decompsition for Total Variation Minimization

Tai, Xue-Cheng Department of Mathematics, Univ. of Bergen

Abstract: This talk is concerned with overlapping domain decomposition methods (DDMs), based on successive subspace correction (SSC) and parallel subspace correction (PSC), for the Rudin, Osher and Fatemi (ROF) model in image restoration. In distinct contrast with recent attempts along this line, we work with a dual formulation of the ROF model, where one significant difficulty lies in the decomposition of the global constraint of the dual variable. We propose a stable unit decomposition which

▶ MS-We-E-46-2 16:30–17:00

A Reconstruction Method of Intra-Ventricular Flow Velocity Using Color Flow Ultrasound

Ahn, Chi Young National Inst. for Mathematical Sci.

Abstract: We propose a 2D Navier-Stokes model to reconstruct intraventricular flows using color flow images and left ventricular boundaries extracted from echocardiography data. The proposed model considers both in-plane and out-of-plane blood flows for an imaging plane in apical long-axis three-chamber view. Blood flows in the imaging domain are reconstructed through solving a system of equations, which include a 2D incompressible Navie-Stokes equation with a mass source term and the color flow data measurement equation.

▶ MS-We-E-46-3 17:00–17:30

Adaptive Regularization Method for Tomography Reconstruction

Lu, Yao Sun Yat-sen Univ.

Abstract: The purpose of this study was to implement the adaptive regularization rooted from traditional discrete Total Variation (TV) regularization for iterative tomography reconstruction in mesh domain to suppress image noise accumulation with increasing iteration number. In order to accomplish these aims we used reconstruction algorithms in mesh domains that employed TV priors applied in a continuous form. A computationally efficient approach for the proposed continuous regularization was derived for piece-wise linear basis functions.

▶ MS-We-E-46-4 17:30–18:00

An Alternating Minimization Model for Tomography Reconstruction in Hydrodynamic Experiments

Kong, Linghai Inst. of Applied Physics & Computational Mathematics

Abstract: Flash radiography with CCD-based camera plays an important role in studying the dynamical behavior of material under a shock through tomographic reconstruction techniques, where the map is degraded by blur and noise. A new regularized alternating minimization model is proposed by exploiting the EM algorithm and the augented Lagragian method. Numerical tests are illustrated to validate the model.

MS-We-E-47 16:00–18:00 108

Numerical methods for compressible multi-phase flows - Part III of VI

For Part 1, see MS-Mo-D-08
For Part 2, see MS-Mo-E-08
For Part 4, see MS-Th-BC-47
For Part 5, see MS-Th-D-47
For Part 6, see MS-Th-E-47

Organizer: Deng, Xiaolong Beijing Computational Sci. Research Center
Organizer: Wei, Suhua Inst. of Applied Physics & Computational Mathematics
Organizer: Tian, Baolin Insitute of Applied Physics & Computational Mathematics
Organizer: Tiegang, Liu Beihang Univ.
Organizer: Sussman, Mark Florida State Univ.
Organizer: Wang, Shuanghu IAPCM

Abstract: Compressible multi-phase flows appear in many natural phenomena, and are very important in many applications, including space science, aerospace engineering, energy, homeland security, etc. Numerical calculation is a key for understanding many related problems. More and more numerical methods are being developed and improved. In this mini-symposium, novel numerical methods will be presented to show the progress in the area of compressible multi-phase flows, including interface capturing/tracking methods, phase change calculations, mixing methods, fluid-structure interaction

methods, multi-physics calculations, adaptive mesh refinement, and high performance computing.

▶ MS-We-E-47-1 16:00–16:30

RKDG Methods with Cut Cell for Compressible Multi-phase Flows: Full Navier-Stokes Equations

Li, Maojun Chongqing Univ.
Deng, Xiaolong Beijing Computational Sci. Research Center

Abstract: Following our earlier works with Euler equations, full Navier-Stokes equations are realized in the cut-cell based RKDG method to simulate compressible multi-phase flows, by including viscosity and conductivity effects. In this method, material interface is represented by cut faces and evolved with the help of Level Set function. Sharp interface makes it more naturally to satisfy all the jump conditions, including normal and tangential shear forces and heat balance, and DG makes it more accurate.

▶ MS-We-E-47-2 16:30–17:00

The Bubble Dynamics Near A Solid Boundary in A Compressible Fluid

Shiping, Wang Harbin Engineering Univ.
Xi, Ye Harbin Engineering Univ.
Zhang, Aman Harbin Engineering Univ.

Abstract: Currently the BEM model ignores the compressibility of the fluid which assumes that the fluid particle velocity is much smaller than sound velocity. But a bubble’s jet velocity would reach over 100 m/s. The fluid compressibility should not be ignored. Recently, we have extended this model which considers the weak compressibility of the fluid solving linear wave equation. Finally, this numerical model is used to analyze the 3D bubble motion under acoustic travelling waves.

▶ MS-We-E-47-3 17:00–17:30

Exact Solutions to Riemann Problems of Gas-water-solid-vacuum Systems and Constructions of Numerical Algorithms

Tang, Hansong City College, City Univ. of New York, Changsha Univ. of Sci. & Tech.

Abstract: A review will be given on exact solutions of Riemann problems we obtained for flows of gas, water, solid, and vacuum systems (JCP 1996; 1999). Then, the solutions are employed to develop MUSCL-type schemes for flows of gas-water-solid systems associated with cavitation and rupture and deal with grid interfaces in domain decomposition methods for gaseous flows. Finally, discussion on relevant work and outlook for further development in this direction will be given.

▶ MS-We-E-47-4 17:30–18:00

A Multi-Material ALE Method for Compressible Rayleigh-Taylor Instabilities

Tian, Baolin Insitute of Applied Physics & Computational Mathematics

Abstract: Rayleigh-Taylor Instabilities can be found in a variety of science areas and practical applications, such as astrophysics and ICF. In this work, a Multi-Material ALE(Arbitrary Lagrangian-Eulerian) method coupled with five-equation model is proposed based on a novel closure model for multifluid mixed cells. With the proposed methods and code, compressible Rayleigh-Taylor Instabilities were simulated, and the effects of different Atwood numbers and acceleration history were studied.

MS-We-E-48 16:00–18:00 212B

Structural analysis and collective dynamics on complex networking systems

Organizer: Chengyi, Xia Tianjin Univ. of Tech.
Organizer: Zengqiang, Chen Nankai Univ.

Abstract: In the past years, network science has successfully characterized the interactions among the components of a great number of real-world systems which include natural, social, biological, technological and engineering systems. Among them, the node represents the constituting components and link mimics the interaction between components. However, as real-world systems continuously evolve and novel data analysis or processing technologies emerge, it is necessary to further explore the structure of and collective dynamics taking upon complex networking systems. In this miniSymposia, we invite 4 speakers to talk about the collective dynamics of multi-agent's systems, the analysis and optimization of interdependent networks, global dispersal of emerging infectious diseases all over the world, and application of complex network theory into the detection and identification of industrial multiphase flow. The current symposia will contribute to deeply understanding the structure and dynamical evolution of realistic networking systems.

▶ MS-We-E-48-1 16:00–16:30

Consensus of Heterogeneous Multi-agent Networks with Singular Dynamic Systems

Zengqiang, Chen Nankai Univ.
Geng, Hua Nankai Univ.

Abstract: In this paper, consensus of singular multi-agent systems with heterogeneous dynamics is investigated. The definition of quasi-homogeneous singular first-order multi-agent systems is introduced via the coordinate transformation. Necessary and sufficient condition on consensus ability is given between the heterogeneous system and quasi-homogeneous system. Then the consensus problem of singular multi-agent system is discussed when the communication topology is fixed and directed. Under some assumptions, a sufficient condition of consensus for the singular multi-agent system ispresented.

▶ MS-We-E-48-2 16:30–17:00

Complex Network from Multivariate Time Series for Characterizing Experimental Two-phase Flow

Gao, Zhong-Ke Tianjin Univ.

Abstract: We design a new multi-sector conductance sensor and measure multivariate signals from gas-liquid/oil-water two-phase flow experiments. Then, we propose two novel methods to derive multiscale complex network and multi-frequency complex network from multivariate time series. The results indicate the analysis of multiscale complex network recovers deeper insights into the dynamic behavior governing the transitions of gas-liquid flow patterns, and the community structures of multi-frequency complex network allows uncovering the complicated oil-water flow structures.

▶ MS-We-E-48-3 17:00–17:30

Interdependent Networks: Modeling, Vulnerability Analysis and Optimization

Sun, Shiwen Tianjin Univ. of Tech.

Abstract: Attack vulnerability of isolated and interdependent networks has been investigated extensively. Optimized networks with onion structure have improved robustness to resist malicious attacks. In our study, we investigate two important dynamical properties: synchronization behavior and structural controllability of optimized onion networks. Then, a new interdependent system composed of two optimized networks is proposed. The effect of different coupling patterns (such as random, assortative, disassortative) is analyzed.

▶ MS-We-E-48-4 17:30–18:00

The Dynamics Underlying Global Spread of Emerging Infectious Diseases

WANG, Lin The Univ. of Hong Kong

Abstract: Understanding the dynamics underlying global transmission of emerging infectious diseases via international mobility is evidently pivotal in infectious disease epidemiology as seen in past pandemics as well as the ongoing spread of Ebola within and from West Africa via air travel. Here we use the global epidemic model to establish a theory, explicitly characterising how global spread of EIDs depends on the mobility network and local epidemic factors.

MS-We-E-50 16:00–18:00 207

Synchronization of complex networks and multi-agent systems

Organizer: Huang, Chi Taiyuan Univ. of Tech.
Organizer: Qingying, Miao Shanghai jiao tong Univ.
Organizer: Tang, Yang East China Univ. of Sci. & Tech.

Abstract: Complex networks and multi-agent systems have, in recent years, brought many innovative impacts to large-scale systems. However, great challenges also come forth due to distinct complex situations and imperative requirements in human life nowadays. This session attempts to present recent progress of synchronization of complex dynamical networks and multi-agent systems. We focus on synchronization of multiplex networks, synchronization of networks with random event-sampling scheme, leader-following consensus of multi-agent systems and consensus of switched system multi-agent systems.

▶ MS-We-E-50-1 16:00–16:30

Leader-following Consensus of Nonlinear Multi-agent Systems with Mixed Delays and Uncertain Parameters via Adaptive Pining Intermittent Control

Hongjie, Li zhejiang Univ.

Abstract: The paper investigates leader-following consensus problem of multi-agent systems with delayed nonlinear dynamics and uncertain parameters, where only a small fraction of followers can sense the leader’s information on a sequence of disconnected time intervals. A novel distributed adaptive pinning intermittent control protocol is proposed based only on local information of the network structure, and some novel criteria are derived. Finally, a numerical example is provided to demonstrate the effectiveness of the obtained theoretical results.

▶ MS-We-E-50-2 16:30–17:00

A Unified Switched System Approach to Consensus Control of Multi-Agent

Systems

Zhai, Guisheng — Shibaura Inst. of Tech.
Huang, Chi — Taiyuan Univ. of Tech.

Abstract: We consider a consensus control problem for multi-agent systems with quantitatively changing interconnection graphs, focusing on the case of involving disconnected interconnections. Motivated by observing that the consensus control can be reduced to stabilization of a kind of switched linear systems, we establish a unified approach for the consensus control problem on hand, by utilizing the existing vigorous results for analysis and design of switched systems.

▶ MS-We-E-50-3 17:00–17:30

Synchronization Analysis of Complex Networks with Random Event-driven Sampling Scheme

Huang, Chi — Taiyuan Univ. of Tech.

Abstract: Information of nodes are sampled before communication. The sampling is operated in an event-driven fashion. An event condition is designed for each node to govern the sampling instants. The condition is checked periodically. when the condition is violated, the sampling will be carried out. At each checking instant, the next checking period is randomly chosen from several candidates. Thus, the sampling instants of different nodes are mutually distinct and hard to be predicted.

▶ MS-We-E-50-4 17:30–18:00

Adaptive Synchronization of Multiplex Networks

Qingying, Miao — Shanghai jiao tong Univ.

Abstract: In this report, we study the problem of synchronization of multiplex networks. We consider the networks with different topological structure in each layer, set up inter-layer connections. We study the synchronization of the networks with adaptive coupling strength in each layer. We find that the inter-layer connections based on nodes' property influence the synchronization of the multiplex networks. This gives us some hint in building the inter-layer connections among different networks.

MS-We-E-51 16:00–18:00 209A

Collective dynamics of online social systems - Part II of II

For Part 1, see MS-We-D-51

Organizer: Jianguo, Liu — Univ. of Shanghai for Sci. & Tech.

Abstract: Billions of online user's behavior data provide valuable opportunity to analyze the collective behavior patterns of online users, interest migration patterns, measuring online user reputation, designing personalized recommendation algorithms, online link prediction, as well as other new challenges. This Minisymposia will introduce the pioneer progress of online user behavior analysis scientists from China, including the statistics properties of online user behavior, online information dissemination, interest measurements, and personalized recommendation algorithms, which would help researchers catch up the current situation of this research direction.

▶ MS-We-E-51-1 16:00–16:30

An Empirical Study on Topic Interests and Topic Information Diffusion in Microblog Networks

Hu, Haibo — East China Univ. of Sci. & Tech.

Abstract: Through the analysis and comparison of the diffusion difference of diverse topic categories, we find that users prefer the information with lifestyle topic, reposting probability is significantly different among microblogs within different topic categories, and the average reposting count can be 10 times in difference. In microblog information diffusion trees, diffusion depth, diffusion time interval and users' diffusion ability all show different characteristics for microblogs with different topic categories.

▶ MS-We-E-51-2 16:30–17:00

Ranking Online Reputation and Quality via the Beta Probability Distribution

Xiaolu, Liu — Univ. of Shanghai for Sci. & Tech.

Abstract: In this paper we present an algorithm ranking online object quality and user reputation in terms of the beta probability distribution (RBPD). We extend the method adopting the beta probability distribution to model the reputation from social networks to bipartite networks. The experimental results for the empirical networks show that the AUC values of the RBPD algorithm can reach 0.8929 and 0.8483 in Movielens and Netflix.

▶ MS-We-E-51-3 17:00–17:30

Evolution Properties of Online User Preference

JI, Lei — Univ. of Shanghai for Sci. & Tech.

Abstract: In this paper, we empirically analyze the evolution characteristics of online user rating behaviors. The diversity of user's preference indicates that for users who just enter the system their tastes are increasingly diverse. Results show that for movies and reviews, the correlation between the user rating and the object quality presents specific pattern in the given system, which suggests that users would rapidly develop their different preference for different objects.

▶ MS-We-E-51-4 17:30–18:00

Locating Influential Nodes via Dynamics-sensitive Centrality

Lin, Jianhong — Univ. of Shanghai for Sci. & Tech.

Abstract: In this paper, we present a dynamics sensitivity (DS) centrality that integrates topological features and dynamical properties. The DS centrality can be directly applied in locating influential spreaders. According to the simulation results on four real networks for both susceptible-infected-recovered (SIR) and susceptible-infected (SI) spreading models, the DS centrality is more accurate than degree, k-shell index and eigenvector centrality.

MS-We-E-52 16:00–18:00 212A

Topology identification of complex networks

Organizer: Xiaoqun, Wu — Wuhan Univ.

Abstract: Network topology plays a crucial role in determining a network's intrinsic dynamics and function, thus understanding and modeling the topology of a complex network will lead to greater knowledge of its evolutionary mechanisms and to a better understanding of its behaviors. In the past few years, topology identification of complex networks has received increasing interest and wide attention. Many approaches have been developed for this purpose, including adaptive control based identification, information-theoretic methods, and intelligent optimization algorithms. We hope to have more researchers or engineers to present and discuss the latest development on this topic, which could provide more convenient approaches to recovering network topology and reduce application costs.

▶ MS-We-E-52-1 16:00–16:30

Collective Behaviours Through Social Interactions in Bird Flocks

Wang, Xiong — Chinese Acad. of Sience
Mao, Yuanyuan — Chinese Acad. of Sience
Lu, Jinhu — Acad. of Mathematics & Sys. Sci., Chinese Acad. of Sci.

Abstract: Collective behaviours of multi-agent systems(MAS) often exhibit through social interactions among their agents. We concentrate on several models of collective behaviours in bird flocks, a representative MAS. This article is aimed at providing a discussion of the various facets of this interdisciplinary field, including simulation models, mathematical methods and control theory. The purposes are to offer readers a better understanding of complex systems and to promote this emerging topic on MAS.

▶ MS-We-E-52-2 16:30–17:00

Inferring Topologies via Driving-Based Generalized Synchronization of Two-Layer Networks

Xiaoqun, Wu — Wuhan Univ.

Abstract: In this presentation, we will report topology identification of complex dynamical networks with coupling delay via generalized synchronization of a two-layer network. Particularly, based on the LaSalle-type invariance principle, an adaptive control technique is proposed to infer the underlying network topology by constructing an auxiliary layer and designing proper control input and updating laws. The method is also applicable to infer topology of a subnetwork embedded within a large-scale network and locate hidden sources.

▶ MS-We-E-52-3 17:00–17:30

Structural Reduction for Controlling Complex Networks

Wang, Wen-Xu — Beijing Normal Univ.

Abstract: By implementing 1st- and 2nd-order structural reduction, we preserve a minimum set of driver nodes for achieving full control of any networks. The framework has advantages compared to recently developed approaches. Applying our tools to complex networks yields several interesting results, including a phase transition at natural logarithm when carrying out the 1st-order structural reduction and two phase transitions in node classification. We also offered analytical predictions of all the results based on network theory.

MS-We-E-53 16:00–18:00 311B

Mathematical analysis of algorithmic trading and limit order markets

Organizer: Ludkovski, Mike — UC Santa Barbara
Organizer: Leung, Tim — Columbia Univ.
Organizer: Gao, Xuefeng — The Chinese Univ. of Hong Kong

Abstract: The availability of high frequency financial data opens up new arenas for the application of continuous time stochastic modeling and introduces new problems. Modeling: How should limit order book data be incorporated in tick-by-tick modeling? Information: How do agents process and act up-

on this vast information set? Trading: How can algorithmic trading strategies take advantage of this knowledge? Mathematics: How to construct scaling limits of microstructure models to obtain a macroscropic description of price dynamics? This mini symposium will address several of these interesting issues bringing together expertise in applied mathematics, operations research and statistics.

▶ MS-We-E-53-1 16:00–16:30

Hydrodynamic Limit of Order Book Dynamics

Gao, Xuefeng — The Chinese Univ. of Hong Kong

Abstract: We investigate the dynamics of the limit order book shape on the "macroscopic" time scale, motivated by study of price impact and optimal execution. We develop a fluid approximation for the sample path behavior of order book shape in certain asymptotic regime. Our main result states that a pair of measure-valued processes, representing the sell-side shape and buy-side shape of the order book, converges to a pair of deterministic measure-valued processes in a certain sense.

▶ MS-We-E-53-2 16:30–17:00

Stochastic Model for Spread-price Dynamics in Order-driven Markets

Chen, Xinyun — State Univ. of New York at Stony Brook

Abstract: We construct and study a continuous time model that incorporates the whole limit order book to inform the joint evolution of the spread and the price processes. The construction of our model is guided by empirical data. In particular, empirical observations suggest a multi-scale asymptotic regime, under which we obtain a jump-diffusion processes governing the evolution of the spread-price dynamics. The simulation results reproduce stylized features observed empirically.

▶ MS-We-E-53-3 17:00–17:30

Optimal Exposure Problem in Limit Order Book

Chen, Yuanyuan — The Chinese Univ. of Hong Kong
Li, Duan — The Chinese Univ. of Hong Kong
Gao, Xuefeng — The Chinese Univ. of Hong Kong

Abstract: We study a multi-stage optimal exposure problem which a large buyer faces. The buyer needs to decide at each time t whether to submit limit order or hidden order, or both and how many for each. With a dynamic programming model, we identify certain market conditions under which the buyer would never use iceberg orders. We further present some findings on how the market parameters affect the choice made among limit, hidden and iceberg orders.

▶ MS-We-E-53-4 17:30–18:00

Dynamics of Order Positions in A Limit Order Book

Ruan, Zhao — Univ. of California, Berkeley

Abstract: The dynamics of an order position in a LOB is a critical yet missing piece when modeling the LOB and dealing with the inventory/execution risk with consideration of microstructure of the LOB. We will present some of our recent progress regarding the limiting behavior of that dynamics, including some explicit expressions for various quantities of interests. This talk is based on joint work with X. Guo (UC Berkeley) and L. J. Zhu (U. of Minnesota).

MS-We-E-54 16:00–18:10 VIP1-2

Cooperative Games and Applications in Modern Industry

Organizer: Li, Deng-Feng — Fuzhou Univ.

Abstract: The cooperative game theory is an important part of the game theory, which belongs to the field of the applied mathematics. In modern industry, there are lots of decision problems which may be modelled as cooperative games. In this minisymposia, we mainly concern the modeling methods of cooperative games for practical industry decision problems such as service industry and E-commerce, allocation (or imputation) of profit/cost from viewpoint of cooperative games and computation algorithms. Other kinds of cooperative games under uncertain situations such as interval-valued cooperative games, fuzzy cooperative games, cooperative games with fuzzy coalitions are belonged to this minisymposia. Certainly, the cooperative games include transferable and nontransferable cooperative games.

▶ MS-We-E-54-1 16:00–16:30

A Strategic Analysis of Consumer-related Managerial Incentive Design

Li, Kevin — Univ. of Windsor
Junsong, Bian — Odette School of Business, Univ. of Windsor
Guo, Xiaolei — Univeristy of Windsor

Abstract: This paper investigates strategic managerial incentive design regarding firms' attitude towards consumer surplus in a duopoly where each firm consists of an owner and a manager. We consider Bertrand and Cournot competition modes with the firms' products being either substitutes or complements. We analyze the endogenous design of such managerial incentives and, then, examine their strategic effect on firms' profit, consumer surplus and social welfare.

▶ MS-We-E-54-2 16:30–17:00

China Urban Agglomeration Efficiency Research under New Industrialization

Lin, Donghua — Management Department of Shanghai Open Univ.

Abstract: With the continuous development of economic globalization and regionalization, urban agglomeration, whose economic efficiency directly affects the competitiveness of a country, has become a basic regional unit of a country's participating in the global competition and international division of labor. This paper, under the background of new industrialization, conducts an empirical analysis of China's 13 major urban agglomerations' economic efficiency in the years 2008-2012 by applying DEA method and related panel data. The research shows that from the dynamic aspect, the comprehensive economic efficiency of China's urban agglomerations has been fluctuating over the past five years, with their gaps widening further. From the regional aspect, eastern urban agglomerations are generally better at integrated management and resource allocation and utilization, followed by those in central and then western areas. But central urban agglomerations are almost at the same level as eastern regions in terms of scale agglomeration effects, while the western regions are still backward. Further study shows that there is a weak positive correlation between scale efficiency and urban agglomeration scale. Therefore, to improve the scale efficiency of China's urban agglomerations, we should take the new industry as a starting point and focus on the inner cluster aggregation effect, but not others like denotative development. From the urban agglomeration aspect, the following three agglomerations, namely the Yangtze River Delta, the Pearl River Delta and Huhho -Baotou-Ordos regions, are in the efficient frontier, but most other urban agglomerations' economic efficiency is far from validity. The invalid economic efficiency of those agglomerations, represented by Beijing, Tianjin and Hebei, is mainly caused by invalid pure technical efficiency. Therefore, to further improve the regional economy centered on urban agglomeration, we should first effectively enhance the ability of resource allocation and utilization and scale aggregation by perfecting the management system of urban agglomeration. That is the key to upgrade the economic efficiency of China's urban agglomerations.

▶ MS-We-E-54-3 17:00–17:30

Cooperation in Dynamic Network Games with Pairwise Interactions

Petrosyan, Leon — Saint Petersburg State Univ.

Abstract: A finite cooperative multistage network game with pairwise interactions proceeds as follows. In a stage game a player plays a two-person nonzero-sum game with each of his neighbors and after that a random "shock" affects one of the players. The characteristic function is constructed and as a solution concept the Shapley value is chosen. It is proved that the Shapley value is subgame-consistent. The results are illustrated with an example.

▶ CP-We-E-54-4 17:30–17:50

Stability in Evolutionary and Population Games

Fryer, Dashiell — Pomona College

Abstract: The replicator dynamics provide a model for Darwinian evolution. Fitter than average types proliferate while less fit types decay. It can be shown that a Nash equilibrium for the fitness landscape is also an equilibrium for these dynamics. Thus connecting evolutionary theory to game theory. A well known result in evolutionary games states that information theory can bee used to describe the stability of these equilibrium points. In this talk, I will discuss generalizations of the connection between game, evolutionary, and information theories. This will include a broadening the class of dynamics, using time scales other than the continuum, and removing the assumption of infinite population size.

▶ CP-We-E-54-5 17:50–18:10

Applications of Conformal Mapping and Complex Variable Method for Solving Heat-Conduction Equations of Thermo-elasticity and Nonlinear Analysis of Irregular-Shaped Plates under Mechanical and Thermal Loading- A Brief Review.

Biswas, Paritosh — Von Karman Society for Advanced Study & Research in Mathematical & Social Sci.

Abstract: Heat-Conduction in plates under stationary and non-stationary cases, Thermal Buckling of Plates and Nonlinear analysis of Plates having polygonal or irregular-shaped boundaries under mechanical and thermal loadings can conveniently be analysed by the suitable applications of conformal mapping and complex variables. This is a review paper on how the method has succinctly been employed by earlier authors with the inclusion of a new prob-

lem on the buckling of an irregular - shaped sandwich plate. The essence of the method is to transform the basic equations into complex co-ordinates and conformally mapped onto a unit circle of which the solutions are known for different boundary conditions [clamped or simply-supported]. Application of the Galerkin's Procedure ultimately leads to the Duffing's cubic equations the solution of which can be obtained in terms of Jacobian Elliptic Functions. Since the mapping function co-efficients are known for different plate shapes, numerical results can conveniently be obtained.

MS-We-E-55 16:00–18:00 106

New advances in model order reduction: methods, algorithms, and applications - Part I of II

For Part 2, see MS-Th-BC-55

Organizer: Feng, Lihong Max Planck Inst. for Dynamics of Complex Technical Sys.

Abstract: This minisymposium intends to bring together new progresses in different aspects of model order reduction (MOR): methods, algorithms and applications. The topics include various MOR methods: interpolatory method, reduced basis method, POD, for various complex systems: linear, nonlinear, parametric, and for various applications: flow control, population balance system, neutral delayed system, chromatography, uncertainty quantification, electromagnetcs, vibro-acoustics systems, coupled systems. The speakers are quite international and have senior research experiences in MOR.

▶ MS-We-E-55-1 16:00–16:30

Parameterized Model Order Reduction of Delayed Systems by Means of An Enhanced Interpolation Approach with Scaling Coefficients

Ferranti, Francesco Vrije Universiteit Brussel

Abstract: High-speed systems require electromagnetic methods as analysis and design tools, which often generate large systems of equations. When the frequency content of signals increases or the geometrical dimensions become electrically large, time delays must be taken into account. In this talk, a parameterized model order reduction method for neutral delay differential equations is presented. It is based on the use of a model order reduction technique, amplitude and frequency scaling coefficients and positive interpolation schemes.

▶ MS-We-E-55-2 16:30–17:00

A New Error Bound for Parametrized Nonlinear Dynamical Systems

Feng, Lihong Max Planck Inst. for Dynamics of Complex Technical Sys.
Zhang, Yongjin Max Planck Inst. for Dynamics of Complex Technical Sys.
Benner, Peter Max Planck Inst. for Dynamics of Complex Technical Sys.

Abstract: In this work we propose an efficient output error bound for reduced-order modeling of parametrized nonlinear dynamical systems. The error bound estimates the error of the output of the reduced-order model at each time integration step. It is an error bound in time domain, and is applicable to both linear and nonlinear systems. Based on a primal-dual approach, the error bound is shown to be much sharper than the existing error estimations.

▶ MS-We-E-55-3 17:00–17:30

Application of POD to Population Balance Systems in Chemical Engineering

Mangold, Michael Max Planck Inst. for Dynamics of Complex Technical Sys.

Abstract: Particle systems are important in the chemical industry. Particle processes are often described by population balance models containing partial integro differential equations in time, space, and additional property coordinates like particle size or composition. The numerical solution of such models is expensive and time consuming and hence hardly applicable to process design and control. This contributions shows that POD is an attractive method for obtaining nonlinear reduced models. Examples from crystallization and granulation are discussed.

▶ MS-We-E-55-4 17:30–18:00

Using Krylov-type Parametric Model Reduction to Accelerate Uncertainty Quantification of Electro-Thermal Circuit Models

Yue, Yao MPI-Magdeburg
Feng, Lihong Max Planck Inst. for Dynamics of Complex Technical Sys.
Meuris, Peter MAGWEL NV
Schoenmaker, Wim MAGWEL NV
Benner, Peter Max Planck Inst. for Dynamics of Complex Technical Sys.

Abstract: Uncertainty quantification for high-order electro-thermal models of power-MOS devices is computationally expensive. To reduce the computational cost, we employ a Krylov-type parametric model reduction method, which builds a reduced model of high accuracy for parameter values within a certain range. We embed the reduced model into a Latin hypercube sampling method and a stochastic collocation method for uncertainty quantification. Numerical results validate the efficiency and high accuracy of the proposed method.

MS-We-E-56 16:00–18:30 403

Modeling, Applications, Numerical Methods, and Mathematical Analysis of Fractional Partial Differential Equations II - Part III of IV

For Part 1, see MS-Tu-E-56
For Part 2, see MS-We-D-56
For Part 4, see MS-Th-BC-56

Organizer: Karniadakis, George Brown Univ.
Organizer: Wang, Hong Univ. of South Carolina

Abstract: Fractional Partial Differential Equations (FPDEs) are emerging as a new powerful tool for modeling many difficult complex systems, i.e., systems with overlapping microscopic and macroscopic scales or systems with long-range time memory and long-range spatial interactions. They offer a new way of accessing the mesoscale using the continuum formulation and hence extending the continuum description for multiscale modeling of viscoelastic materials, control of autonomous vehicles, transitional and turbulent flows, wave propagation in porous media, electric transmission lines, and speech signals. FPDEs raise modeling, computational, mathematical, and numerical difficulties that have not been encountered in the context of integer-order partial differential equations. The aim of this minisymposium is to cover the recent development in mathematical and numerical analysis, computational algorithms, and applications in the context of FPDEs and related nonlocal problems.

▶ MS-We-E-56-1 16:00–16:30

Multigrid Methods for Fractional Elliptic Equations

Chen, Long Univ. of California at Irvine
Salgado, Abner Univ. of Tennessee
Nochetto, Ricardo Univ. of Maryland

Abstract: We develop and analyze multilevel methods for solving the α-harmonic extension problems which is to localize fractional powers of elliptic operators. As the elliptic coefficients is degenerate or singular, graded meshes in the extended variable should be used. We present a multilevel method with line smoothers and obtain a nearly uniform convergence result on anisotropic meshes. We also develop an efficient and easy-to-use algebraic multigrid solver for fractional powers of elliptic operators.

▶ MS-We-E-56-2 16:30–17:00

A Petrov-Galerkin Finite Element Method for Variable-coefficient Fractional Diffusion Equations

Zhu, Shengfeng East China Normal Univ.

Abstract: We utilize the discontinuous Petrov-Galerkin (DPG) framework to develop a Petrov-Galerkin finite element method for variable-coefficient fractional diffusion equations. We prove the wellposedness and optimal-order convergence of the Petrov-Galerkin finite element method. Numerical examples are presented to verify the theoretical results.

▶ MS-We-E-56-3 17:00–17:30

Numerical Simulation for Conservative Fractional Diffusion Equations by An Expanded Mixed Formulation

Chen, Huanzhen College of Mathematical Sci. Shandong Normal Univ.

Abstract: we adopt the saddle-point theoretical framework to analyze the conservative fractional diffusion equations. By introducing a fractional-order flux as auxiliary variable, we establish the well-posedness of the saddle-point variational formulation. we propose a locally-conservative expanded mixed finite element procedure and prove the existence and uniqueness of the mixed finite element solution. Optimal-order error estimates are derived in terms of the right-hand side both for sufficiently smooth solution and non-smooth solution.

▶ MS-We-E-56-4 17:30–18:00

Closed-loop Controlled Spraying of Anomalously Diffusing Pests Using Networked Unmanned Aircraft Crop-dusters: the Anisotropic Case

Cao, Jianxiong Shanghai Univ.
Chen, YangQuan Univ. of California, Mreced
Li, Changpin Shanghai Univ

Abstract: This work considers crop pest management as a closed-loop spray control system where actuators and sensors could be collocated on net-

worked unmanned aerial crop-dusters. The pest spreading is considered as an anomalous diffusion process governed by a partial differential equation with both spatial and temporal fractional orders. The control objective is to optimally administer the networked unmanned aircraft crop-dusters for pest control. Numerical simulation studies are presented when the spatial fractional order dynamics is anisotropic.

▶ MS-We-E-56-5 18:00–18:30

Second-order Approximations for Variable Order Fractional Derivatives: Algorithms and Applications

Zhao, Xuan Southeast Univ.
Sun, Zhi-zhong Southeast Univ.
Karniadakis, George Brown Univ.

Abstract: We derive two second-order approximation formulas for the fractional time derivatives involved in anomalous diffusion and wave propagation. Simulations of wave propagation in a truncated domain to demonstrate how erroneous wave reflections at the boundaries can be eliminated by super-diffusion, and also simulations of the Burgers equation that serve as a testbed for studying the loss and recovery of monotonicity using again variable rate diffusion as a function of space and/or time.

MS-We-E-57 16:00–18:00 402A

Advances in Numerical Methods for Porous Media Flow - Part IV of IV

For Part 1, see MS-Tu-D-57
For Part 2, see MS-Tu-E-57
For Part 3, see MS-We-D-57

Organizer: Wang, Hong Univ. of South Carolina
Organizer: Sun, Shuyu King Abdullah Univ. of Sci. & Tech.
Organizer: Rui, Hongxing Department of Mathematics, Shandong Univ.

Abstract: Porous media flow has wide applications in many areas, including environmental, energy, biological and engineering applications. They lead to strongly coupled transport processes also with nonlinear chemical reactions, which are computationally challenging, for it demands high accuracy and local mass conservation. Porous media manifest dramatically differently at different spatial and temporal scales. Heterogeneity, anisotropy, and discontinuity of medium properties require special treatment. The aim of this minisymposium is to bring together researchers in the aforementioned field to highlight the current developments, to exchange the latest research ideas, and to promote further collaborations in the community.

▶ MS-We-E-57-1 16:00–16:30

Mathematical Modeling and Simulation for PPG Flooding in Oil Recovery

CHENG, Aijie Shandong Univ.

Abstract: In this talk, we first introduce the mechanism of PPG (Pre-formed Particle Gel) flooding in oil recovery, then the transport behavior of PPG, the evolution of the physical properties of underground fluids and oil-water two-phase flow in porous media are governed with a system of PDEs. Some numerical results are presented in comparison with laboratory experiments and field data.

▶ MS-We-E-57-2 16:30–17:00

A probabilistic collocation Eulerian – Lagrangian localized adjoint method on sparse grids for assessing CO2 leakage through wells in randomly heterogeneous porous media

Ren, Yongqiang School of Mathematics, Shandong Univ.
Wang, Hong Univ. of South Carolina

Abstract: We develop a probabilistic collocation Eulerian – Lagrangian localized adjoint method on sparse grids for assessing CO2 leakage through wells in randomly heterogeneous porous media, by utilizing the intrinsic mathematical, numerical, and physical properties of the mathematical model. We model the process in which CO2 is injected into a deep aquifer, spreads within the aquifer and, upon reaching a leaky well, rises up to a shallower aquifer, to quantify the leakage rate, which depends on the pressure build-up in the aquifer due to injection and the buoyancy of CO2. The underlying Eulerian – Lagrangian framework has high potential to improve the efficiency and accuracy for the numerical simulation of complex flow and transport processes in CO2 sequestration. The sparse grid probabilistic collocation framework adds computationally efficient uncertainty quantification functionality onto pre-existing Eulerian – Lagrangian methods in a nonintrusive manner. It also provides a scalable framework to consider uncertainty in a straightforward parallel manner. Preliminary numerical experiments show the feasibility and potential of the method.

▶ CP-We-E-57-3 17:00–17:20

Shock Propagation Through Inhomogeneous Media with Smoothed Particle Hydrodynamics

Koren, Barry Eindhoven Univ. of Tech.
Van Der Linden, Bas Eindhoven Univ. of Tech.
Zisis, Iason Eindhoven Univ. of Tech.

Abstract: Hypervelocity impacts of space debris onto orbiting spacecraft are typically simulated through the Smoothed Particle Hydrodynamics (SPH) method. Hypervelocity impacts are shock-propagation problems, which in case of inhomogeneous materials require compressible multiphase schemes. From a variational principle, we derive novel SPH schemes and we validate their accuracy against exact solutions of one-dimensional shock-propagation problems, as well as against experimental results for shock-bubble interactions and hypervelocity impacts. Excellent computational results are obtained for very complex impact problems.

▶ CP-We-E-57-4 17:20–17:40

THERMAL CONVECTION OF MAGNETO COMPRESSIBLE COUPLE-STRESS FLUID SATURATED IN A POROUS MEDIUM WITH HALL CURRENT

Mehta, Chander Govt College Sanjauli Distt Shimla (H.P)-171006, India

Abstract: An investigation is made on the effect of Hall currents on thermal instability of a compressible couple-stress fluid in the presence of horizontal magnetic field saturated in a porous medium is considered. The analysis is carried out within the framework of linear stability theory and normal mode technique. A dispersion relation governing the effects of viscoelasticity, Hall currents, compressibility, magnetic field and porous medium is derived.

▶ CP-We-E-57-5 17:40–18:00

Reflection of Elastic Waves in Thermoelastic Saturated Porous Medium

Singh, SS Mizoram Univ.

Abstract: The problem of reflection of plane waves due to an incident longitudinal wave at a plane free boundary of thermoelastic saturated porous half space has been investigated. There exist four types of plane waves in thermoelastic saturated porous medium in which three of them are attenuating longitudinal waves and another one is non-attenuating transverse wave. The amplitude and energy ratios for the reflected waves are derived analytically and computed numerically.

MS-We-E-58 16:00–18:30 401

Numerical Methods for Multi-physics Problems - Part III of III

For Part 1, see MS-Tu-E-58
For Part 2, see MS-We-D-58

Organizer: Bazilevs, Yuri Univ. of California, San Diego
Organizer: Xu, Jinchao PKU,and The Pennsylvania State Univ.
Organizer: Zhang, Shuo Inst. of Computational Mathematics, Chinese Acad. of Sci.

Abstract: Most systems targeted by mathematical modeling in modern science and engineering are multi-physical and multi-scale. These models involve complex coupled nonlinear systems of PDEs built from different physical processes at different scales. Developing robust, efficient, and practical numerical algorithms that can tackle these complex models is one central task of modern computational sciences and also a challenging one. This minisymposium will gather together experts from around the world in the related fields in industrial and applied mathematics to exchange ideas regarding the development of robust and efficient numerical schemes that preserve the key physics of these models, and to study the development of fast and efficient linear and nonlinear solvers that are scalable and optimal.

▶ MS-We-E-58-1 16:00–16:30

A Fictitious Domain Method with A Hybrid Cell Model for Simulating Motion of Cells in Fluid Flow

Hao, Wenrui Ohio State Univ.

Abstract: This talk will deliver a hybrid model to represent membranes of biological cells and use the distributed-Lagrange-multiplier/fictitious-domain formulation for simulating the fluid/cell interactions. The hybrid model representing the cellular structure consists of a continuum representation of the lipid bilayer, from which the bending force is calculated through energetic variational approach, a discrete cytoskeleton model representing network filament, and area/volume constraints. Numerical results show that our method is suited to the simulation of the cell motion.

▶ MS-We-E-58-2 16:30–17:00

Structure-Preserving and Energy Stable Finite Element Methods for MHD Systems

Hu, Kaibo Peking Univ.
Ma, Yicong Penn State Univ.

Xu, Jinchao PKU,and The Pennsylvania State Univ.

Abstract: In this presentation, we report some structure-preserving and energy-stable finite element methods for solving the time-dependent and stationary incompressible MHD systems and their extended versions. One goal is to preserve some key divergence-free conditions strongly on the discrete level by means of appropriate mixed formulations and appropriate finite element spaces for various physical variables. Furthermore, we will present and compare numerical schemes based on different variables and formulations.

▶ MS-We-E-58-3 17:00–17:30

Robust Preconditioners for the Incompressible MHD System

Ma, Yicong Penn State Univ.
Hu, Kaibo Peking Univ.
Hu, Xiaozhe Tufts Univ.
Xu, Jinchao PKU,and The Pennsylvania State Univ.

Abstract: In this talk, we present two classes of robust preconditioners for the structure-preserving discretization of the incompressible MHD system. We study preconditioners for both MinRes and GMRes methods, and prove the uniform convergence in both cases. We also present preliminary numerical results to support the theoretical conclusions and demonstrate the robustness of the proposed preconditioners.

▶ MS-We-E-58-4 17:30–18:00

The Hemodynamic Simulation for Cardiovascular Disease

Chang, Yu Beijing Univ. of Tech.

Abstract: Cardiovascular disease including heart failure, coronary disease, arterial aneurysm and atrial fibrillation has been the challenge for the world. In the progress of treatment disease, some biomechanical problem spark bitter controversy. Our researches mainly utilize finite element analysis to study the hemodynamic effect of artificial heart on cardiovascular disease, the problem of surgical planning, the hemodynamic between arterial aneurysm and arterial stent and microwave ablation of atrial fibrillation.

▶ MS-We-E-58-5 18:00–18:30

Solving the Two-dimensional Navier-Stokes Cahn-Hilliard System Using Divergence-conforming Spaces

Sarmiento, Adel King Abdullah Univ. of Sci. & Tech.
Vignal, Philippe King Abdullah Univ. of Sci. & Tech.
Espath, Luis Felipe King Abdullah Univ. of Sci. & Tech.
Cortes, Adriano King Abdullah Univ. of Sci. & Tech.
Dalcin, Lisandro King Abdullah Univ. of Sci. & Tech.
Calo, Victor King Abdullah Univ. of Sci. & Tech.

Abstract: We analyze the spinodal decomposition under the effect of shear flow, coupling the phase separation mechanism of the Cahn-Hilliard equation with the incompressible Navier-Stokes equations. We present a novel discretization, using divergence-conforming B-spline spaces to satisfy the mass conservation equation exactly, and higher-order continuity to discretize the fourth order derivatives of the Cahn-hilliard equation. We study the coupling of the systems using an energy balance under parameter variation.

MS-We-E-59 16:00–18:00 402B

Optimal Design of Inhomogeneous Anisotropic Materials and the Shape Forming Methods - Part I of II

For Part 2, see MS-Th-BC-59

Organizer: Rybka, Piotr The Univ. of Warsaw
Organizer: Lewinski, Tomasz Warsaw Univ. of Tech.

Abstract: The origin of topology optimization is the relaxation by homogenization – the problem of an optimal layout of two sotropic materials of fixed amounts to achieve given aims. Here minimization of the compliance plays a crucial role. Admitting void as a material one paves the way towards the shape forming theory. Alternatively, in the Free Material Design (FMD) all components of Hooke tensor are design variables. The stress-based FMD is a method of a simultaneous material and shape design.
Our aim is to gather experts in the field to analyze links between these methods and develop rigorous results on topology optimization.

▶ MS-We-E-59-1 16:00–16:30

Free Material Design in the Stress-based Setting

Lewinski, Tomasz Warsaw Univ. of Tech.

Abstract: The paper concerns optimal design of anisotropy of elastic continuum structures within the Free Material Design (FMD) setting. A proof is given that the problem reduces to Monge-Kantorovich equation. Several versions of FMD are studied, corresponding to crystal symmetry classes assumed. Both isotropy and cubic symmetry lead to similar auxiliary minimization problems. Optimal isotropic materials exhibit auxetic properties, while optimal cubic materials are characterized by only two nonzero eigenvalues of the Hooke tensor.

▶ MS-We-E-59-2 16:30–17:00

Optimal Design of Three-phase Elastic Structures

Dzierzanowski, Grzegorz Warsaw Univ. of Tech.

Abstract: This study concerns optimal distribution of two materials and void in a two-dimensional load-bearing structure. The goal is to minimize the weighted sum of structural compliance (work of the load) and area occupied by materials (total cost of the structure). Mathematically, the task involves determination of a divergence-free second-order symmetric tensor field minimizing the functional whose argument is a quasiconvex envelope of a multiwell Lagrangian representing structural stress energy density plus cost of material fraction.

▶ MS-We-E-59-3 17:00–17:30

Robust Compliance Optimal Design for Viscoelastic Composites

Cherkaev, Elena Univ. of Utah

Abstract: The talk discusses a minmax approach to optimal design of a viscoelastic domain filled with two different materials. The problem is formulated as minimization of the principal compliance which is the maximum of the compliance of the domain under an applied admissible force. Integral representation of the effective viscoelastic tensor is used to explore the properties of the optimal design.

▶ MS-We-E-59-4 17:30–18:00

Structures of Optimal Multimaterial Composites

Cherkaev, Andrej Univ. of Utah

Abstract: The problem of optimal displacement of several materials in a domain is formulated as a variational problem for a multiwell Lagrangian; it does not has a classical minimizer but minimizing sequences. The new bounds are described that generalize the known translation bounds (polyconvex envelope) by accounting for newly found inequalities on the minimizers; the matching minimizing sequences (microstructures) that realize these bounds are found. Examples are demonstrated.

IM-We-E-60 16:00–18:00 310

Industrial Mathematics Around the World - Part VI of VIII

Hyperbolic Models and Applications

For Part 1, see IM-Mo-D-60
For Part 2, see IM-Mo-E-60
For Part 3, see IM-Tu-D-60
For Part 4, see IM-Tu-E-60
For Part 5, see IM-We-D-60
For Part 7, see IM-Th-BC-60
For Part 8, see IM-Th-D-60

Organizer: Cai, Zhijie Fudan Univ.
Organizer: Chen, Gui-Qiang G. Univ. of Oxford
Organizer: Huang, Huaxiong York Univ.
Organizer: LU, Liqiang Fudan Univ.
Organizer: Ockendon, Hilary Univ. of Oxford
Organizer: Ockendon, John Univ. of Oxford
Organizer: Peng, Shige Shandong Univ.
Organizer: Tan, Yongji Fudan Univ.
Organizer: Wake, Graeme Massey Univ.,
Organizer: Zhu, Yichao The Hong Kong Univ. of Sci. & Tech.
Organizer: CHENG, JIN Fudan Univ.

Abstract: The aim of this section is to boost the use of mathematics as an industrial resource in China and around the world. It will highlight (i) the global experience in industrial mathematics and (ii) the new mathematical ideas that these activities have created as well as the exploitation of existing technologies to new applications. Participants will come from both academia and industry and, for this purpose, the section is proposed to consist of eight minisymposia. Four of them will overview the identification and solution of industrially-driven mathematical problems and the mechanisms that have evolved to deal with them in different regions: China, other Asia-Pacific countries, Europe and North America. Three of the remaining minisymposia will focus on the problems coming from different industrial sectors: financial industry, petroleum industry and industrial areas in which wave propagation is important. The last minisymposium will involve an open discussion on how the global mathematics community can best respond to the increasing demand from industry for applied and computational mathematics; the agenda will include both the mechanisms for academic / industrial collaboration and the areas where it will be most fruitful.

▶ IM-We-E-60-1 16:00–16:30

Mathematical Analysis of Supersonic Flow Past Bodies

Chen, Shuxing fudan unniversity

Abstract: Abstract: When a supersonic flow passes a given body, there will appear a shock ahead of the body generally. To clearly understand the wave structure, as well as the flow field between the shock and the surface of the body is a fundamental problem in gas dynamics. In this lecture I will introduce the history and the recent progress of the mathematical study on

▶ IM-We-E-60-2 16:30–17:00

Spurious Numerical Phenomenon in Hyperbolic Conservation Laws with Stiff Source Term

Liu, Hong Shanghai Jiaotong Univ.
Bin, Zhang Shanghai Jiaotong Univ.
QingBing, Zhang Beijing Inst. of Electronic Sys. Engineering

Abstract: A well-know spurious numerical phenomenon in simulating the hyperbolic conservation laws with stiff source term may occur due to the underresolved numerical solution. In this paper, the generation mechanism of spurious numerical phenomenon in detonation problems is developed first. Then, the equilibrium state method which has the ability to cure the spurious numerical solutions is introduced. Finally, some new multi-dimensional cases are used to test the reliability and robustness of the proposed method.

▶ IM-We-E-60-3 17:00–17:30

Traffic Flow on Networks and Social Dynamics of Large Groups

Piccoli, Benedetto Rutgers Univ. - Camden

Abstract: Since mid 90s conservation laws on graphs are used as model for traffic flow on networks, with applications to water channels, supply chains, vehicular traffic and other. Vehicular traffic can be seen also as a "social dynamics" problem, i.e. a group of autonomous agents with structured interaction rules of social type. After reviewing the conservation laws approach, we will describe a new one based on measure measure solution to transport equations in Wasserstein setting.

▶ IM-We-E-60-4 17:30–18:00

Numerical Schemes for the Special Relativistic Hydrodynamics

Tang, Huazhong Peking Univ.

Abstract: Relativistic hydrodynamics play essential roles in many fields of modern physics, e.g. astrophysics. This talk would like to present our latest works on some numerical schemes for the special relativistic hydrodynamics, including high order physical constraints-preserving finite difference WENO schemes etc.

CP-We-E-61 16:00–18:00 101
Computational Science

Chair: Cao, Shunxiang Virginia Polytechnic Inst. & State Univ.

Abstract:

▶ CP-We-E-61-1 16:00–16:20

A Numerically Stable Asynchronous Partitioned Procedure for Incompressible Fluid-Structure Interaction Problems

Cao, Shunxiang Virginia Polytechnic Inst. & State Univ.
Wang, Kevin Virginia Tech

Abstract: Numerical instability is a major issue in the solution of fluid-structure interaction problems, particularly when partitioned procedures are used. We present a novel partitioned procedure with superior stability properties for incompressible viscous fluids and elastic structures. This procedure features the use of asynchronous time grids for the fluid and structural governing equations, as well as carefully designed load predictor and corrector. The salient properties of this procedure will be demonstrated both analytically and numerically.

▶ CP-We-E-61-2 16:20–16:40

Image Segmentation with Eigenfunctions of An Anisotropic Diffusion Operator

Wang, Jingyue FuZhu Univ.
Huang, Weizhang Univ. of Kansas
Wang, Meiqing FuZhu Univ.

Abstract: We propose the eigenvalue problem of an anisotropic diffusion operator for image segmentation. The diffusion matrix is defined based on the input image. The eigenfunctions and the projection of the input image in some eigenspace capture key features of the input image. The eigenvalue problem is related to the algebraic eigenvalue problems resulting from several commonly used discrete spectral clustering models. The relation provides a better understanding and helps developing more efficient numerical implementation and rigorous numerical analysis for discrete spectral segmentation methods. A numerical implementation based on a finite element method with an anisotropic mesh adaptation strategy is presented. We show that the numerical scheme gives much more accurate results on eigenfunctions than uniform meshes. Several interesting features of the model are examined in numerical examples and possible applications are discussed.

▶ CP-We-E-61-3 16:40–17:00

Group Similarity for Image Segmentation

Xu, Haiping Fuzhou Univ.
Wang, Jingyue FuZhu Univ.
Wang, Meiqing FuZhu Univ.

Abstract: We propose to use the group similarity of object shapes from a series of similar images as a prior to aid variational segmentation models. We show that the rank of the matrix consisting of multiple shapes is a good measure for the group similarity of the shapes. We also develop a fast algorithm to solve the proposed model.

▶ CP-We-E-61-4 17:00–17:20

A Numerical Comparison of Some Multiscale Finite Element Type Approaches for Convection-dominated Problems in Heterogeneous Media

Madiot, Francois Univ. Paris Est

Abstract: Advection-diffusion equations arise in many engineering applications, including e.g. pollutants transport into a flow. In various applications, convection dominates over the diffusion. In that regime, standard numerical approaches loose their accuracy, and stabilized methods are required. In this work, we consider the case when the problem is multiscale, in addition to being convection-dominated. Groundwater pollution through infiltration of a fluid in a porous medium is one example. MsFEM-type approaches are thus in order to cope with the multiscale nature of the problem. The objective of this work is to understand how to adapt the stabilized methods and the MsFEM-like multiscale methods to efficiently solve multiscale advection-diffusion problems in the convection-dominated regime. We will describe different possibilities to simultaneously treat both difficulties. The proposed methods will be compared in terms of accuracy and cost. This is a joint work with C. Le Bris and F. Legoll.

▶ CP-We-E-61-5 17:20–17:40

Drawing of Microstructured Optical Fibres with Elliptical Channels

Buchak, Peter Imperial College London
Crowdy, Darren Imperial College London
Stokes, Yvonne The Univ. of Adelaide
Chen, Michael Univ. of Adelaide
Ebendorff-Heidepriem, Heike Univ. of Adelaide

Abstract: Microstructured optical fibres (MOFs) derive novel optical capabilities from having a large number of channels running along their length. They are fabricated by drawing a molten glass preform at low Reynolds number, during which the cross section deforms under surface tension, with the result that the configuration of the channels in the fibre may differ from the perform. This unintended deformation is inadequately understood and is difficult to investigate experimentally, necessitating extensive trial and error. In this talk, we describe a model we have developed to predict the deformation for MOFs with elliptical channels. Our model circumvents the need for expensive computational methods. More importantly, it can be used to determine the preform configuration required to produce a fibre with a desired arrangement of channels. We show comparisons with numerics and experiment and describe software tools we have developed that can be used by fabricators to design preforms.

▶ CP-We-E-61-6 17:40–18:00

Drawing of Microstuctured Optical Fibres with Pressurisation of the Internal Channels

Chen, Michael Univ. of Adelaide
Stokes, Yvonne The Univ. of Adelaide
Buchak, Peter Imperial College London
Crowdy, Darren Imperial College London
Ebendorff-Heidepriem, Heike Univ. of Adelaide

Abstract: Microstructured optical fibres are distinguished from solid optical fibres by the large number of internal air channels running along their length. These fibres are manufactured by heating and stretching a preform, which has some cross-sectional pattern of holes. In stretching the preform with a diameter of 1-3cm to a fibre with a diameter of the order of 100 micrometers, the cross-sectional hole pattern changes in scale but is also deformed due to surface tension. A practical way of countering this deformation is to introduce pressurisation in the internal channels. This pressure acts against surface tension and potentially provides an extra degree of control over the shape of the internal channel geometry. We generalise an existing model of fibre drawing to include channel pressurisation and present examples of pressurised fibre drawing for several cross-sectional geometries of practical importance,

including a comparison between our model and the results of some recent experiments.

CP-We-E-62 16:00–18:20 102
Fluids
Chair: Gupta, Neelam — Indian Inst. of Tech. Bombay
Abstract:

▶CP-We-E-62-1 16:00–16:20
Dissipative Waves with Mixed Nonlinearity in Real Fluids
Gupta, Neelam — Indian Inst. of Tech. Bombay
Sharma, Vishnu Dutt — IIT Bombay

Abstract: We exploit weakly nonlinear theory and the method of multiple scales to arrive at an evolution equation that governs the wave amplitude in a two-dimensional dissipative flow of a real gas; the evolution equation exhibits quadratic as well as cubic nonlinearity. The real fluid effects are characterized by a van der Waals type equation of state. Some basic features of the Khokhlov-Zabolotskaya-Kuznetsov equation and the nature of the flow pattern (influenced by the real gas effects) that finally evolve are elucidated.

▶CP-We-E-62-2 16:20–16:40
Electro-osmotic Flow and Heat Transfer in Microchannels with Interfacial Slip
Shit, Gopal Chandra — Jadavpur Univ., Kolkata

Abstract: In this paper we have investigated the two layer ﬂuid ﬂow and heat transfer in a microchannel. The fluid is flowing under the combined inﬂuence of pressure gradient and electro-osmotic force. The velocity slip condition at the channel wall as well as in the interfacial region of two layer ﬂuid has been taken into account. The governing equations consisting with the linearized Poisson Boltzmann equation, the Cauchy momentum equation and thermal energy equation are solved analytically within the framework of the Debye-Hu ̈ckel approximation. The eﬀects of diﬀerent dimensionless parameters and the interfacial zeta potential diﬀerence on the velocity proﬁle as well as the temperature distribution are obtained. The study reveals that the temperature enhancement is strongly depends on the Joule heating parameter. The interfacial zeta potential diﬀerence has also enhancing eﬀect on fluid flow and heat transfer. From a clinical point of view, our findings will be considered in the design and evaluation of vascular medical devices etc.

▶CP-We-E-62-3 16:40–17:00
Spherical Shock Wave in Mixture of Non-ideal Gas and Small Solid Particles under Gravitational Field with Conductive and Radiative Heat Fluxes
Nath, G. — Motilal Nehru National Inst. of Tech. Allahabad

Abstract: The shock is assumed to be driven out by a moving piston and the dusty gas to be a mixture of non-ideal (or perfect) gas and small solid particles, in which solid particles are continuously distributed. It is assumed that the equilibrium flow-conditions are maintained and variable energy input is continuously supplied by the piston. The heat conduction is express in terms of Fourier’ s law and the radiation is considered to be of the diffusion type for an optically thick grey gas model. The medium is assumed to be under a gravitational field due to heavy nucleus at the origin (Roche Model). The effects of the variation of the gravitational parameter, non-idealness of the gas and the mass concentration of solid particles in the mixture and the ratio of the density of solid particles to the initial density of the gas on the flow variables are investigated.

▶CP-We-E-62-4 17:00–17:20
NUMERICAL STUDY OF TRANSIENT 2-D COMPRESSIBLE FLOW WITH HEAT AND MASS TRANSFER USING THE FINITE VOLUME METHOD
Vusala, Ambethkar — Univ. of Delhi
Srivastava, Mohit — Univ. of Delhi

Abstract: In this paper, we used a finite volume method to investigate the problem of transient 2-D compressible flow, with heat and mass transfer in a rectangular domain. We have used this method to solve the governing equations with given initial and wall slip boundary conditions. We implemented the SIMPLE-TS algorithm in order to compute the numerical solutions for the flow variables viz. velocity, pressure, temperature, concentration and density. The variation of density of the fluid along the horizontal and vertical lines through geometric center of the rectangular domain has been studied. The transient solutions of temperature and concentration indicate that, the transient flow though dominates initially, it finally settles down to steady state solutions after elapse of some time. Based on the numerical computations of temperature, concentration, Nusselt and Schmidt numbers, we found that the heat and mass transfer for different fluids increased towards left side of the domain.

▶CP-We-E-62-5 17:20–17:40
Scale Truncation in Large-eddy Simulation of Turbulent Flow by Regularization
Verstappen, Roel — Johann Bernoulli Inst., Univ. of Groningen

Abstract: This paper is about a relaxation model for large-eddy simulation of turbulent flow that truncates the too small scales of motion by making sure that they do not get energy from the larger eddies. To verify that a box filter is introduced and the relaxation parameter is determined in such a way that the production of small, box-fitting scales is counteracted by the modeled dissipation. This dissipation-production balance is worked out with the help of Poincare’s inequality, which results in a relaxation model that depends on the invariants of the velocity gradient. This model is discretized and equipped with a Schumann filter. It is successfully tested for isotropic turbulence as well as for turbulent channel flow

▶CP-We-E-62-6 17:40–18:00
Three-dimensional Effects in the Drawing of A Precast Glass Sheet
O’Kiely, Doireann — Univ. of Oxford

Abstract: Glass sheets may be manufactured by casting a thick ribbon and subsequently redrawing it to the required thickness. The resulting sheets commonly possess undesired thick edges. We present a three-dimensional mathematical model that shows that the sheet motion is one-dimensional in the bulk, with thickening confined to two-dimensional boundary layers at the edges. The boundary layer problem is matched to the bulk and predicts the shape of these thick edges.

▶CP-We-E-62-7 18:00–18:20
Onset of Darcy - Brinkman Convection in A Fluid Saturated Anisotropic Porous Layer with Soret Effect
Gaikwad, Sravan Nayeka — Gulbarga Univ.
Javaji, Anuradha — Gulbarga Univ., Kalburgi

Abstract: The linear stability analysis is based on normal mode technique, while nonlinear analysis is depending on the truncated representation of the Fourier series. The modified Darcy –Brinkman Maxwell model is used for the momentum equation. The Rayleigh number for stationary, oscillatory and finite amplitude convection is obtained analytically. The effects of various parameters are shown graphically. The nonlinear theory is used to find the heat and mass transfer.

CP-We-E-63 16:00–18:20 103
Numerical Analysis
Chair: Gu, Lemin — Tongji Univ.
Abstract:

▶CP-We-E-63-1 16:00–16:20
Minimum-minimum Optimal Approximation Principle and Method
Gu, Lemin — Tongji Univ.

Abstract: In 1857 Russian mathematician P.L.Chebyshev established the optimal uniform approximation principle, the core of Chebyshev optimal approximation is to minimize the maximum absolute error, referred to as Minimax approximation. In accordance with the principle of reciprocity, must also have a contrast of the optimal approximation,” Minimum-minimum optimal approximation” , referred to as Mini-mini approximation. the existence question about Mini-mini approximation polynomials, which including the differential equations, the relevant definitions, the corresponding nature, the mathematical expressions, the recursive formula, the relationship of Chebyshev polynomials, are discussed and proved. The view is presented that the result of minimum-minimum optimal approximation must be zero, so it is also called the zero-error approximation. It is pointed out that it is just Least Absolute Deviation (LAD) approximation proposed by mathematician Boscovitch in 1755 and Laplace in 1795. Chebyshev optimal approximation and LAD approximation, the two approximations is both the opposition and contradictory, and coexists in erroneous minimizing category. Mini-mini approximation in the processing of discrete data, forming a ”Mini-mini curve fitting method”, which is a novel and practical method. By an example of 2000-2013 Chinese natural gas production and consumption data processing, the paper introduces the method.

▶CP-We-E-63-2 16:20–16:40
A Robin-Type Non-Overlapping Domain Decomposition Procedure for Second Order Parabolic Problems
Pradhan, Debasish — Defence Inst. of Advanced Tech.

Abstract: This article deals with the analysis of an iterative non overlapping domain decomposition (DD) method for parabolic problems, using Robin-type boundary condition on the inter-subdomain boundaries, which can be solved in parallel with local communications. The proposed iterative method allows us to relax the continuity condition for Lagrange multipliers on the inter-subdomain boundaries. In order to derive the corresponding discrete problem, we apply a non-conforming Galerkin method using the lowest order

Crouzeix-Raviart elements. The convergence of the iterative scheme is obtained by proving that the spectral radius of the matrix associated with the fixed point iterations is less than 1. We derive the upper bound of the rate of convergence which is of order 1 - $O(h^{1/2}H^{-1/2})$, where h is the finite element mesh parameter, H is the maximum diameter of the subdomains and Δt is the time step. Finally the numerical experiments confirm the theoretical results.

▶ CP-We-E-63-3 16:40–17:00

A Double Exponentially Convergent Method for Solving ODEs

Lu, Tzon-Tzer National Sun Yat-sen Univ.

Abstract: The traditional numerical methods for differential equations, including finite difference, finite element, finite volume, boundary element and Runge-Kutta methods, all possess polynomial convergence. Modern methods like spectral method, radial basis, method of fundamental solution and Trefftz method, all have exponential convergence, and even super-geometric convergence in very special cases. In this talk, we present a Newton-like method in power series domain for ODEs. It has the speed of double-exponential convergence, which will be the fastest among all existing numerical ODE methods.

▶ CP-We-E-63-4 17:00–17:20

Iterative Schemes Based on Hierarchical Tensor Representations: Rank and Complexity Estimates

Bachmayr, Markus UPMC Paris 06

Abstract: A widespread approach for solving high-dimensional problems using low-rank tensor representations is to modify a convergent standard iterative method by a rank reduction in each step. It is then crucial to ensure convergence while maintaining control of the resulting growth of tensor ranks. We present fully adaptive algorithms that provably achieve this (joint work with Wolfgang Dahmen) and recent developments based on soft thresholding of hierarchical tensors (joint work with Reinhold Schneider).

▶ CP-We-E-63-5 17:20–17:40

A New Bound on the Integration Error of An Enough Smooth Function by Quaisi-Monte Carlo Integration and the Existence of Point Sets to Make the Bound Small

Yoshiki, Takehito univ.Tokyo

Abstract: Quasi-Monte Carlo integration is one of the methods for numerical integration. In this method, we approximates the integrated value of a function f(x) over the s-dimensional unit cube by the average of f(x) over a finite point set P. The purpose of this study is to make the integration error small by choosing an appropriate point set P. To find such a point set, we make an Koksma-Hlawka type inequality, which bounds the integration error small by the product of some norm —f— of f and some positive value W(P) called figure of merit of P. If we can find P with small W(P), we can make the integration error small by P for f with —f— finite. In this talk, we introduce a new Koksma-Hlawka inequality for an enough smooth function space and show the existence of point sets P with W(P) small.

▶ CP-We-E-63-6 17:40–18:00

Difference Potentials Method for 2-D Elliptic and Parabolic Interface Problems

Xia, Qing Univ. of Utah
Albright, Jason Univ. of Utah
Epshteyn, Yekaterina Univ. of Utah

Abstract: The Difference Potentials Method (DPM) is a framework for developing efficient, high order accurate numerical methods for boundary value problems on arbitrary domains. In this talk I will introduce DPM-based schemes for numerical solutions of 2D elliptic and parabolic interface problems. Performance and flexibility of the resulting methods will be illustrated numerically and compared against Immersed Interface Method results.
This is joint work with J. Albright and Y. Epshteyn.

▶ CP-We-E-63-7 18:00–18:20

Numerical Analysis and Fast Solutions for Fully Discrete Schemes for Conservative Diffusion Problem

Cui, Xia Inst. of Applied Physics & Computational Mathematics, Beijing, China
Yuan, Guang-wei Inst. of Applied Physics & Computational Mathematics, Beijing, China
Yue, Jing-yan Inst. of Applied Physics & Computational Mathematics, Beijing, China

Abstract: Theoretical analysis on nonlinear fully implicit finite difference schemes for nonlinear conservative diffusion problem is presented. Proper iterations are designed to realize fast solutions. Difficulties arising from nonlinear conservative diffusion operator are overcome. An entire characteristic theoretical analysis system is constructed which includes the existence, convergence, stability, uniqueness of the solutions of nonlinear discrete schemes, the convergence and convergent speed of iteration schemes, and the logical relations among them. Numerical tests show obvious acceleration effects.

CP-We-E-64 16:00–18:20 104

Simulation and Modeling

Chair: Shen, Zhengdi Cornell Univ.

Abstract:

▶ CP-We-E-64-1 16:00–16:20

Optimal Control of Piecewise-deterministic Processes

Shen, Zhengdi Cornell Univ.
Vladimirsky, Alexander Cornell Univ.

Abstract: The fully deterministic optimal control leads to a first-order nonlinear Hamilton-Jacobi-Bellman (HJB) equation. The standard stochastic optimal control yields a second-order semilinear HJB PDE. Unfortunately, neither of the above is suitable for modeling discrete-time random perturbations important in many applications including robotics. In contrast, the "piecewise-deterministic" model leads to a system of weakly-couple first-order HJB PDEs. We discuss its use and computational challenges in robotic path planning. (This is joint work with A. Vladimirsky.)

▶ CP-We-E-64-2 16:20–16:40

Numerical Study of Pulsatile Flow in Stenosed Carotid Artery Bifurcation

Singh, Sarita WIT-Uttarakhand Technical Univ., Dehradun India

Abstract: Real carotid arteries are elastic and perfused with a non-Newtonian fluid. The blood flow dynamics of a stenosed subject specific carotid bifurcation were numerically simulated using finite element method computationally. A coupling effect between elastic deformation of stenosed carotid artery wall and fluid. A flow rate at various location in stenosed carotid artery (CCA & ICA) for different-different frequencies 0, 60, 90,120 pulse/min with 600 Reynolds number by FLUIENT.

▶ CP-We-E-64-3 16:40–17:00

Modelling for Computational Cost Reduction and Optimisation of An Impinging Swirling Jet Created by A Rotating Pipe with Application to Heat Transfer from A Heated Solid Flat Plate

Granados-Ortiz, Francisco-Javier Univ. of Greenwich
Ortega-Casanova, Joaquin Univ. of Malaga
Lai, Choi-Hong Univ. of Greenwich

Abstract: Swirling flows in pipes are widely used in industry. In our case, this impinging jet is generated by a rotating pipe. For the heat transfer purpose, once the jet exits the pipe, it spreads until it impinges against a heated flat plate located at a dimensionless distance H/D from the exit pipe, where D is the diameter of the pipe and H is the distance.
Both the axial and azimutal velocity profile at the exit of the pipe are mathematically modelled. The model will include equations and coefficients that depends on the input factors, which will be also modelled. The two-step CFD process of the heat transfer simulation (swirl flow generation and heat transfer itself) can now be reduced to a single-step one by adding the modelled equations to a code in the CFD solver. The optimal configuration of the set-up for the heat transfer application will also be

▶ CP-We-E-64-4 17:00–17:20

Mathematical Modeling and Simulations for Future Nonvolatile Memories

Grigoriu, Andreea Univ. Paris Diderot, lab. Jacques Louis Lions

Abstract: The increasing use of portable electronic devices that require data storage implies a strong need in developing new types of memories. Conductive-Bridge Random-Access memory (CBRAM) is a promising technology for future nonvolatile memories, that are being developed to replace the popular flash memory. The complexity of physical phenomena that take place at a nanoscale require mathematical support besides the classical experimental approach. Present work proposes two types of models: deterministic and stochastic in order to analyse different properties of the electronic devices by the mean of numerical simulations. Analysis of existence of solutions together with the analysis of the stability of the numerical schemes used for simulations is being made.

▶ CP-We-E-64-5 17:20–17:40

Multiscale Modeling for Continuum Mechanics of Lungs

Saini, Anju Indian Inst. of Tech. Roorkee
Katiyar, V. K. IIT Roorkee
Parida, Manoranjan IIT Roorkee

Abstract: An isotropic constitutive model for the lung parenchyma has been derived from the theory of hypo-elasticity. The objective is to make use of it

to signify the mechanical reaction of this soft tissue in sophisticated, computational, fluid-dynamic models of the lung. This demands that the continuum model be accurate, however simple and well-organized. An intent algorithm for its numeric integration is presented. The response of the model is determined for several boundary-value problems whose experiments are used for material characterization. The effective elastic, bulk, and shear moduli, and Poisson' s ratio, as tangent functions, are also derived. It is assumed that, and beginning steps have been taken toward proving that the material parameters for this hypo-elastic model will correlate with the response of a micro-mechanics based model.

▶CP-We-E-64-6 17:40–18:00

Numerical Algorithm for Simulating Hyperbolic Conservation Laws.

Garg, Naveen Kumar Indian Inst. of Sci.
Suswaram, Raghurama Rao, V. Indian Inst. of Sci.
Sekhar, Muddu Indian Inst. of Sci.

Abstract: A simple and accurate central scheme in finite volume framework is developed for systems of hyperbolic conservation laws, using a splitting of strongly hyperbolic and weakly hyperbolic parts. This leads to the flux function of 1D inviscid Euler compressible system being split into convection and pressure parts and 1D inviscid shallow water system into convection and celerity parts. The numerical diffusion is fixed based on flux equivalence principle, which leads to the satisfaction of the jump conditions. The numerical scheme is tested on various shock tube problems of gas dynamics for 1D Euler equations and on dam breaking problems for shallow water equations. Exact upwind schemes like Roe and Godunov violate entropy condition. Similarly, Schemes based on Convection-Pressure splitting like AUSM family of schemes vilolate entropy condition and give sonic glitch. Novelty of our scheme is that it can capture stationary discontinuities exactly without violating entropy condition.

▶CP-We-E-64-7 18:00–18:20

Numerical Methods for Multiscale Inverse Problems

Frederick, Christina Georgia Inst. of Tech.

Abstract: We will consider inverse problems for partial differential equations with highly oscillatory coefficients. Determining the coefficients in the equation from given observational data involves both the general difficulty of finding an inverse and the challenge of multi- scale modeling, which is hard even for forward computations. The problem in its full generality is typically ill-posed and one common approach is to replace the original problem by inversion of an effective equation. We will here include microscale features directly in the inverse problem and avoid ill-posedness by assuming that the microscale can be accurately represented by a low-dimensional parametrization. The basis for our inversion will be a coupling of the parametrization to analytic homogenization or a coupling to efficient multiscale numerical methods when analytic homogenization is not available.

CP-We-E-65 16:00–18:00 105

Optimization and Operations Research

Chair: Wei, Dongming Nazarbayev Univ.

Abstract:

▶CP-We-E-65-1 16:00–16:20

Modeling of Advanced Material Structures by Non-linear Differential Equations

Wei, Dongming Nazarbayev Univ.

Abstract: In this talk, we present some nonlinear PDEs arising in modeling of structures made of advanced materials including graphene and polyimide. Analytic solutions of some spring-mass equations associated with the PDEs are presented in terms of generalized trigonometric functions. Analysis and numerical solutions of some of the models are also presented, including nonlinear eigenvalue problems and nonlinear wave equations. Open problems and challenges for modeling of structural nonlinear materials without a well-defined yield are discussed.

▶CP-We-E-65-2 16:20–16:40

Multiscale Modeling on Particle-laden Flows Inside Nanomaterials

Chan, Yue Univ. of Nottingham Ningbo

Abstract: Molecule encapsulation is an important topic in modern technology. Nanomaterials have superior mechanical, electronic and thermal properties so as to provide vital medium to store molecules such as hydrogen, PM2.5 and carbon dioxide. In this talk, we will discuss a multiscale approach to investigate particle-laden flows inside these nanomaterials and derive the concentration evolution of such molecules under various flow fields, which could currently only be done by MD simulations involving huge computational times.

▶CP-We-E-65-3 16:40–17:00

Prediction of Rock Properties Based on X-ray Computed Tomography Images

JOUINI, Soufiane Petroleum Inst. of Abu Dhabi

Abstract: We implement two new approaches to estimate rock properties by using 3D X-ray Computed Tomography scanner images. The first method is a stochastic approach where we model image textures by implementing a parametric model. The main objective is to obtain reliable continuous rock properties estimation values along cores. Also, we classify main representative textural facies in core samples to optimize core plug extraction. The second method is a deterministic approach where we combine image processing techniques and numerical simulations to predict rock properties. The first step consists on segmenting 3D high resolutions micro-Tomography images. Then, we estimate several properties like porosity, permeability and elasticity. We implement, numerical simulations techniques such as Lattice Boltzmann approach to simulate fluid flow and Finite Element Method to solve the elasticity equation on the digital image model of rocks. Finally, we compare estimation results with experimental measurements for real data using both approaches.

▶CP-We-E-65-4 17:00–17:20

A Fast Numerical Scheme for Computing Ruin Probability Using Wavelets

Kwok, Ki Lung The Univ. of Hong Kong

Abstract: Ruin probability is one of risk measures that gauges the risk of a financial institution that needs to pay back its liabilities from time to time. If the liability claims follow a Levy model, the ruin probability would be in the form of an infinite convolution and so difficulty to compute. By making use of the time-frequency localization property of wavelets, we have found a very effective numerical scheme to compute the ruin probability. The scheme is very simple to implement but fast in computational speed. Convergence and error estimate results are also obtained.

▶CP-We-E-65-5 17:20–17:40

Water Quality Modeling for Effluent Discharges from Two Sea Outfalls

Purnama, Anton Sultan Qaboos Univ.

Abstract: Discharging wastewater effluents through long sea outfalls is an economic option for coastal industrial plants. The interactions of two or more effluent plumes are expected as many outfalls often tend to be closely clustered together along the open coastlines. A mathematical model using a two-dimensional advection diffusion equation is presented to study the interaction and merging of effluent discharge plumes and the solution is used to assess the coastal water quality.

MS-We-E-66 16:00–18:00 VIP4-3

Moving interface and free boundary problems in biology - Part II of II

For Part 1, see MS-We-D-66

Organizer: Ranner, Thomas Univ. of Leeds
Organizer: Venkataraman, Chandrasekhar Univ. of Sussex

Abstract: Moving interface and free boundary problems arise in the modelling of a variety of biological phenomena such as tumor growth, cell motility, population dynamics and pattern formation. The models involve systems of nonlinear PDE and the analysis of such models is at the forefront of current research. Often analytical solutions are unavailable and state-of-the-art numerical methods are required for the simulation of the model equations.
The goal of this mini-symposium is to foster the exchange of ideas by bringing together analysts, modellers and experts in scientific computing who share an interest in biological free boundary problems.

▶MS-We-E-66-1 16:00–16:30

Whole Cell Tracking Through the Optimal Control of Geometric Evolution Laws

Venkataraman, Chandrasekhar Univ. of Sussex
Styles, Vanessa Univ. of Sussex

Abstract: Robust cell tracking algorithms are needed for the inference of dynamic features from static imaging data. We formulate the cell tracking problem as an inverse problem for fitting a mathematical model for cell motility to experimental data. The advantage of this approach is that the physics of the model are reflected in the computed trajectories. Efficient multigrid solution methods will also be discussed. Based on joint work with Blazakis, Madzvamuse, Styles and Yang (all Sussex).

▶MS-We-E-66-2 16:30–17:00

Phase Field Modelling of Focal Adhesion Zones in Migrating Cells

Stinner, Bjorn Mathematics Inst., Univ. of Warwick

Abstract: Some recent results on phase field equations on moving surfaces with applications to cell biology will be presented. Both analytical questions regarding the asymptotic limit but also the numerical approximation using surface finite element methods will be addressed. In applications, the surface

often is unknown in the sense that its motion back-couples to the lateral processes. Regarding the cell biological applications we consider the formation of adhesion patches in migrating cells.

▶ MS-We-E-66-3 17:00–17:30

Mathematical Modelling of C. Elegans Locomotion

Ranner, Thomas Univ. of Leeds

Abstract: The nematode Caenorhabditis elegans is a microscopic roundworm found in soil in many temperate regions. It is a popular model organism in many fields, including neuroscience, due to its relatively simple nervous system and anatomy. In this talk, I will present results from an new interdisciplinary approach for the modelling and simulation of the locomotion of C. elegans using geometric partial differential equations.

▶ MS-We-E-66-4 17:30–18:00

Free Versus Fixed: Boundaries in Stokes Flow

Simons, Julie Tulane Univ.

Abstract: Both rigid and free boundaries are important in the study of fluids in a variety of applications, including the behaviors of swimming microorganisms and cellular motility. We will discuss how elastic free boundaries interact with rigid boundaries and the implications for nearly planar swimmers such as sperm. We use the method of images for regularized Stokeslets and a 3D model for an immersed elastic boundary to explore swimming and navigation in complex, viscous environments.

SL-We-1 19:00–20:00 Ballroom C

Special Lecture

Chair: Cook, L. Pamela

Abstract:

▶ SL-We-1 19:00–20:00

Once upon a graph: How to get from now to then in massive networks

Chayes, Jennifer Tour Microsoft Research

Abstract:

Thursday, August 13, 2015

PL-Th-1 8:30–9:30 Ballroom A
Public Lecture
Chair: Li, Tatsien
Abstract:

▶ PL-Th-1 8:30–9:30
Without Mathematics and Supercomputings, No Effective Risk Reduction of Natural Disasters
Zeng, Qingcun — Institute of Geology and Geophysics, CAS

Abstract: This is the extended abstract of the public lecture, talking on the essential role of mathematics and supercomputings in the effective reduction of natural disasters. This lecture makes emphasis on meteorological hazards (because they account for 80% of natural hazards) and focuses on the heavy rain and typhoon disasters as examples. Management of meteorological hazards consists of whole links of human activities, from the design of weather and disaster observations (especially remote sensing) and numerical weather-disaster predictions, priori-description of disaster situation and estimation of losses, the planning of actions and real time regulation of management and so on. Nowadays practices very clearly show that there is no effective reduction of disasters if mathematics and supercomputings are not applied.

EM-Th-BC-01 10:00–12:00 311A
Third Workshop on Hybrid Methodologies for Symbolic-Numeric Computation - Part VII of VIII

For Part 1, see EM-Mo-D-01
For Part 2, see EM-Mo-E-01
For Part 3, see EM-Tu-D-01
For Part 4, see EM-Tu-E-01
For Part 5, see EM-We-D-01
For Part 6, see EM-We-E-01
For Part 8, see EM-Th-D-01

Organizer: Giesbrecht, Mark — Univ. of Waterloo
Organizer: Kaltofen, Erich — North Carolina State Univ.
Organizer: Safey El Din, Mohab — Univ. Pierre & Marie Curie
Organizer: Zhi, Lihong — Acad. of Mathematics & Sys. Sci.

Abstract: Hybrid symbolic-numeric computation methods, which first appeared some twenty years ago, have gained considerable prominence. Algorithms have been developed that improve numeric robustness (e.g., in quadrature or solving ODE systems) using symbolic techniques prior to, or during, a numerical solution. Likewise, traditionally symbolic algorithms have seen speed improvements from adaptation of numeric methods (e.g., lattice reduction methods). There is also an emerging approach of characterizing, locating, and solving “interesting nearby problems”, wherein one seeks an important event (for example a nontrivial factorization or other useful singularities), that in some measure is close to a given problem (one that might have only imprecisely specified data). Many novel techniques have been developed in these complementary areas, but there is a general belief that a deeper understanding and wider approach will foster future progress. The problems we are interested are driven by applications in computational physics (quadrature of singular integrals), dynamics (symplectic integrators), robotics (global solutions of direct and inverse problems near singular manifolds), control theory (stability of models), and the engineering of large-scale continuous and hybrid discrete-continuous dynamical systems. Emphasis will be given to validated and certified outputs via algebraic and exact techniques, error estimation, interval techniques and optimization strategies.
Our workshop will follow up on the seminal SIAM-MSRI Workshop on Hybrid Methodologies for Symbolic-Numeric Computation held in November 2010 and the Fields Institute Workshop on Hybrid Methodologies for Symbolic-Numeric Computation, November 16-19, 2011 at the University of Waterloo, Canada. We will provide a forum for researchers on all sides of hybrid symbolic-numeric computation.

▶ EM-Th-BC-01-1 10:00–11:00
Software and Applications for Polynomial Homotopy Continuation
Leykin, Anton — Georgia Tech

Abstract: Numerical homotopy continuation has become one of standard choices when looking for complex solutions of a system of polynomial equations. I will showcase the polynomial system solver embedded in the computer algebra system Macaulay2 using two applications requiring real solutions. One comes from minimal problems in computer vision, the other is of interest in optimization and concerns determinantal representations of hyperbolic polynomials.

▶ EM-Th-BC-01-2 11:00–11:30
Bertini 2.0 and BertiniLab: Software for Solving Polynomial Systems Numerically
Bates, Dan — Colorado State Univ.

Abstract: Bertini is a software package for solving polynomial systems with numerical and symbolic-numeric methods. Bertini has outgrown its original scope and has become quite difficult to maintain. In this talk, I will introduce some of the features of both Bertini 2.0 (the total redevelopment of Bertini in C++, with many contributors) and BertiniLab (a new interface to Bertini from Matlab, joint with A. Newell and M. Niemerg).

▶ EM-Th-BC-01-3 11:30–12:00
Computing Mixed Volume and All Mixed Cells in Quermassintegral Time.
Malajovich, Gregorio — Universidade Federal do Rio de Janeiro

Abstract: The mixed volume counts the roots of generic sparse polynomial systems. Mixed cells are used to provide starting systems for homotopy algorithms that can find all those roots, and track no unnecessary path. Up to now, algorithms for that task were of enumerative type, with no general non-exponential complexity bound. A geometric algorithm is introduced in this paper. Its complexity is bounded in the average and probability-one settings in terms of certain quermassintegrals.

MS-Th-BC-02 10:00–12:00 309A
Special session 1 of Chinese Conferece of Complex Networks (CCCN) 2015
Organizer: LI, Xiang — Fudan Univ.

Abstract: This session contributes as a part of ICIAM 2015 from the Complex networks and system control TC, which involves two 1-hour speakers as the keynote lectures of CCCN 2015. Two invited speakers are the leading researchers in the involved fields: Prof. Guanrong Chen (City University of Hong Kong) and Prof. Xiaofan Wang (Shanghai Jiao Tong University). Prof. Guanrong CHEN is Chair Professor of CityU, IEEE Fellow, and Member of European Academician, ISI highly cited sciencist. Prof. Xiaofan WANG is Changjiang Scholar and distinguished professor of SJTU and deputy dean of Zhiyuan Collegue of SJTU. Profs. Chen and Wang will give their lectures to introduce the latest advances of complex network theory and network science in China and oversea.

MS-Th-BC-03 10:00–12:00 306A
Mathematics of Evolutionary Game Theory
Organizer: Golubitsky, Martin — The Ohio State Univ.
Organizer: Lou, Yuan — Ohio State & Renmin Univ

Abstract: Evolutionary game theory is the application of game theory to understanding biological and social systems; for example, the evolution of cooperation and animal behavior. The theory involves mathematical tools from game theory, graph theory, dynamical systems, ordinary differential equations, partial differential equations, computational mathematics, stochastic processes, and others. Evolutionary game theory has undergone rapid and exciting developments in the recent years. The aim of this minisymposium is to bring together researchers who are interested in the mathematics, modeling and analysis of evolution games, in order to to identify new challenges and applications, and to accelerate further developments in the field.

▶ MS-Th-BC-03-1 10:00–10:30
ESS in Spatial Model
Lou, Yuan — Ohio State & Renmin Univ

Abstract: From habitat degradation and climate change to spatial spread of invasive species, dispersal plays a central role in determining how organisms cope with a changing environment. How should organisms disperse ”optimally” in heterogeneous environments? We will discuss some recent development on the evolution of dispersal, focusing on finding evolutionarily stable strategies (ESS) for dispersal. This talk is based mainly on joint works with Steve Cantrell, Chris Cosner, and King-Yeung Lam,

▶ MS-Th-BC-03-2 10:30–11:00
Effects of Protected Areas on Harvesting of Renewable Resources
Krivan, Vlastimil — Univ. of South Bohemia

Abstract: The Gordon-Schaefer harvesting model predicts that as the protected area (e.g., marine area) increases, population abundance increases while the maximum sustainable yield (MSY) decreases. This model assumes no dispersal between the harvested area and the protected area. In my talk I will discuss the effect of various animal dispersal modes on population abundance and harvest yield when a protected area is created. The models use evolutionary game approaches to describe animal distributions.

▶ MS-Th-BC-03-3 11:00–11:30

The Reduction Principle, the Ideal Free Distribution, and the Evolution of Dispersal Strategies

Cosner, Chris Univ. of Miami

Abstract: For reaction-diffusion models and their nonlocal and discrete analogues in spatially varying environments the strategy of not dispersing at all is often convergence stable. This is related to a “reduction principle” that in general dispersal reduces growth rates. However, strategies that generate an ideal free population distribution at equilibrium (all individuals have equal fitness, with no net movement) are known to be evolutionarily stable in various cases. I will describe past results and current work.

▶ MS-Th-BC-03-4 11:30–12:00

Normal Forms and Unfoldings of Singular Strategy Functions

Golubitsky, Martin The Ohio State Univ.

Abstract: Xiaohui Wang and I apply singularity theory to classify normal forms and universal unfoldings of the singular strategy functions from adaptive dynamics. Specifically, we study two-player single trait games and identify the most general changes of coordinates that preserve ESS singularities, CvSS singularities, and dimorphism pairs. These changes of coordinates are unusual — but rich enough to allow us to apply standard singularity theory type arguments to obtain our classification.

MS-Th-BC-04 10:00–12:00 308

Curves and Surfaces in Computer Aided Geometric Design - Part I of III

For Part 2, see MS-Th-D-04
For Part 3, see MS-Th-E-04

Organizer: Jia, Xiaohong Chinese Acad. of Sci.
Organizer: Cheng, Jin-San Chinese Acad. of Sci.

Abstract: The symposium is aimed at bridging between people who are working theoretically on curves and surfaces in algebraic geometry and those who are endeavoring to seek for suitable modeling forms of curves and surfaces in Computer Aided Geometric Design. Therefore, the symposium includes wide-ranging topics on curves and surfaces from classic theory aspects to their applications in modern industry. The forms of curves and surfaces consist of but are not limited to: algebraic curves and surfaces, parametric curves and surfaces including NURBS as well as triangular surface patches.

▶ MS-Th-BC-04-1 10:00–10:30

Strata of Rational Curve Parametrizations

Cox, David Amherst College

Abstract: Parametrizations of rational curves in projective space can be grouped into strata according to their mu-type. I will report on joint work with Anthony Iarrobino about some new and old results about these strata, including their dimensions and how they fit together. I will also explore which curves lie on rational normal scrolls.

▶ MS-Th-BC-04-2 10:30–11:00

Moving Curve Ideals of Rational Plane Parametrizations

D'Andrea, Carlos Universitat de Barcelona

Abstract: In the nineties, several methods for dealing in a more efficient way with the implicitization of rational parametrizations were explored in the Computer Aided Geometric Design Community. The analysis of the validity of these techniques has lead to a fruitful interaction between mathematicians and engineers, and several results have been obtained so far. In this talk, we will survey some of these methods, show their mathematical formulation, and survey current results and open questions.

▶ MS-Th-BC-04-3 11:00–11:30

Constructions of Families of Algebraic Curves Whose Jacobians Have Special Endomorphisms.

Hoffman, Jerome W. Louisiana State Univ.

Abstract: Let X be a projective smooth algebraic curve. The Jacobian of X, Jac (X), is a principally polarized abelian variety. We will survey various constructions of curves X of genus 2 and 3 such that the endomorphism ring End(Jac(X)) is strictly larger than the ring of integers Z. This is a joint project with Dun Liang, Zhibin Liang, Ryotaro Okazaki, Yukiko Suzuki and Haohao Wang.

▶ MS-Th-BC-04-4 11:30–12:00

Implicitization of Rational Curves and Surfaces

Wang, Haohao Southeast MO State Univ.

Abstract: The idea of using a matrix formed by the moving planes or moving lines to obtain the implicit equations for rational curves or surfaces was initiated by Sederberg and Chen. Later on, many researchers have made several important contributions on this subject. The purpose of this presentation is to illustrate the methods, the geometric ideas, and the theoretical tools needed to understand this topic.

MS-Th-BC-05 10:00–12:00 215

Applied and Industrial Mathematics in Spain - Part I of II

For Part 2, see MS-Th-D-05

Organizer: Chacon Rebollo, Tomas Univ. of Sevilla

Abstract: This mini symposium presents an overview of the research in applied and industrial mathematics in Spain. This research has experienced a fast development in the last years, reaching a wide geographical and thematic extension. We present some talks on selected topics with a strong focus on real-world applications: analysis of gears in automotive industry, modeling of shallow water flows, wind turbine modeling and several problems proposed by the industry, solved by finite volume methods. Also, some other talks deal with more basic aspects of applied mathematics: mixed methods in Computational Fluid Dynamics, and reduced order models. This overview is complemented with another mini symposium at ICIAM 2015, that exclusively focuses on the Industrial Mathematics in Spain.

▶ MS-Th-BC-05-1 10:00–10:30

On an ad hoc symbolic – numeric approach for the computational simulation of DFIG wind turbines for transient studies

Amat, Sergio U.P.Cartagena

Abstract: A novel symbolic – numeric method is proposed to solve the nonlinear system of wind turbines. Ad hoc local linearization and finite difference discretization method are combined. High accuracy and low computational cost are remarkable advantages of the solution. A high number of individual wind turbines can be simultaneously simulated. Both real wind speed profiles and voltage dips are used to evaluate this approach.

▶ MS-Th-BC-05-2 10:30–11:00

A Two-layer Saint-Venant-Exner Model with Gravitational Effects and Inter-granular Friction

Morales, Tomas Morales Universidad de Cordoba
Fernandez-Nieto, Enrique Universidad de Sevilla
Narbona-Reina, Gladys Universidad de Sevilla

Abstract: In this work a Saint-Venant-Exner type system, including gravitational effects, is deduced following an asymptotic analysis of the Navier-Stokes equations. The model is defined in terms of the mass transference between the static and the moving sediment layers. This deduction allows to explain several hypotheses that typically are included in Saint-Venant-Exner models with heuristic assumptions. And to improve some of these empirical definitions, such as erosion and gravitational terms. Several numerical tests will be presented.

▶ MS-Th-BC-05-3 11:00–11:30

Thermal Processing of A Helical Gear by Global Induction: Modeling and Numerical Simulation

Ortegon Gallego, Francisco Universidad de Cadiz

Abstract: In this presentation we describe the industrial procedure of the heat treating of a steel helical gear by induction. A simple model is used, involving the electromagnetic variables, the temperature and two phase fractions of steel, namely, austenite and martensite. Some numerical simulations of this heating-cooling industrial procedure are also shown.

▶ MS-Th-BC-05-4 11:30–12:00

A New Stabilized Mixed Finite Element Method for the Oseen Problem

Gonzalez Taboada, Maria Universidade da Coruña
Barrios, T.P. Catholic Univ. of the Holly Conception
Cascon Barbero, Jose Manuel Universidad de Salamanca

Abstract: We introduce a new augmented dual-mixed method for the Oseen problem in terms of the velocity and the pseudo-stress. The stabilized formulation is obtained by adding suitable Galerkin least squares terms to the dual-mixed method. We prove that the new formulation and the corresponding Galerkin scheme are well-posed for appropriate values of the stabilization parameters, and establish the convergence and error estimates when the velocity and the pseudo-stress are approximated by Lagrangian and Raviart-Thomas elements.

MS-Th-BC-06 10:00–12:00 201

New Development in Numerical Algorithms for Geophysical Science and Engineering

Organizer: Castillo, Jose — San Diego State Univ.

Organizer: Tang, Hansong — City College, City Univ. of New York, Changsha Univ. of Sci. & Tech.

Abstract: While many classical geophysics problems remain challenging for numerical simulation, yet there is an urgent need to develop new algorithms for emerging phenomena such as oil spill in ocean, extreme surge impinging coastal structures, and oil exploration, which are multiscale and multiphysics in general. This mini-symposium reports recent progress in numerical methods for on coastal ocean flows, waves in plastic medium, seismic waves and concentration of H+ ions as a cause of tumor invasion. The session welcomes researchers from related areas and will provide a platform for them to exchange ideas on encountered difficulties, possible approaches, and future directions.

▶ MS-Th-BC-06-1 10:00–10:30

An Overset-grid Method to Couple Fully 3D Fluid Dynamics and Geophysical Fluid Dynamics Models for Prediction of Multiphysics and Multiscale Coastal Ocean Flows

Tang, Hansong — City College, City Univ. of New York, Changsha Univ. of Sci. & Tech.

Qu, Ke — Dept. of Civil Eng., City College, City Univ. of New York

Abstract: In order to simulate emerging multiscale and multiphysics coastal ocean flow problems, an overset-grid method is developed to couple SIFOM and FVCOM, with the former capturing small-scale, local, fully 3D flows and the latter handling large-scale background currents. SIFOM and FVCOM are strongly coupled in two-way as a single modeling system via domain decomposition. Discussion will be presented on the framework of the SIFOM-FVCOM system, together with numerical experiments to illustrate its unparalleled capabilities.

▶ MS-Th-BC-06-2 10:30–11:00

3D Viscoelastic Anisotropic Seismic Modeling with High-Order Mimetic Finite Differences

Castillo, Jose — San Diego State Univ.

Abstract: We present a scheme to solve three-dimensional viscoelastic anisotropic wave propagation on structured fully staggered-grids. This allows for arbitrary anisotropy as well as grid deformation. Correct representation of surface waves is achieved using high-order mimetic operator] which allow for an accurate, compact and high-order solution at the physical boundary condition. Viscoelastic attenuation is represented with a generalized Maxwell body approximation, which requires auxiliary variables to model the convolutional behavior of the stresses in lossy media.

▶ MS-Th-BC-06-3 11:00–11:30

Discontinuous Garlekin Method and Adaptative Finite Element for A Simulation of A Mesoscale Tumor Invasion.

Turner, Cristina — FaMAF- Universidad Nacional Cordoba

Abstract:
The methods for estimating unknown parameters appearing on a non-linear reaction-diffusion model of tumor invasion are very important due to the impact of Cancer in the society. The model considers that tumor-induced alteration of micro-enviromental pH provides a mechanism for cancer invasion at mesoscale level. We apply Discontinuous Galerkin and Adaptative Finite Element Method with an appropriate splitting method to solve both the direct and the adjoint problem, computing the a-posteriori error.

▶ MS-Th-BC-06-4 11:30–12:00

Ensemble Data Assimilation Analysis System for Sub-Mesoscale Processes

Garcia, Mariangel — San Diego state Univ.

Abstract: The goal in this paper is to use the power of Ensemble Kalman filters in a fully 3D non-hydrostatic model to study sub-mesoscale process and estimate accurately the state variables. Its implementation is very difficult, particularly for physical ocean models, which are highly nonlinear, very sensitive to perturbations and require a dense spatial discretization in order to correctly reproduce the dynamics. The major challenge here is the high computational cost typically incurred by a high-resolution numerical model with a three-dimensional data assimilation scheme in a complicated stratified system. Having the General Curvilinear Coastal Ocean Model (GCCOM) interfaced with the faster data assimilation framework, the Data Assimilation Research Tesbed (DART-NCAR), allowed us to assimilate very high resolution observations (10th of meters) into the system. Aspect of the interface software are discussed here. An Observing System Simulation Experiments(OSSEs) is presented in a very steep seamount test case. This experiment, allow us to explore the proper initial ensemble members for the model, to estimate the observation error variance need it to reproduce the dynamics in a turbulent flow experiment, to analyze the impact of localization in such small processes. Nevertheless, because data assimilation demands quantitative estimates of model uncertainties, it forces us to confront model errors and their correlations, by attempting OSSEs for GCOM monitoring at this stage it will contribute to evaluating the strengths and weaknesses of the model and the data assimilation procedures that are used. with the goal to provide important guidance for future users to improve these systems.

MS-Th-BC-07 10:00–12:00 202A

Uncertainty Quantification for Applications in Earth Sciences - Part II of II

For Part 1, see MS-We-E-07

Organizer: Tong, Charles — Lawrence Livermore National Laboratory

Organizer: Duan, Qingyun — Beijing Normal Univ.

Abstract: Accurate prediction and reliable decision-making in earth systems (watershed, groundwater contamination, carbon sequestration, geothermal reservoir, nuclear waste disposal, etc.) are always challenged by uncertainties of conceptual models, parameters, and experimental and field data. Deterministic models of earth systems are traditionally developed on a single, but presumably "known" geologic structure with "certain" system properties, and may not provide the credibility and confidence in decision making and system forecasting. For this reason, uncertainty quantification (UQ) has been studied, as a branch from mathematics, statistics, and computer science, and applied in developing robust models and simulations in earth systems.
This mini-symposium is proposed to encompasses theoretical UQ study, computational methodology development, and applications in earth systems. We encourage presentations on the studies of model-form and parametric uncertainties, sensitivity analyses, reduced-order model development, uncertainty reduction, uncertainty propagation, risk assessment, and decision-making. We welcome application studies in climate change, hydrologic systems, subsurface flow and reactive transport, subsurface energy storage, CO2 geological sequestration, and clear waste disposal, environmental remediation, natural hazard prediction, etc.

▶ MS-Th-BC-07-1 10:00–10:30

Uncertainty Propagation from CO2 Sequestration to Leakage in Groundwater Aquifers

Sun, Yunwei — Lawrence Livermore National Laboratory

Abstract: We present a global sampling scheme for quantifying uncertainty propagation from CO2 geological sequestration, to leakage pathway, to groundwater system. The risk of CO2 leakage into a drinking water system is assessed with probability distribution in terms of high-dimensional parametric uncertainties and various geological conditions. Monitoring and mitigation strategies are optimized based on the reduced-order model that is developed by integrating physics-specific subsystems

▶ MS-Th-BC-07-2 10:30–11:00

Analysis of Parameter Sensitivity of Two Global Land Surface Models

Li, Jianduo — Beijing Normal Univ.

Wang, Yingping — CSIRO

Duan, Qingyun — Beijing Normal Univ.

Abstract: Here we focus on the errors in model structure and model parameters, and explain the differences in the simulated global gross primary productivity (GPP) and latent heat flux (LE) by two global land surface models: CABLE and JULES. We found that the simulated annual GPP or LE by both models are most sensitive to 3 to 6 model parameters for each plant functional type. Our study highlights the importance of parameter optimization.

▶ CP-Th-BC-07-3 11:00–11:20

Modelling the Onset of Dust Eruptions

McGuinness, Mark — Victoria Univ. of Wellington

Abstract: We present a new model for the initiation of high-speed eruptive two-phase dust flows in the laboratory. Shock-tube experiments have been conducted on beds of solid particles in nitrogen under high pressure, which are suddenly decompressed. Our model is successful in explaining the slab-like structures that are often observed during initiation of bed movement, by considering the interaction between the compressible flow of gas through the bed and the stress field in the particle bed, which ruptures when bed cohesion is overcome by the effective stress in the bed generated by the gas flow. Our model includes the effects of overburden and wall friction, and predicts that all layered configurations will rupture initially in this fashion, consistent with experimental observation. We also find that the modelled dependence of layer size on particle size is a good match to experiment.

▶ CP-Th-BC-07-4 11:20–11:40

Modelling Surtseyan Ejecta

McGuinness, Mark Victoria Univ. of Wellington

Abstract: Surtseyan ejecta are formed in shallow sub-aqueous eruptions. They occur when a combination of liquid water and sediments penetrates into molten magma during an eruption, and is then ejected from the volcano as an inclusion inside a ball of magma. After ejection there is a large temperature gradient between magma and inclusion. As the temperature of the inclusion increases, the liquid water vaporises causing a pressure increase inside the ejected ball. The volcanological question is whether the ball of magma ruptures. There is evidence of intact ejecta so we know that rupture does not always occur. We present partial differential equations that model the transient changes in temperature and pressure in Surtseyan ejecta. These equations are reduced by ignoring small parameters, and then solved numerically and asymptotically to explore the parametric conditions for rupture of ejecta.

MS-Th-BC-08 10:00–12:00 202B

The Ginzburg-Landau Model and Related Topics - Part III of IV

For Part 1, see MS-We-D-08
For Part 2, see MS-We-E-08
For Part 4, see MS-Th-D-08

Organizer: Golovaty, Dmitry The Univ. of Akron
Organizer: Giorgi, Tiziana New Mexico State Univ.

Abstract: The focus of the minisymposium is on mathematical problems related to Ginzburg-Landau model with application in physics and materials science including but not limited to: superconductivity, superfluidity, liquid crystals, and polymers. The speakers in this minisymposium will describe their recent research, including the development and structure of singular solutions of the Ginzburg-Landau-type problems and the dynamics of vortex motion. This minisymposium is sponsored by the SIAM Activity Group on Mathematical Aspects of Materials Science (SIAG/MS).

▶ MS-Th-BC-08-1 10:00–10:30

Quasilinear Systems Involving Operator Curl

Chen, Jun Fujian Agriculture & Forestry Univ.

Abstract: In this talk, I would like to mainly introduce an extended magnetostatic Born-Infeld model, which involves functionals with degree one growth in operator curl, and show the existence of solutions with Holder continuity. Some results on a q-curlcurl system will also be shown.

▶ MS-Th-BC-08-2 10:30–11:00

Profiles of Liquid Crystal Point Defects.

Slastikov, Valeriy Univ. of Bristol

Abstract: Using methods of calculus of variations and partial differential equations we investigate stability and minimality properties of symmetric solutions corresponding to liquid crystal point defects in 2D and 3D.

▶ MS-Th-BC-08-3 11:00–11:30

Symmetry Breaking of Nematic Umbilical Defects Through An Amplitude Equation

Kowalczyk, Michal Universidad de Chile

Abstract: The existence, stability properties, and bifurcation diagram of the nematic umbilical defects is studied. Close to the Fréedericksz transition of nematic liquid crystals with negative anisotropic dielectric constant and homeotropic anchoring, an anisotropic Ginzburg-Landau equation for the amplitude of the tilt of the director away from the vertical axis is derived by taking the 3D to 2D limit of the Frank-Oseen model. The anisotropic Ginzburg-Landau equation allows us to reveal the mechanism of symmetry breaking

▶ MS-Th-BC-08-4 11:30–12:00

Dissipative Dynamics in Nematics: from Doi-Smoluchowski to Vortices

Fatkullin, Ibrahim Univ. of Arizona
Slastikov, Valeriy Univ. of Bristol

Abstract: The basic kinetic model for nematic liquid crystals is the Doi model. It describes dissipative evolution of the probability density of molecular orientations. Another, model, the Landau-de Gennes model, describes evolution of the field of the order parameter tensor. I will discuss the similarities and differences between these models in the two-dimensional case, and will show how both models result in the vortex motion analogous to that in the Ginzburg-Landau model of super-conductivity.

MS-Th-BC-09 10:00–12:00 203A

Applied and computational complex analysis I

Organizer: Pelloni, Beatrice Univ. of Reading

Abstract: The focus of the session is on fundamental complex analysis methods for exploring the deep mathematical connections between shapes, singularities of complex functions, and spectra. We have assembled a list of researchers that have in common the use of tools of complex analysis for uncovering the underlying structure of mathematical and physical phenomena. Such tools are fundamental, for example, in the study of boundary value problems and differential operators via the Unified Transform of Fokas, in the derivation of integral transforms for medical imaging, in Crowdy's work on the evolution of shapes in boundary value problems, such as in the famous Hele-Shaw problem, and in the study of the geometric patterns arising in the study of singularities of certain distinguished ODEs.. The full impact of such approaches is only beginning to be felt and in this symposium the speakers will discuss advances and open challenges, theoretical and numerical. This is one minisymposium in a series of two, organised by the network ACCA-UK and ACCA-Japan.

▶ MS-Th-BC-09-1 10:00–10:30

Fast Solution of the Boundary Integral Equations with the Generalized Neumann Kernel

Nasser, Mohamed M S King Khalid Uinversity

Abstract: We briefly review the derivation and the properties of the boundary integral equations with the generalized Neumann kernel which have been derived in the past decade by the author and his collaborators. We then present a fast numerical method for solving these integral equations. The presented method gives accurate results even for domains of very high connectivity, domains with piecewise smooth boundaries, domains with close-to-touching boundaries, and domains of real world problems.

▶ MS-Th-BC-09-2 10:30–11:00

Augmented Eigenfunctions: A New Spectral Object Appearing in the Integral Representation of the Solution of Linear Initial-boundary Value Problems

Smith, David Univ. of Cincinnati

Abstract: We study initial-boundary value problems for linear, equations of arbitrary order, on a finite or semi-infinite domain, with arbitrary boundary conditions, using the Unified Transform Method of Fokas. The solution obtained is expressed as an integral, which represents a new kind of spectral transform. We compare the new solution representation, with classical Fourier transform solution representations. In doing so, we discover a new species of spectral object.

▶ MS-Th-BC-09-3 11:00–11:30

Computation of An Infinite Integral with Unbounded Integrand

Ooura, Takuya Kyoto Univ

Abstract: The infinite integral $\int_0^\infty x dx/(1 + x^6 \sin^2 x)$ has an unbounded integrand but is convergent. Computing the value of this integral has been a problem since 1984. We demonstrate that the method using the Hilbert transform to cancel the singularity of the integrand and compute the value of the integral with high accuracy using a superconvergent double exponential quadrature.

▶ MS-Th-BC-09-4 11:30–12:00

Fourier-Mellin Transforms for Multiply Connected Circular Domains and Applications

Crowdy, Darren Imperial College London

Abstract: In this talk we present new transform pairs for analytic functions defined in generally multiply connected circular domains. Circular domains are those with boundaries made up of circular arcs or straight lines. The transform pairs, which will be shown to be the natural generalizations of classical Fourier and Mellin transforms, can be used to solve boundary value problems for harmonic and biharmonic fields that are not amenable to solution by traditional techniques.

MS-Th-BC-10 10:00–12:00 206B

Singular Problems and Integral Dynamical Models in Applied Mathematics - Part I of II

For Part 2, see MS-Th-D-10

Organizer: Sidorov, Denis Energy Sys. Inst., Russian Acad. of Sci. (SB)

Abstract: This mini-symposium concentrates on the theory of singular equations especially applicable to stability, bifurcation and algorithmic analysis of DE/IEs in mechanics and mathematical physics. Mini-symposium addresses the recent results on existence theorems, regularization, and identification, including asymptotic, numerical and group theoretic methods. The employment of such methods in various problems in modern physics, heat-and-power engineering, and mechanics (plasma, aeroelasticity theory, phase transitions, rheology) has given the authors rich possibilities for creativity and applications. The special attention will be paid to Vlasov-Maxwell systems which are in the core of relativistic models of plasma physics and Maxwell models of

photonic crystalls.

▶ MS-Th-BC-10-1 10:00–10:30

Perturbation Theory and the Banach－Steinhaus Theorem for Regularisation of the First Kind Equations

Sidorov, Denis — Energy Sys. Inst., Russian Acad. of Sci. (SB)
Sidorov, Nikolai — Irkutsk State Univ.

Abstract: The regularising equations with vector regularisation parameter are proposed for linear operator equations with closed operator in Banach spaces. Range of operator can be non-closed, homogeneous equation may have a non-trivial solution. We assume that delta-approximations of both the source function and operator are known. The uniqueness theorem is proved for the special auxiliary regularising equation. The proposed abstract scheme is applied for the stable differentiation. This is a joint work with Professor N.A. Sidorov.

▶ MS-Th-BC-10-2 10:30–11:00

On Application of the Lyapunov-Schmidt-Trenogin Method to Bifurcation Analysis of the Vlasov-Maxwell System

Sidorov, Denis — Energy Sys. Inst., Russian Acad. of Sci. (SB)

Abstract: In this talk we concentrate on the analytical Lyapunov-Schmidt-Trenogin method in the novel framework of bifurcation analysis of the Vlasov-Maxwell system. The review of existence theorems of bifurcation points of solutions for nonlinear operator equation in Banach spaces will be presented. The sufficient conditions of bifurcation of solutions of boundary-value problem for Vlasov-Maxwell system will be formulated.

▶ MS-Th-BC-10-3 11:00–11:30

Evolutionary Integral Operator Equations with Piecewise Continuous Kernels

Sidorov, Denis — Energy Sys. Inst., Russian Acad. of Sci. (SB)
Sidorov, Nikolai — Irkutsk State Univ.

Abstract: We obtain sufficient conditions for the existence and uniqueness of continuous solutions of evolutionary (Volterra) linear and non-linear operator equations of the first kind with piecewise continuous kernels. For the case of non-unique solution we prove existence theorems for the parametric families of solutions and present their asymptotic approximation in the form of logarithmic polynomials.

▶ MS-Th-BC-10-4 11:30–12:00

On Numerical Solution of Weakly Regular Integral Equations

Sidorov, Denis — Energy Sys. Inst., Russian Acad. of Sci. (SB)
Tynda, Aleksandr — Penza State Univ.
Muftahov, Ildar — Irkutsk State Technical Univ.

Abstract: Volterra (evolutionary) integral equations of the first kind with jump discontinuous kernels play important role in many models of evolving dynamical systems. Regularization method and sufficient conditions for existence and uniqueness of the solution of such integral equations are discussed. An efficient numerical method based on mid-rectangular quadrature are proposed. Two methods are suggested: in 1st one the solution is contracted as piecewise linear and as piecewise constant in the 2nd case.

MS-Th-BC-11 10:00–12:00 203B

Nonlinear Eigenvalue Problems - Part III of III

For Part 1, see MS-We-D-11
For Part 2, see MS-We-E-11

Organizer: Kressner, Daniel — EPFL
Organizer: Su, Yangfeng — Fudan Univ.

Abstract: Eigenvalue problems that are nonlinear in the eigenvalue parameter regularly appear in the analysis of vibrations and frequency-dependent material properties. It is not uncommon to find that model reduction techniques turn linear into nonlinear eigenvalue problems (NEP). Current research directions for NEPs include efficient and reliable algorithms for problems of small size, memory-efficient and robust algorithms for large-scale problems, as well as structure-preserving algorithms for structured NEPs. This MS aims to give an overview of state-of-the-art developments on the analysis, algorithms, and applications.

▶ MS-Th-BC-11-1 10:00–10:30

Arnoldi-type Contour Integral-based Eigensolver for Solving Nonlinear Eigenvalue Problems

Imakura, Akira — Univ. of Tsukuba
Sakurai, Tetsuya — Univ. of Tsukuba

Abstract: In this talk, we consider a method for finding all eigenvalues located in a certain region and the corresponding eigenvectors of nonlinear eigenvalue problems. Recently, we have developed the contour integral-based eigensolvers for solving generalized and nonlinear eigenvalue problems. In this talk, we propose an Arnoldi-type contour integral-based eigensolver, which is based on the block Arnoldi method of standard eigenvalue problems, for solving nonlinear eigenvalue problems.

▶ MS-Th-BC-11-2 10:30–11:00

A Fixed-point Characterization of the Convergence of the Self-consistent Field Iteration

Jarlebring, Elias — KTH

Abstract: Flavors of the self-consistent field iteration is one of the leading approaches to solve certain types of nonlinear eigenvalue problems in quantum chemistry. We present a characterization of the convergence of this iteration. The characterization gives an explicit sufficient and essentially necessary conditions for local convergence. The characterization is illustrated with examples, which also suggest new acceleration techniques.

▶ MS-Th-BC-11-3 11:00–11:30

Constructing Strong L-ifications of Arbitrary Degree

De Teran, Fernando — Universidad Carlos III de Madrid
Dopico, Froilan M. — Universidad Carlos III de Madrid
Van Dooren, Paul — Catholic Univ. of Louvain

Abstract: We revisit the problem of constructing strong L-ifications of a given matrix polynomial P(s) of degree D and size mxn. A strong L-ification of P(s) is a matrix polynomial of degree L having the same finite and infinite elementary divisors, and the same number of left and right minimal indices as the original matrix polynomial P(s). We give a general construction of strong L-ifications for very general choices of degree.

▶ MS-Th-BC-11-4 11:30–12:00

Numerical Analysis of Cubic Formula

Su, Yangfeng — Fudan Univ.
LU, DING — Fudan Univ.

Abstract: As the quadratic root formula, the cubic one may also suffer from backward instability. In this talk, we introduce some stability results for cubic root formula, including explicit expression of the tropical roots for root distributions of cubic equations, which root(s) from cubic root formula are always backward stable, and how to do deflation to compute all three roots such that they are backward stable.

MS-Th-BC-12 10:00–12:00 208B

Bifurcation, Stability and Applications - Part I of II

For Part 2, see MS-Th-D-12

Organizer: Loginov, Boris — Ulyanovsk State Technical Univ.

Abstract: In applications of bifurcation theory the situation arises when the finite-dimensional branching equation (BEqs) is potential, while the original nonlinear equation haven't this property. Three articles are devoted to this phenomenon. Here sufficient conditions for BEq potentiality and pseudopotentiality are obtained, particularly under group symmetry conditions, when the bifurcation point has nontrivial stationary subgroup. For stationary and dynamic bifurcation problems general theorems are proved about the inheritance of the group symmetry of original nonlinear equation by the relevant Lyapounov and Schmidt BEqs moving along the trajectory of the branching point, taking into account the presence of stationary subgroup of the branching point. Theorems on the BEqs reduction (its order lowering) are proved at the action of continuous group symmetry, G-invariant implicit operators theorems are proved for stationary and dynamic bifurcation. Simple, but very technical examples of SO(2) and SH(2) symmetries are considered with the general form of C1-smooth BEq construction on allowed group symmetry. With the aid of Morse-Conley topological index theory it is proved the bifurcation existence theorem for Andronov-Hopf bifurcation. Sufficient conditions for the linearized stability of bifurcating solutions are obtained. The obtained results are applied to bifurcation problems with E. Schmidt spectrum in the linearization. Three communications are devoted to nonlinear equations, their solutions stability and bifurcation theory to problems of hydroaeroelasticity . One of them considers the multiparameter bifurcation problems on the divergence of the elongated plate in supersonic gas flow compressed or extended by external boundary conditions in the exact statement, that is achieved by the representation of the bifurcation manifold through the roots of the characteristic equation of the linearized ODE. Here the most difficulties arise at the analytical proof of the divergence absence. The Fredholm property of these problems is proved also on the base of the usage of the roots of characteristic equations of the linearization. Lyapounov functions and functionals, Lyapounov vector- functions techniques is applied to the investigation of solutions stability in two reports to hydroaeroelasticity problems and two articles on the stabilization of nonlinear systems motions (with digital control and with aftereffect.)

▶MS-Th-BC-12-1 10:00–10:30

Symmetry and Potentiality in Branching Theory Problems with Stationary Subgroup of Branching Point

Loginov, Boris — Ulyanovsk State Technical Univ.
Konopleva, Irina — Ulyanovsk State Technical Univ.

Abstract: For stationary and dynamic branching in DE nonresolved under derivative admitting generally noncompact symmetry with pseudopotential branching equations (BEqs) and stationary subgroup of bifurcation point necessary and sufficient conditions of the potential invariance are established. Cosymmetric identities of the BEqs and Lie algebra operators allow to prove theorems on BEqs reduction by the number of equations, G-invariant implicit operators' theorems are proved. Criteria of linearized stability of bifurcation solution families and simple applications are given.

▶MS-Th-BC-12-2 10:30–11:00

Bifurcation Problem on Schmidt Spectrum under Group Symmetry Conditions

Loginov, Boris — Ulyanovsk State Technical Univ.
Konopleva, Irina — Ulyanovsk State Technical Univ.

Abstract: At the beginning of XX century E.Schmidt had introduced for an operator and adjoint to it the spectrum notion. Here stationary and dynamic bifurcation problems on Schmidt spectrum for DEs non-resolved by the derivative under generally non-compact group symmetry are investigated. The general theorem on group symmetry inheritance by the relevant branching equations, moving along bifurcation point trajectory allows to prove G-invariant implicit operators theorem and variational types BEqs reduction by the number of equations.

▶MS-Th-BC-12-3 11:00–11:30

Andronov-Hoph Bifurcation in Equations with Symmetrizable Operators

Kim-Tyan, Luiza — National Research Technological Univ. (Moscow Inst. of Steel & Alloys)

Abstract: For first order differential equations in Banach spaces with densely defined linear Fredholm operator before the derivative and small parameter in nonlinearity in the linearization Andronov-Hoph bifurcation problem is considered. On the base of the suggested by V.A.Trenogin symmetrizability notion for the linear operators in Banach spaces sufficient conditions for Lyapounov-Schmidt branching equation pseudopotentiality types A and B are obtained and at the usage of Conley-Morse index theory the bifurcation existence theorem is proved.

▶MS-Th-BC-12-4 11:30–12:00

Multiparameter Bifurcation Problems on Divergence of Elongated Plate in Supersonic Gas Flow

Badokina, Tatyana — Mordovian State Univ. of N. P. Ogarev
Loginov, Boris — Ulyanovsk State Technical Univ.

Abstract: Bifurcation problem about buckling of strip-plate in supersonic gas flow under compressed/extended boundary stresses is considered. The dependence on bifurcation parameters (Mach number, compression/extension coefficient) and small normal load, expressed through the roots of the characteristic equation for the linearization, allows to give the problem exact statement, to determine the parameters critical manifolds, to construct (first for aeroelasticity problems) Green functions for the linearizations and bifurcating solutions asymptotics by Lyapounov-Schmidt method.

MS-Th-BC-13 10:00–12:00 VIP3-2

Progress in hyperbolic problems and applications - Part II of VI

For Part 1, see MS-We-E-13
For Part 3, see MS-Th-D-13
For Part 4, see MS-Th-E-13
For Part 5, see MS-Fr-D-13
For Part 6, see MS-Fr-E-13

Organizer: Wang, Ying — Univ. of Oklahoma
Organizer: Tesdall, Allen — City Univ. of New York, College of Staten Island

Abstract: Hyperbolic conservation laws form the basis for the mathematical modeling of many physical systems, and describe a wide range of wave propagation and fluid flow phenomena, including shock waves in nonlinear situations. For one dimensional systems with small data, a well-posedness theory of entropy weak solutions is well known. Analysis in several space dimensions, however, remains an enormous challenge. In this minisymposium, recent results in the theory and numerical analysis of hyperbolic problems will be presented. A variety of computational techniques, including finite volume, finite element, spectral, WENO, and discontinuous Galerkin methods, will be represented.

▶MS-Th-BC-13-1 10:00–10:30

Shock Formation at the Sonic Line

Ying, Hao — The Ohio State Univ.

Abstract: We study a problem of self-similar unsteady transonic small disturbance equation which contains a shock forming at the sonic line. This is a mixed elliptic-hyperbolic type problem where the elliptic region and hyperbolic region are separated by a shock and a sonic line. It can be reformulated as a free boundary problem for nonlinear degenerate elliptic PDE of second order. We establish a result on existence of the solution to this configuration.

▶MS-Th-BC-13-2 10:30–11:00

Derivation and Some Asymptotic Estimates of the Convergence Rate of A Schwarz Waveform Relaxation Domain Decomposition Method for Some Quantum Wave Equations

Lorin, Emmanuel — Carleton Univ. & Centre de Recherches Mathematiques (Montreal)

Abstract: This presentation is dedicated to the derivation of a Schwarz waveform relaxation domain decomposition method using high order pseudodifferential transmission conditions. This method will be applied to linear and nonlinear Schroedinger equations in real and imaginary time. We will show some numerical and analytical convergence rate estimates. This is a joint work with X. Antoine (University of Lorraine)

▶MS-Th-BC-13-3 11:00–11:30

A High Order Finite Difference Method with Subcell Resolution for Stiff Multispecies Reacting Flows

Wang, Wei — Florida International Univ.
Shu, Chi-Wang — Brown Univ.

Abstract: In this talk, we propose a high order finite difference WENO method with Harten's ENO subcell resolution idea for the chemical reactive flows. The proposed method is a modified fractional step method which solves the convection step and reaction step separately. A fifth-order WENO is used in convection step. In the reaction step, a modified ODE solver is applied but with the flow variables in the discontinuity region modified by the subcell resolution idea.

▶MS-Th-BC-13-4 11:30–12:00

Asymptotic Preserving Method for the Radiative Transfer Equation

Xing, Yulong — Oak Ridge National Laboratory & Univ. of Tennessee

Abstract: Many kinetic equations converge to macroscopic models when the mean free path ϵ-¿0. Asymptotic preserving (AP) methods are designed to preserve the asymptotic limits in the discrete setting. In this presentation, we consider the radiative transfer equation and present a mixed DG-FV method. Rigorous analysis will be provided to show that the proposed methods are AP and consistent with the limit equation in the asymptotic regimes. Numerical examples are presented to demonstrate their performance.

MS-Th-BC-14 10:00–12:00 111

Eigenvalues of partial differential operators and their applications - Part II of III

For Part 1, see MS-We-E-14
For Part 3, see MS-Th-D-14

Organizer: Kao, Chiu-Yen — Clarmeont McKenna College
Organizer: Osting, Braxton — Univ. of Utah

Abstract: Eigenvalues and eigenfunctions are fundamental to the understanding of the dynamics and properties of solutions to partial differential equations. This minisymposium features the latest progress on numerical and theoretical approaches for solving linear and nonlinear eigenvalue problems, eigenvalue optimization, and their applications in several different and important scientific areas including mechanical vibration, optimal conductivity, photonic crystals, and shape classification and recognition.

▶MS-Th-BC-14-1 10:00–10:30

Shape Optimization for Eigenvalue Problem Involving Biharmonic Operators.

Kao, Chiu-Yen — Clarmeont McKenna College

Abstract: The displacement of an isotropic plate vibration satisfies a fourth order partial differential equation with a biharmonic operator. In this talk, we will discuss several recent results for shape optimization of the corresponding eigenvalue problem. The aim is to find the minimum or maximum of a particular eigenvalue. We use efficient rearrangement algorithms to achieve the optimal configuration and numerous results will be shown to demonstrate the efficiency and robustness of the algorithms.

▶MS-Th-BC-14-2 10:30–11:00

An Optimization Problem Arising in A Quantum Dot

Mohammadi, Seyyed Abbas — Yasouj Univ.

Voss, Heinrich — Hamburg Univ. of Tech.

Abstract: In this paper we examine an eigenvalue optimization problem with nonlinear dependence on the eigenparameter. We prove the existence of a solution, and we propose a numerical algorithm to obtain an approximate description of the optimizer. Such nonlinear eigenvalue problems appear as the Hamiltonian equation governing some quantum dot nanostructures.

▶ MS-Th-BC-14-3 — 11:00–11:30

Fast Computation of Dirichlet and Neumann Eigenfunctions

Hassell, Andrew — Australian National Univ.

Abstract: Recently, Alex Barnett and I published a fast method, the 'weighted Neumann-to-Dirichlet method', for rapidly computing eigenfunctions and eigenvalues of the Laplacian on Euclidean domains (Comm. Pure Appl. Math. 67 (2014), 351-407). However, the method, as published, is applicable only to the Dirichlet boundary condition and starshaped domains. In this talk, I describe joint work with Barnett on developing this method to rapidly compute Laplace eigenfunctions for general boundary conditions and domains.

▶ MS-Th-BC-14-4 — 11:30–12:00

Lower Bounds for the First Eigenvalue of the Vibrating Clamped Plate under Compression

Ashbaugh, Mark — Univ. of Missouri

Abstract: We give a sharp lower bound to the fundamental frequency of a clamped vibrating plate under compression in the context of plates of different shapes of fixed area. Mathematically, the problem is that of bounding the first eigenvalue of a certain 4th-order partial differential operator with leading term the bi-Laplacian from below by a positive constant over the domain's area squared. We give a Rayleigh-Faber-Krahn-type result for this problem. (Joint with Benguria and Mahadevan.)

MS-Th-BC-15 — 10:00–12:00 — 213B

Recent Trends in Homogenization of Partial Differential Equations

Organizer: Damlamian, Alain — UPEC

Organizer: Donato, Patrizia — Univ. of Rouen

Abstract: This minisymposium is devoted to homogenization and applications. This theory allows for efficient treatment of PDE's with multiple scales giving an equivalent mascroscopic description (which makes their numerical treatment significantly simpler).

▶ MS-Th-BC-15-1 — 10:00–10:30

General Methods in Homogenization. Application to Perforated Domains

Cioranescu, Doina — Univ. Pierre et Marie Curie, Laboratoire J.L.Lions

Abstract: The mathematical theory of homogenization studies the asymptotic behavior of problems with small parameters describing for example, heterogeneities (oscillating coeffcients) or the geometry of domains (size of holes in porous media). The classical tools that we discuss are the multiple scale method, Tartar's oscillating test functions method, the two-scale convergence. We describe here an alternative, the periodic unfolding. Applications will be discussed as in particular, homogenization in perforated domains.

▶ MS-Th-BC-15-2 — 10:30–11:00

Homogenization of Parabolic Problems via the Periodic Unfolding Method

Yang, Zhanying — South-Central Univ. for Nationalities

Abstract: This talk will survey some recent progress for the homogenization and correctors of a parabolic problem with imperfect interfaces. Imperfect interfaces are modeled by a boundary conditions where the jump of the solution across the interface is proportional to the flux (which itself does not exhibit a jump).

▶ MS-Th-BC-15-3 — 11:00–11:30

Asymptotic Analysis of the Approximate Control for A Class of Parabolic Equations with Interfacial Contact Resistance

Jose, Editha — Univ. of the Philippines Los Banos

Donato, Patrizia — Univ. of Rouen

Abstract: We study the asymptotic behavior of the approximate control for a class of parabolic equations with periodic rapidly oscillating coefficients in composites with a periodic interfacial resistance. We first prove the approximate controllability of the problem as well as the homogenized one, which is a coupled system P.D.E.-O.D.E. Then we show that the control and the corresponding solution of the periodic problem converge respectively to the control and to the solution of the homogenized problem.

▶ MS-Th-BC-15-4 — 11:30–12:00

Effective Properties of Suspensions and Fluid Emulsions

Vernescu, Bogdan — Worcester Polytechnic Inst.

Abstract: We study suspensions of rigid particles in a Newtonian fluid, and of fluid emulsions of deformable droplets, in the presence of surface discontinuities. The macroscopic effects of the velocity slip on the particles' surfaces in suspensions, and the effects of the droplets' surface tension in emulsions are derived.

MS-Th-BC-16 — 10:00–12:00 — 205A

Lie Symmetries, Solutions and Conservation laws of nonlinear differential equations - Part III of III

For Part 1, see MS-We-D-16

For Part 2, see MS-We-E-16

Organizer: Khalique, Chaudry Masood — North-West Univ., Mafikeng Campus

Organizer: Zhang, Lijun — Zhejiang Sci-Tech Univ.

Abstract: This mini-symposium is devoted to all research areas that are related to nonlinear differential equations and their applications in science and engineering. The main focus of this mini-symposium is on the Lie symmetry analysis, conservation laws and their applications to ordinary and partial differential equations. These differential equations could originate from mathematical models of diverse disciplines such as architecture, chemical kinetics, civil engineering, ecology, economics, engineering, fluid mechanics, biology and finance. Other approaches in finding exact solutions to nonlinear differential equations will also be discussed. This includes, but not limited to, asymptotic analysis methodologies, bifurcation theory, inverse scattering transform techniques, the Hirota method, the Adomian decomposition method, and others.

▶ MS-Th-BC-16-1 — 10:00–10:30

Lie Group Classification of A Generalized Coupled (2+1)-dimensional Hyperbolic System

Mothibi, Dimpho — North-West Univ.

Abstract: We carry out Lie group classification of a generalized coupled (2+1)-dimensional hyperbolic system. Several cases arise for which the Principal Lie algebra extends. Group-invariant solutions will be presented for some cases.

▶ MS-Th-BC-16-2 — 10:30–11:00

Traveling Wave Solutions of Higher-order Wave Equations

Zhang, Lijun — Zhejiang Sci-Tech Univ.

Abstract: We investigate the exact traveling wave solutions of the fifth-order Kaup-Kuperschmidt equation. The bifurcation and exact solutions of a general first-order nonlinear equation are investigated. With the help of Maple and by using the bifurcation and exact solutions of two derived subequations, we obtain two families of solitary wave solutions and two families of periodic wave solutions of the KK equation.

▶ CP-Th-BC-16-3 — 11:00–11:20

An Improved Square Formulation for Schubert Calculus

Hein, Nickolas — Univ. of Nebraska at Kearney

Sottile, Frank — Texas A&M Univ.

Abstract: Formulating a Schubert problem as the solutions to a system of equations in either Pluecker space or in the local coordinates of a Schubert cell typically involves more equations than variables. Using reduction to the diagonal, we previously gave a formulation for Schubert calculus that involved the same number of variables as equations (a square formulation). We give a diﬀerent square formulation which involves fewer equations and variables. The idea behind our formulation is that partial desingularizations of Schubert varieties have simple descriptions.

▶ CP-Th-BC-16-4 — 11:20–11:40

The Stokes and Navier-Stokes Equations with Non Standard Boundary Conditions

SELOULA, Nour — Univ. of Caen

Abstract: We consider the stationary and the non stationary Stokes equations with nonstandard boundary conditions where the pressure and the tangential velocity are imposed . We prove the existence and uniqueness of weak, strong and very weak solutions. We give a variant of the Stokes system with these boundary conditions, in the case where the compatibility condition is not verified. We also study the non linear Navier stokes problem.

▶ CP-Th-BC-16-5 — 11:40–12:00

An Effective High-order Stereo-modeling Method for Solving Wave Equations

Li, Jingshuang — China Univ. of Mining & Tech. (Beijing)

Yang, Dinghui — Tsinghua Univ.

Yang, Lei — China Univ. of Mining & Tech.

Abstract: In this study, we develop a new finite difference method, which use not only displacement but also its gradients, to solve the acoustic and elastic wave equations for seismic modeling to meet the high demand today. The analyses of this 12th order stereo-modeling (12-STEM) method including the theoretical error, stability condition and numerical dispersion relation are given

in detail. Compared with 12th order Lax-Wendroff correction (12-LWC) methods, and 4th order stereo-modeling method, 12-STEM is proved to be the most accurate, low-dispersive, low-numerical anisotropic and efficient. The results show that the maximum error of the phase velocity is only about 3% for 12-STEM, whereas it's about 15% for 12-LWC. Under the condition of no visible numerical dispersion, the computational speed of 12-STEM is roughly 8 times faster than that of 12-LWC. However, 12-STEM requires only about 38% of the storage space for the 12-LWC for comparable reliability.

MS-Th-BC-17 10:00–12:00 205B

Singular limits in mathematical physics - Part II of V

For Part 1, see MS-We-E-17
For Part 3, see MS-Th-D-17
For Part 4, see MS-Th-E-17
For Part 5, see MS-Fr-D-17

Organizer: Cheng, Bin — Univ. of Surrey
Organizer: Secchi, Paolo — Univ. of Brescia
Organizer: Ju, Qiangchang — Inst. of Applied Physics & Computational Mathematics (IAPCM)
Organizer: Jiang, Ning — Tsinghua Univ., Beijing

Abstract: This minisymposium will address recent advances in analytical and numerical studies of singular limits of multiscale physical models as certain parameters approach zero or infinity. It shall cover such areas as incompressible and fast rotating limits in fluid dynamics, hydrodynamical limits of complex fluid and kinetic models, and relaxations. The singular nature of these models makes it challenging to rigorously justify and quantify their limits and to numerically simulate them in a way consistent with theory. Novel techniques and results in partial differential equations, stochastic differential equations and numerical analysis will be discussed.

▶ MS-Th-BC-17-1 10:00–10:30

Singular Limits of Smooth Solutions of Evolutionary PDEs and Their Numerical Analysis

Schochet, Steve — Tel Aviv Univ.

Abstract: After reviewing the theory of singular limits of smooth solutions of evolutionary partial differential equations both for the standard case in which the large terms have constant-coefficients and for some equations having variable-coefficient large terms, an analysis of certain numerical schemes for singular limits will be presented that is analogous to the corresponding PDE theory. The analysis has so far be done for certain finite-difference schemes but some preliminary results are available for finite-volume schemes.

▶ MS-Th-BC-17-2 10:30–11:00

The Singular Limits for the Full Navier-Stokes-Poisson System

Ju, Qiangchang — Inst. of Applied Physics & Computational Mathematics (IAPCM)

Abstract: We shall report the recent results of the quasi-neutral limit of the full Navier-Stokes-Poisson system for both strong solution and weak solutions. In particular, The effect of large temperature variations will be discussed.

▶ MS-Th-BC-17-3 11:00–11:30

Toward A Justification of Variational Asymptotics for Multiscale Systems with Strong Gyroscopic Forcing

Oliver, Marcel — Jacobs Univ.

Abstract: In systems with strong gyroscopic forces, approximate equations for the dynamics on a slow manifold can be found via variational asymptotics. The results generally differ from those obtained by classical Hamiltonian normal form theory. We explain the method, using the non-relativistic limit of the nonlinear Klein-Gordon equation as an example, and prove a shadowing result for this particular case.

▶ MS-Th-BC-17-4 11:30–12:00

Solutions for Semigeostrophic System with General Initial Data

Feldman, Mikhail — Univ. of Wisconsin-Madison

Abstract: We study semigeostrophic system with general convex initial data in physical space, which includes the case when the dual-space solutions are singular measures. To accommodate general initial data, we introduce a notion of relaxed renormalized Lagrangian solutions. We show weak stability and existence of solutions. The renormalization property ensures the return from physical to dual space; as consequences we get conservation of energy and a weak time-regularity of solutions. Joint work with A. Tudorascu.

MS-Th-BC-18 10:00–12:00 209B

Recent Advances in Stochastic Approximation for Uncertainty Quantification: Analysis and Computation - Part II of II

For Part 1, see MS-We-E-18

Organizer: Archibald, Rick — Oak Ridge National Laboratory
Organizer: Webster, Clayton — Oak Ridge National Laboratory
Organizer: Zhang, Guannan — Oak Ridge National Laboratory

Abstract: This mini-symposium focuses on the fundamental problem of how to accurately approximate solutions of both forward and inverse complex systems with random inputs. Predicting the behavior of complex phenomena relies on constructing solutions in terms of high dimensional spaces, particularly in the case when the input data are affected by large amounts of uncertainties. The resulting explosion in computational effort is a symptom of the curse of dimensionality. This mini-symposium aims at exploring recent advances in high-dimensional approximation, sparse polynomial approximation, multilevel methods, model calibration and data-driven reduced order modeling.

▶ MS-Th-BC-18-1 10:00–10:30

Multivariate Markov Nikolskii Inequalities for Polynomials on Downward Closed Sets and Application to Polynomial Approximation by Discrete Least Squares

Migliorati, Giovanni — Pierre & Marie Curie Univ.

Abstract: We present Markov and Nikolskii inequalities for multivariate polynomials indexed by downward closed multi-index sets in any dimension. Afterwards we show how these inequalities come into play in the analysis of the stability and accuracy of discrete least squares on multivariate polynomial spaces with noiseless or noisy evaluations at random or low-discrepancy point sets, with applications to the numerical approximation of the solution to PDEs with stochastic data.

▶ MS-Th-BC-18-2 10:30–11:00

A Stochastic Collocation Approach for Multi-Fidelity Model Classes

Narayan, Akil — Univ. of Massachusetts Dartmouth
Xiu, Dongbin — Univ. of Utah

Abstract: We present a novel algorithm for robustly incorporating inexpensive low-fidelity models and data into expensive high-fidelity simulations. Our approach maintains high-fidelity model accuracy while requiring only low-fidelity computational effort. The method is non-intrusive and extensible, effectively working with black-box simulation tools. Our procedure can address multi-physics situations, missing parameters, and an arbitrary numbers of model with varying degrees of fidelity.

▶ MS-Th-BC-18-3 11:00–11:30

Analysis of Quasi-optimal Polynomial Approximations for High-dimensional Parameterized PDEs

Webster, Clayton — Oak Ridge National Laboratory
Zhang, Guannan — Oak Ridge National Laboratory

Abstract: In this talk, we present a generalized methodology for analyzing the convergence of quasi-optimal polynomial and interpolation approximations, applicable to a wide class of parameterized PDEs with both deterministic and stochastic inputs. Such quasi-optimal methods construct an index set that corresponds to the "best M-terms," based on sharp estimates of the polynomial coefficients. Computational evidence complements the theory and shows the advantage of our generalized methodology compared to previously developed estimates.

▶ MS-Th-BC-18-4 11:30–12:00

Starting from Measurements: An Integrated UQ Cycle with Adaptive Sparse Grids

Pflueger, Dirk — Univ. of Stuttgart

Abstract: We consider non-intrusive stochastic collocation for uncertainty quantification as our applications prevent us from changes in the underlying simulation code. We propose spatially adaptive sparse grids for both density estimation and stochastic collocation. With their help, the numerical discretization is still possible in higher-dimensional settings. This allows us to start with data that is provided by measurements and to combine the estimated densities with the simulation's surrogate without introducing additional sampling or approximation errors.

MS-Th-BC-19 10:00–12:00 307B

Women in Applied Mathematics: Recent Advances in Modeling, Numerical Algorithms, and Applications - Part II of IV

For Part 1, see MS-We-E-19
For Part 3, see MS-Th-D-19
For Part 4, see MS-Th-E-19

Organizer: Li, Fengyan — Rensselaer Polytechnic Inst.
Organizer: Cheng, Juan — Inst. of Applied Physics & Computational Mathematics

Abstract: This mini-symposium aims at bringing women mathematicians to share recent progress and to inspire new ideas in applied mathematics. Talks may address modeling, theoretical and computational aspects of numerical methods, as well as various applications arising from biomedical problems, fluid dynamics, electromagnetism, rarefied gas dynamics, and constrained optimal control problems etc. Besides the scientific aspects, the fourth part of this mini-symposium is a career panel session, which is to create a platform for women mathematicians at different stages with different career paths to network, to exchange experiences and advices in career advancement, and to discuss challenges and strategies for a successful career.

▶MS-Th-BC-19-1 10:00–10:30

Construction of Explicit Numerical Methods for the Vlasov-Maxwell Equations with Poisson Structure

Yajuan, Sun — Acad. of Mathematics & Sys. Sci., Chinese Acad. of Sci.

Abstract: By defining a non-canonical Poisson structure, the Vlasov-Maxwell equation is written in a Hamiltonian form. We use the particle-in-cell (PIC) method to compute the Vlasov-Maxwell equation. By using this method, the individual particles in six-dimensional phase space are tracked in self-consistent electromagnetic fields sampled on Eulerian grid. In this talk, we prove that with the PIC method the semi-discretized system is still Hamiltonian with the discrete Poisson structure. By splitting the Hamiltonian function of the semi-discretized system, we present the explicit numerical methods which can preserve the Poisson structure of the Vlasov-Maxwell equations.

▶MS-Th-BC-19-2 10:30–11:00

Superconvergence and Superconvergent Filtering for Semi-Lagrangian Discontinuous Galerkin Schemes

Ryan, Jennifer — Univ. of East Anglia
Seal, David — Michigan State Univ.

Abstract: In this work, we show that the application of Smoothness-Increasing Accuracy Conserving (SIAC) filters to a non-standard, semi-Lagrangian discontinuous Galerkin time stepping method improves the order from k+1 to 2k+1. This extension requires analyzing the underlying projection operators tied to the SLDG scheme. We show that we do indeed increase the order of accuracy of the final solution as well as reduce the errors and increase the smoothness of the post-processed approximation.

▶MS-Th-BC-19-3 11:00–11:30

Spectral Method for Optimal Control Problems Governed by PDEs with State Constraints

Chen, Yanping — South China Normal Universtiy

Abstract: In our researches, the control problems with state (control-state) constraints are approximated by Galerkin spectral method. The optimality conditions are constructed, and a priori and a posteriori error estimates are derived. Moreover, numerical tests confirm the theoretical analysis, and indicate the proposed method in our work is competitive for computing these control problems.

▶MS-Th-BC-19-4 11:30–12:00

High-order Methods for High-performance Simulations

MIN, MISUN — Argonne National Laboratory

Abstract: I will present recent algorithmic developments for solving electromagnetic systems based on classical and quantum mechanical modeling approaches. Studies include scalable algorithms for quantum absorption analysis and electron transport for plasmonics and quantum systems and photovoltaics. These efforts include high-order numerical discretizations, involving the design of accurate transparent boundary operators and efficient preconditioners, and scalable algorithms and large-scale simulations with hybrid programming for advanced computing architecture.

MS-Th-BC-20 10:00–12:00 210B

Theory, Computation, and Application of Transmission Eigenvalues - Part III of III

For Part 1, see MS-We-D-20
For Part 2, see MS-We-E-20

Organizer: Sun, Jiguang — Michigan Technological Univ.
Organizer: Cakoni, Fioralba — Univ. of Delaware

Abstract: Transmission eigenvalue problem is a new research area arising from the inverse scattering theory of inhomogeneous media. The problem is non-selfadjoint, non-standard and not covered by any classical partial differential equation. Since 2007, the problem received significant attention including a special issue of transmission eigenvalues of Inverse Problems. This mini symposium will bring top researchers from America, Europe, and Asia to present the recent advances of the theory, computation, and applications of transmission eigenvalues. It will also be a great chances for these researchers to exchange new ideas and discuss the future development for the transmission eigenvalue problem.

▶MS-Th-BC-20-1 10:00–10:30

On the Eigenvalue Density Theorems in Interior Transmission Problem and Its Applications

Chen, Lung-Hui — National Chung Cheng Univ.

Abstract: Starting with the interior transmission condition on the boundary of the perturbation, we will demonstrate how to apply Cartwright-Polya-Levinson theory to obtain its indicator function. By this indicator function, we can describe the eigenvalue density in interior transmission problem. Conversely, the eigenvalue density determines the indicator function. When perturbing the indicator function, we obtain the information on the index of refraction. As an application, we examine the thermoacoustic tomography.

▶CP-Th-BC-20-2 10:30–10:50

Interaction of Water Waves with A Pair of Semi-infinite Elastic Plates over Undulating Bed Topography

Samantaray, Sudhanshu Shekhar — Divine Residential College, Nayagarh
Biswal, Trilochan — Vivekananda Inst. of Tech., Bhubaneswar
Martha, Subash Chandra — INDIAN Inst. OF Tech. ROPAR

Abstract: Interaction of water waves with floating structures have been investigated assuming linear theory in the literature of the last few decades. In this present paper, the interaction of water waves with a pair of semi-infinite elastic plates, separated by a gap of finite width, floating horizontally over the bottom bed which has small undulation, is investigated. Employing perturbation analysis, the boundary value problem under consideration is solved. The first order reflection and transmission coefficients are obtained in terms of integrals involving the shape function representing the bottom undulation and the solution of the scattering problem necessitating elastic plate which is floating over the flat bed. For sinusoidal undulation of the bottom, the numerical values of these coefficients are obtained and depicted graphically.

▶CP-Th-BC-20-3 10:50–11:10

Detecting Highly Cyclic Structure with Complex Eigenpairs

Klymko, Christine — Lawrence Livermore National Laboratory
Sanders, Geoffrey — LLNL

Abstract: Highly 3- and 4- cyclic subgraph topologies are detectable via calculation of eigenvectors associated with certain complex eigenvalues of Markov propagators. We characterize this phenomenon theoretically to understand the capabilities and limitations for utilizing eigenvectors in this venture. We provide algorithms for approximating these eigenvectors and give numerical results, both for software that utilizes complex arithmetic and software that is limited to real arithmetic. Additionally, we discuss the application of these techniques to motif detection.

▶CP-Th-BC-20-4 11:10–11:30

Least-squares Spectral Element Methods for 3D Elliptic and Stokes Eigenvalue Problems

Husain, Akhlaq — LNM Inst. of Information Tech. Jaipur

Abstract: In this talk we discuss how to solve elliptic and Stokes eigenvalue problems on three dimensional polyhedral domains using least squares h−p/spectral element methods. We obtain exponential rate of convergence for approximate eigenvalues as well as the eigenfunctions when the domains are smooth. The computational results confirm the theoretical estimates and effectiveness of the method in dealing with eigenvalue problems. The results presented here are valid for multiple or clustered eigenvalues also.

MS-Th-BC-21 10:00–12:00 309B
Minisymposium on discontinuous Galerkin method: recent development and applications - Part V of VIII
For Part 1, see MS-Tu-D-21
For Part 2, see MS-Tu-E-21
For Part 3, see MS-We-D-21
For Part 4, see MS-We-E-21
For Part 6, see MS-Th-D-21
For Part 7, see MS-Th-E-21
For Part 8, see MS-Fr-D-21
Organizer: Xu, Yan — Univ. of Sci. & Tech. of China
Organizer: Shu, Chi-Wang — Brown Univ.
Abstract: Over the last few years, discontinuous Galerkin (DG) methods have found their way into the main stream of computational sciences and are now being successfully applied in almost all areas of natural sciences and engineering. The aim of this minisymposium is to present the most recent developments in the design and theoretical analysis of DG methods, and to discuss relevant issues related to the practical implementation and applications of these methods. Topics include: theoretical aspects and numerical analysis of discontinuous Galerkin methods, non-linear problems, and applications. Particular emphasis will be given to applications coming from fluid dynamics, solid mechanics and kinetic theory.

▶ MS-Th-BC-21-1 10:00–10:30
Some Recent Development of Superconvergence Study of Discontinuous Galerkin Methods
Zhimin, Zhang — Beijing Computational Sci. Research Center, & Wayne State Univ.

Abstract: Superconvergence phenomenon is well understood for the h-version finite element method and researchers in this field have accumulated a vast literature during the past 40 years. However, the relevant study for the discontinuous Galerkin method is far from complete. In this talk, we summarize some recent development on superconvergence study for discontinuous Galerkin methods. In addition, some current issues and un-solved problems will also be addressed.

▶ MS-Th-BC-21-2 10:30–11:00
Superconvergent Hybridizable Discontinuous Galerkin Method for Third-order Equations
Chen, Yanlai — Univ. of Massachusetts Dartmouth

Abstract: We design and analyze the first hybridizable discontinuous Galerkin methods for stationary, third-order linear equations in one-space dimension. 13 methods will be analyzed in a unified setting. They all provide superconvergent approximations to the exact solution and its derivatives. We also prove that their numerical traces converge at the nodes with order at least 2k+1 allowing an element-by-element post-processing for more accurate solutions. This is joint work with Bo Dong (UMassD) and Bernardo Cockburn (UMN).

▶ MS-Th-BC-21-3 11:00–11:30
Superaccuracy, Superconvergence and Postprocessing of the DG Solutions of Hyperbolic Equations
Krivodonova, Lilia — Univ. of Waterloo

Abstract: We discuss a connection between super accuracy in wave number approximation, spatial superconvergence at the roots of Radau polynomials and postprocessing techniques. We show that superconvergence and superaccuracy are related to the same subdiagonal Pade approximants. Further, postprocessing is possible due to a particular structure of the spatial error and recovers the superaccuracy of the method. While these concepts have been discussed before, we will present a theory that ties these three phenomena together.

▶ MS-Th-BC-21-4 11:30–12:00
HDG Methods for Diffusion: Superconvergence by M-decompositions
Fu, Guosheng — Univ. of Minnesota

Abstract: We introduce the concept of an M-decomposition and show how to use it to systematically construct hybridizable discontinuous Galerkin and mixed methods for steady-state diffusion methods with superconvergence properties on unstructured meshes.

MS-Th-BC-22 10:00–12:00 206A
Recent development and applications of weighted essential non-oscillatory methods - Part I of V
For Part 2, see MS-Th-D-22
For Part 3, see MS-Th-E-22
For Part 4, see MS-Fr-D-22
For Part 5, see MS-Fr-E-22
Organizer: Qiu, Jianxian — Xiamen Univ.
Organizer: Shu, Chi-Wang — Brown Univ.
Abstract: The spectrum covered by the minisymposium ranges from recent development, analysis, implementation and applications, for the weighted essential non-oscillatory (WENO) methods. The WENO methods provide a practical effective framework to solve out many nonlinear wave-dominated problems with discontinuities or sharp gradient regions, which play an important role arising in many applications of computational fluid dynamics, computational astrophysics, computational plasma physics, semiconductor device simulations, among others. Devising robust, accurate and efficient WENO methods for solving these problems is of considerable importance and, as expected, has attracted the interest of many researchers and practitioners. This minisymposium serves as a good forum for researchers to exchange ideas and to promote this active and important research direction.

▶ MS-Th-BC-22-1 10:00–10:30
WENO Schemes: Survey and Recent Developments
Shu, Chi-Wang — Brown Univ.

Abstract: We give a short survey of WENO schemes and then review some of their recent developments, including a simple WENO limiter for DG and CPR schemes, finite difference WENO schemes with positivity-preserving limiter for correlated random walk with density-dependent turning rates, WENO compact schemes, and free-stream preserving finite difference WENO schemes on curvilinear meshes.

▶ MS-Th-BC-22-2 10:30–11:00
On the Maximum Principle Preserving Flux Limiters with Application to High Order Conservative Schemes
Xu, Zhengfu — Michigan Technological Univ.

Abstract: In this presentation, we will discuss the maximum principle preserving flux limiters from the algorithm design, accuracy analysis to their applications to high order conservative schemes, such as finite difference/finite volume WENO, discontinuous Galerkin methods. We will also discuss the generalization to positivity preserving high order finite difference WENO scheme solving compressible Euler equations.

▶ MS-Th-BC-22-3 11:00–11:30
Positivity-preserving High Order Schemes for Conservation Laws
Zhang, Xiangxiong — Purdue Univ.

Abstract: We will discuss the construction of arbitrarily high order accurate DG and WENO schemes which satisfy a strict maximum principle for nonlinear scalar conservation laws, passive convection in incompressible flows, and preserve positivity of density and pressure for compressible Euler equations in gas dynamics. The main difficulty is how to enforce the positivity without destroying the high order accuracy and the local conservation, which was unknown previously regarding higher than second order accuracy.

▶ MS-Th-BC-22-4 11:30–12:00
High Order Positivity-preserving Lagrangian Schemes for Multi-material Compressible Flow
Cheng, Juan — Inst. of Applied Physics & Computational Mathematics

Abstract: In this talk, we will present our recent work on the design of high order positivity-preserving Lagrangian schemes. We construct a class of uniformly high order accurate conservative Lagrangian schemes which preserve positivity of physically positive variables such as density and internal energy in the simulation of compressible multi-material flows with general equations of state. One- and two-dimensional numerical tests for the positivity-preserving Lagrangian schemes are provided to demonstrate the effectiveness of the method.

MS-Th-BC-23 10:00–12:00 208A
Recent Developments in the Numerical Analysis of DAEs and Constrained PDEs
Organizer: Altmann, Robert — TU Berlin
Organizer: Heiland, Jan — MPI Magdeburg
Abstract: A common and convenient way to model multi-component phenomena is to model the components seperately and to glue them together via coupling the variables at the interfaces. This approach leads to constrained

PDEs that are more generally described as abstract DAEs or PDAEs and that require sophisticated methods for their numerical and analytical treatment. Our speakers reflect the broad application area of constrained PDEs and discuss difficulties in the application side and recent advances in the analysis and the numerical approximation. The talks cover general theoretical aspects of PDAEs with applications in the modelling of elastodynamics, flow networks, and fluid dynamics as well as specific issues that come with time integration of DAEs.

▶ MS-Th-BC-23-1 10:00–10:30

Numerical Analysis of Numerical Methods for Neutral Delay Differential Algebraic Equations

Tian, Hongjiong — Shanghai Normal Univ.

Abstract: This talk is concerned with numerical stability of general linear methods for a system of linear neutral delay differential-algebraic equations. A sufficient and necessary condition for asymptotic stability of general linear methods solving such systems is derived. Based on this main result, we further investigate the asymptotic stability of linear multistep methods, Runge-Kutta methods, and block theta-methods, respectively. Numerical experiments confirm our theoretical result.

▶ MS-Th-BC-23-2 10:30–11:00

Modeling and Numerical Analysis of PDAEs Describing Flow Networks

Tischendorf, Caren — Humboldt Univ. of Berlin

Abstract: The simulation of flow networks as electric circuits, water and gas supplying networks leads to partial differential algebraic equation systems (PDAEs). Such systems contain partial differential equations of elliptic/parabolic/hyperbolic type and/or ordinary differential equations coupled with constraints. We present some common structures of such PDAEs caused by the network toplogy. We demonstrate that the stability of numerical schemes is highly influenced the constraints and present some suitable discretizations for certain prototype PDAEs.

▶ MS-Th-BC-23-3 11:00–11:30

Operator DAEs with Noise Arising in Fluid Dynamics

Mena, Hermann — Univ. of Innsbruck
Altmann, Robert — TU Berlin
Levajkovic, Tijana — Department of MAthematics, Univ. of Innsbruck

Abstract: We consider an abstract formulation of a constrained PDE of semi-explicit structure (PDAE) with consistent initial value and noise. This PDAE appears in fluid dynamics, e.g. Stokes equation. We apply the polynomial chaos expansion methodology and deal with the arising infinite dimensional triangular system of deterministic equations. Because of the differential-algebraic structure, the system is very sensible to perturbations in the constraint equation. Thus, we consider for the analysis a regularized version of the system.

MS-Th-BC-24 10:00–12:00 211

Combinatorial Issues in Sparse Matrix Computation

Organizer: Ng, Esmond — Lawrence Berkeley National Laboratory
Organizer: Duff, Iain — STFC Rutherford Appleton Laboratory

Abstract: Sparse matrix computation is rich in combinatorial problems. Reordering for sparsity preservation in matrix factorization is one such problem. Partitioning for parallel matrix factorization is another. In this minisymposium, we feature some recent work on the combinatorial aspect of sparse matrix computation. Some of the talks will focus on algorithmic development, while others will investigate more theoretical issues.

▶ MS-Th-BC-24-1 10:00–10:30

Towards A Recursive Graph Bipartitioning Algorithm for Well Balanced Domain Decomposition

Casadei, Astrid — Inria
Pierre, RAMET — Bordeaux Univ. & Inria
Roman, Jean — Inria

Abstract: In the context of hybrid sparse linear solvers based on domain decomposition and Schur complement approaches, getting a domain decomposition tool leading to a good balancing of both the internal node set size and the interface node set size is a critical point for parallel computation. We propose several variations of the existing algorithms in the multilevel Scotch partitioner and we illustrate the improved results on a collection of graphs coming from numerical scientific applications.

▶ MS-Th-BC-24-2 10:30–11:00

Experiments with A Nested Dissection Code

Ashcraft, Cleve — Livermore Software Tech. Corporation
Duff, Iain — STFC Rutherford Appleton Laboratory
Scott, Jennifer — STFC
Thorne, Sue — STFC

Abstract: We study the constituent parts of dissection orderings including algorithms based on the Ford-Fulkerson algorithm for network flows. We show the power and limitations of such methods for refining the cut sets. We also compare single and multilevel approaches. We will illustrate our algorithms and compare them with MeTiS orderings by runs on both model problems and realistic test cases.

▶ MS-Th-BC-24-3 11:00–11:30

Recent Progress on the Minimum Local Fill Ordering Heuristic

Ng, Esmond — Lawrence Berkeley National Laboratory
Peyton, Barry — Dalton State College

Abstract: The minimum local fill (MLF) heuristic computes a fill-reducing permutation for sparse Cholesky factorization. It is generally believed that MLF is very expensive and produces marginally better permutations than the well-known minimum degree (MD) heuristic. Recently we have introduced implementations of MLF that are effective in reducing fill but are not too costly when compared with MD. In this talk, we will describe further enhancements that result in more efficient implementations of the MLF heuristic.

▶ MS-Th-BC-24-4 11:30–12:00

Hypergraph Models to Reorder Sparse Matrices into Special Forms for Efficient Matrix Computations

Aykanat, Cevdet — Bilkent Univ.

Abstract: Efficient processing of many scientific applications that involve repeated sparse matrix computations requires reordering rows/columns of these matrices into special forms. These applications involve parallel sparse iterative solvers, and parallel and cache-efficient computation of sparse kernel operations such as sparse matrix-vector multiplication, sparse matrix-matrix multiplication, etc. This talk discusses various hypergraph-partitioning-based models proposed to reorder sparse matrices and shows how the objectives and constraints of these models encode the optimization of the underlying application.

MS-Th-BC-25 10:00–12:00 210A

Numerical Methods for Stochastic PDE and Uncertainty Quantification - Part IV of IV

For Part 1, see MS-Tu-E-25
For Part 2, see MS-We-D-25
For Part 3, see MS-We-E-25

Organizer: ZHOU, TAO — AMSS, the Chinese Acad. of Sci.
Organizer: Yu, Xijun — Inst. of Applied Physics & Computational Mathematics
Organizer: Xiu, Dongbin — Univ. of Utah

Abstract: Efficient solution strategy for stochastic partial differential equations (SPDE) has been a classical topic, as many physical phenomena are inherently random. The topic has received an increasing amount of attention in recent years, driven by the need for uncertainty quantification (UQ). In UQ, even deterministic systems need to be modeled as random because of the uncertainty in the system inputs. Stochastic problems become more challenging to solve, as they often reside in high dimensional random space. The purpose of this mini-symposium is to gather researchers from mathematics and computer science and engineering to interchange the latest advances in simulation techniques for SPDE and UQ. The focus will be on efficient algorithms for practical systems, particularly those arising from multidisciplinary problems.

▶ MS-Th-BC-25-1 10:00–10:30

Stochastic Collocation Methods via L1 Minimization Using Randomized Quadratures

GUO, LING — Department of Mathematics, Shanghai Normal Univ.
Narayan, Akil — Univ. of Massachusetts Dartmouth
Xiu, Dongbin — Univ. of Utah
ZHOU, TAO — AMSS, the Chinese Acad. of Sci.

Abstract: In this talk, we discuss the stochastic collocation methods via l1 minimization, by randomly sampling from the corresponding tensor grid of Gaussian points. A non-intrusive algorithm is established to construct polynomial approximations for parametric functions. We provide theoretical analysis on the validity of the approach. The framework includes both the bounded and the unbounded measures. Several numerical examples are given to confirm the theoretical results and examine the efficiency of our method.

▶ MS-Th-BC-25-2 10:30–11:00

Graph Theoretic Models for the Solution of Stochastic Multiscale Problems

Zabaras, Nicholas Warwick Centre for Predictive Modelling, Univ. of Warwick

Abstract: In this presentation, we will advocate the exploration of synergies between the machine learning and uncertainty quantification research communities towards addressing the aforementioned problems. In particular, we will present a data-driven probabilistic graphical model based methodology to efficiently perform uncertainty quantification in multiscale systems. We make predictions from the probabilistic graphical model using (loopy) belief propagation algorithms.

▶ CP-Th-BC-25-3 11:00–11:20

Principal Component Analysis for Multiple Time Series Data: A Symbolic Data Analysis Approach

Wu, Han-Ming Tamkang Univ.

Abstract: This study extended the principal component analysis (PCA) to multiple time series data through a symbolic data analysis approach. Firstly the data is converted to the time dependent intervals where the interval is described by a starting value and an ending value of a time period. Then, PCA is applied to those intervals of directed segments. The proposed method is useful for exploring the insight structure and the behaviors of objects in a lower-dimensional space.

▶ CP-Th-BC-25-4 11:20–11:40

A Consumption-Investment Problem with A Diminishing Basket of Goods

Mousa, Abdelrahim Birzeit Univ.

Abstract: We consider the problem faced by an economic agent trying to find the optimal strategies for the joint management of her consumption from a basket of K goods that may become unavailable for consumption from some random time τ_i onwards, and her investment portfolio in a financial market model comprised of one risk-free security and an arbitrary number of risky securities driven by a multidimensional Brownian motion. We apply previous abstract results on stochastic optimal control problem with multiple random time horizons to obtain a sequence of dynamic programming principles and the corresponding Hamilton-Jacobi-Bellman equations. We then proceed with a numerical study of the value function and corresponding optimal strategies for the problem under consideration in the case of discounted constant relative risk aversion utility functions (CRRA).

▶ CP-Th-BC-25-5 11:40–12:00

A Backward Dual Representation for the Quantile Hedging of Bermudan Options

BOUVERET, GERALDINE IMPERIAL COLLEGE LONDON

Abstract: We study the problem of hedging a claim of Bermudan style with a given probability p within a Markovian complete financial market. More precisely, we want to characterize the minimal initial value v(.,p) of an hedging portfolio for which we can find a financial strategy such that, with a probability p, it remains above the exercise value of the Bermudan option at any possible exercise date. This problem is referred to as a stochastic target and quantile hedging problem and is an extension to [1] and [2]. Using stochastic target and duality arguments, we derive a backward algorithm for the Fenchel transform of the pricing function. We provide numerical illustrations.
[1] Bruno Bouchard, Romuald Elie, and Nizar Touzi. Stochastic target problems with controlled loss. SIAM Journal on Control and Optimization, 48(5):3123 - 3150, 2009. [2] Hans Föllmer and Peter Leukert. Quantile hedging. Finance and Stochastics, 3(3):251 - 273, 1999.

MS-Th-BC-26 10:00–12:05 110

Recent advances in modeling, analysis, and methodology for interface and free boundary problems and applications - Part V of V

For Part 1, see MS-Mo-D-57
For Part 2, see MS-Mo-E-57
For Part 3, see MS-We-D-26
For Part 4, see MS-We-E-26

Organizer: Li, Zhilin North Carolina State Univ.
Organizer: Lai, Ming-Chih National Chiao Tung Univ.

Abstract: In recent years, there is increasing interest in the development and application of advanced computational techniques for interface problems, problem with free boundary and moving interface, fluid-structure interactions driven by applications in physiology, fluid mechanics, material sciences, porous media flow, and biology. There are also many numerical approaches developed in recent years. The aim of this mini-symposium is to bring together scientists in the field to exchange their recent research discoveries and future directions, to stimulate novel ideas, and to nurture collaborations. The focus would be on Cartesian grid method such as the immersed boundary/interface methods, the level set methods, fluid-structure interactions, and applications.

▶ MS-Th-BC-26-1 10:00–10:25

Surfactant Driven Tipstreaming in A Flow Focusing Geometry

Wrobel, Jacek Tulane Univ.

Abstract: We model a surfactant-mediated tipstreaming in a microfluidic flow focusing device. That microfluidic method for production of submicrometer and potentially nanoscale droplets and particles uses the elongational flow along with dissolved surfactant in one of the liquid phases to create strong surfaces tension gradient. The concentration of bulk soluble surfactant was found to significantly effect the mode of formation and size of the emitted droplets.

▶ MS-Th-BC-26-2 10:25–10:50

Towards A Spectacular Solver of the Low-Mach Multiphase Navier-Stokes/Brinkman Equations under Strong Stresses

Angot, Philippe Aix-Marseille Univ.

Abstract: We present the Vector Penalty-Projection methods; see [Ph. Angot, J.-P. Caltagirone and P. Fabrie, Applied Mathematics Letters －25(11), 1681–1688, 2012 & 26(4), 445–451, 2013]. These methods prove to be efficient, fast and robust to compute incompressible or low Mach multiphase flows under strong stresses : large density, viscosity or anisotropic permeability jumps, strong surface tension, or with open boundary conditions, whereas other methods run slower or crash. We show theoretical convergence and numerical results.

▶ MS-Th-BC-26-3 10:50–11:15

Numerical Method for Elastic and Plastic Equations

Ito, Kazufumi North Carolina State Univ.

Abstract: A new variational difference method for elastic and plastic deformation is developed. Our objective is to develop a very efficient and effective method for determining the effective property of composite materials. Our formulation enables us to input the material law and morphography of components directly into models to determine the homogenized constitutive law. An efficient and noble implementation of our numerical methods are also discussed.

▶ MS-Th-BC-26-4 11:15–11:40

A Cartesian Grid Method for Moving Interface and Free Boundary Problems

Ying, Wenjun Shanghai Jiao Tong Univ.

Abstract: This talk presents a new Cartesian grid method for moving interface and free boundary problems in both two and three dimensions. The method avoids the generation of any unstructured grids for both the volume and the boundary (interface) of the domain. The method represents the domain boundary or interface by its intersection points with an underlying Cartesian grid. This representation makes numerical interpolation and differentiation as well as relocation of the discretization points much easier.

▶ MS-Th-BC-26-5 11:40–12:05

Vesicle Flows: Simulations, Dynamics and Rheology

Veerapaneni, Shravan Univ. of Michigan

Abstract: In this talk, we will present recent progress in our group on numerical algorithms for simulating dense vesicle suspensions in viscous fluids. Capturing the close two-body interactions of vesicles (or other soft-particles) poses significant numerical challenges owing to the near-singularity in the hydrodynamic interaction forces. We present a new spectrally-accurate algorithm for computing such forces. A novel fast algorithm for simulating multiphase through periodic geometries of arbitrary shape will be presented.

MS-Th-BC-27 10:00–12:00 407

Decoupling methods for multi-physics and multi-scale problems - Part IV of VIII

For Part 1, see MS-Tu-E-27
For Part 2, see MS-We-D-27
For Part 3, see MS-We-E-27
For Part 5, see MS-Th-D-27
For Part 6, see MS-Th-E-27
For Part 7, see MS-Fr-D-27
For Part 8, see MS-Fr-E-27

Organizer: He, Xiaoming Missouri Univ. of Sci. & Tech.
Organizer: Xu, Xuejun Inst. of Computational Mathematics, AMSS, CAS

Abstract: The inherent multi-physics and multi-scale features of many real world problems accentuate the importance to develop efficient and stable numerical methods for the relevant PDEs, especially the decoupling methods. Although great efforts have been made for solving these problems, many practical and analytical challenges remain to be solved. This mini-symposium intends to create a forum for junior and senior researchers from different fields

to discuss recent advances on the decoupling methods for multi-physics and multi-scale problems with their applications.

▶ MS-Th-BC-27-1 10:00–10:30

Partitioned Two-step Second-order Method for Magnetohydrodynamics in Elsässer Variables

Trenchea, Catalin Univ. of Pittsburgh

Abstract: We propose a partitioned, two step, second-order method for magnetohydrodynamics in Elsässer variables, which treats implicitly the subproblem terms and explicitly the coupling terms. The stability analysis shows that the method is unconditionally stable for the magnetic Prandtl number in the interval (0.5,2). In a large number of laboratory simulations, the magnetic Prandtl number is taken to be unity. The algorithm is shown to be long-time stable, and the finite element error analysis is presented with a numerical test supporting the theory.

▶ MS-Th-BC-27-2 10:30–11:00

Multiscale Weak Galerkin Methods

Ye, Xiu Univ. of Arkansas at Little Rock

Abstract: Multiscale weak Galerkin finite element methods will be introduced in the presentation. The Weak Galerkin method is an extension of the standard Galerkin finite element method where classical derivatives were substituted by weakly defined derivatives on functions with discontinuity. It has the flexibility of employing discontinuous elements and shares the simple formulations of continuous finite element methods at the same time. There is a natural connection between weak Galerkin finite element methods and multiscale methods.

▶ MS-Th-BC-27-3 11:00–11:30

A Surrogate Bayesian Inference Approach with Application to Large Eddy Simulation Turbulence Models

Webster, Clayton Oak Ridge National Laboratory
Tran, Hoang Oak Ridge National Laboratory
Zhang, Guannan Oak Ridge National Laboratory

Abstract: In this effort, we developed an adaptive hierarchical sparse-grid (AHSG) surrogate modeling approach to Bayesian inference of large eddy simulation (LES) models, which, through a numerical demonstration of the Smagorinsky turbulence model of two-dimensional flow around a cylinder at sub-critical Reynolds number, is proven to significantly reduce the number of costly LES executions without losing much accuracy in the posterior probability estimation.

▶ MS-Th-BC-27-4 11:30–12:00

A Dual–mixed Finite Element Method for the Brinkman Problem

Neilan, Michael Univ. of Pittsburgh

Abstract: In this talk, we develop a dual mixed finite element method for the Brinkman problem. In this approach, the velocity and the deviatoric part of the velocity gradient are approximated by discontinuous piecewise polynomials, and the total stress tensor is approximated by standard divergence–conforming finite element elements. Existence, uniqueness and error estimates and discussed, and numerical experiments are given.

MS-Th-BC-28 10:00–12:05 109

Numerical Analysis for Forward-Backward Stochastic Differential Equations and Related Problems - Part II of II

For Part 1, see MS-We-E-28

Organizer: Zhao, Weidong Shandong Univ.
Organizer: ZHOU, TAO AMSS, the Chinese Acad. of Sci.

Abstract: Backward stochastic differential equations (BSDE's) were first introduced by J.M. Bismut in 1973 and generalized to the nonlinear form by Pardoux and Peng in 1990. Since then, BSDEs and coupled FBSDEs have been widely studied and used in connection with partial differential equations, stochastic optimal control theory, nonlinear filtering and mathematical finance. The numerical analysis of FBSDEs is more complicated than that of classical SDEs, so that there are many interesting and challenging open problems. The mini-symposium aims at exploring efforts related to numerical analysis for F-BSDEs and related problems such as SPDEs, nonlocal diffusions, nonlinear filtering, stochastic optimal control, mathematical finance, etc.

▶ MS-Th-BC-28-1 10:00–10:25

High Order Numerical Schemes for the Coupled FBSDEs with Applications to Stochastic Optimal Control

Zhao, Weidong Shandong Univ.
ZHOU, TAO AMSS, the Chinese Acad. of Sci.

Abstract: In this talk, we will introduce accurate numerical methods for solving coupled nonlinear forward backward stochastic differential equations with applications in solving fully nonlinear second-order parabolic partial differential equations and stochastic optimal control problems.

▶ MS-Th-BC-28-2 10:25–10:50

Error Estimate of the Crank-Nicolson Scheme for Solving the Decoupled FB-SDEs

Li, Yang Univ. of Shanghai for Sci. & Tech.
Zhao, Weidong Shandong Univ.

Abstract: In this talk, by the theory of the multiple Malliavin calculus, we will introduce Crank-Nicolson scheme for solving decoupled forward-backward s-tochastic differential equations, and give the rigorous proof of second-order convergence rate of the scheme.

▶ MS-Th-BC-28-3 10:50–11:15

Efficient Numerical Methods for Backward Forward Doubly Stochastic Differential Equations and Their Applications to Nonlinear Filtering Problems

Cao, Yanzhao Auburn Univ.

Abstract: Nonlinear filtering problems arise in many application fields such as financial mathematics, signal processing, target tracking, and biological sciences. As a class of stochastic computing problems, high dimensionality and low regularity are the bottlenecks of solving nonlinear filtering problems. In this talk, we present a class high order numerical methods for nonlinear filtering problems through construction of high order methods for forward backward doubly stochastic differential equations.

▶ MS-Th-BC-28-4 11:15–11:40

Numerical Approximation of Switching Problems

Chassagneux, Jean-francois Imperial College London

Abstract: We use the representation of Switching Problems as obliquely reflected BSDEs to obtain a numerical approximation of the solution. We thus focus on the discretization of the obliquely reflected BSDEs. By proving a stability result for the Euler scheme associated to the BSDEs, we are able to obtain convergence result in the case where the driver of the BSDE depends on z. This is a joint work with A. Richou.

▶ MS-Th-BC-28-5 11:40–12:05

Fourier Cosine Expansions for Backward Stochastic Differential Equations in Finance

Oosterlee, Cornelis CWI -center for mathematics & computer Sci.

Abstract: In this presentation we will explain how Fourier cosine expansions can be used to solve BSDEs originating from finance. By solving BSDEs, we can find the solution of a time-dependent PDE by means of the computation of conditional expectations. We have developed a Fourier technique to deal with BSDEs highly efficiently called the BCOS method ("BSDE COS method"), based on a time-stepping procedure. The resulting discrete schemes have a close connection to fundamental solutions of PDEs, and their Fourier transforms, and also to the characteristic function, which is the Fourier transform of the probability density function, well-known in probability theory. We will solve BSDEs appearing in finance with second-order accuracy in time.

MS-Th-BC-29 10:00–12:00 305

Numerical Homogenization and Multiscale Model Reduction Methods - Part I of V

For Part 2, see MS-Th-D-29
For Part 3, see MS-Th-E-29
For Part 4, see MS-Fr-D-29
For Part 5, see MS-Fr-E-29

Organizer: Zhang, Lei Shanghai Jiao Tong Univ.
Organizer: Peterseim, Daniel Universität Bonn
Organizer: Jiang, Lijian Hunan Univ.
Organizer: Chung, Eric The Chinese Univ. of Hong Kong

Abstract: Problems that transcend a variety of strongly coupled time and length scales are ubiquitous in modern science and engineering such as physics, biology, and materials. Those multiscale problems pose major mathematical challenges in terms of analysis, modeling and simulation. At the same time, advances in the development of multiscale mathematical methods coupled with continually increasing computing power have provided scientist-s with the unprecedented opportunity to study complex behavior and model systems over a wide range of scales.
This minisymposium is aimed at presenting the state-of-the-art in multiscale modeling, simulation and analysis for the applications in science and engineering. It will focus on the developments and challenges in numerical multiscale methods and multiscale model reduction methods. The lectures will cover the following subjects: - Numerical homogenization methods, e.g. Generalized FEM, MsFEM, FEM-HMM, DG methods, Partition of Unity methods, multiscale domain decomposition etc. - Multiscale model reduction method-

s for stochastic systems, such as stochastic PDEs and random materials. - Multiscale methods for problems arising in composite materials and heterogeneous porous media. - Multiscale methods for eigenvalue problems, high frequency waves, and multiscale hyperbolic PDEs. - Multiscale modeling in various applications such as reservoir performance prediction, bio-motility, chemical vapor infiltration, etc.

▶ MS-Th-BC-29-1 10:00–10:30

Eliminating the Pollution Effect in Helmholtz Problems by Local Subscale Correction

Peterseim, Daniel Universität Bonn

Abstract: We introduce a new Petrov-Galerkin multiscale method for the numerical approximation of the Helmholtz equation with large wave number k in bounded domains. The discrete spaces are generated from standard mesh-based finite elements by local subscale corrections in the spirit of numerical homogenization. If the mesh size H and the oversampling parameter l are such that Hk and log(k)/l fall below some generic constants, the method is stable and accute; pollution effects are eliminated.

▶ MS-Th-BC-29-2 10:30–11:00

Fast Multiscale Gaussian Wavepacket Transforms and Multiscale Gaussian Beams for Wave Equations

Qian, Jianliang Michigan State Univ.

Abstract: We develop new multiscale Gaussian beam methods for initial boundary value problems of wave equations in the high frequency regime. The starting tools are fast multiscale Gaussian wavepacket transforms and Gaussian beams. 2-D and 3-D examples demonstrate the performance of the new method.

▶ MS-Th-BC-29-3 11:00–11:30

Multi-scale Methods for Elliptic Equations with Highly Oscillatory Periodic Diffusion Coefficients and Stochastic Potentials

Jing, Wenjia Univ. of Chicago

Abstract: We study the limiting distribution of the random part of the homogenization error of elliptic equations with highly oscillatory periodic diffusion coefficients and highly oscillatory random potentials. We characterize this distribution theoretically, and then study finite element based multi-scale methods for such equations, and emphasize their performances not only in capturing the homogenization limit, but also in capturing this limiting fluctuations.

▶ MS-Th-BC-29-4 11:30–12:00

Multiscale Approximations for Mixed Finite Element Methods

Henning, Patrick Univ. of Muenster

Abstract: We propose and analyze a mixed finite element method for solving elliptic multiscale problems. The method is based on a localized orthogonal decomposition (LOD) of Raviart-Thomas finite element spaces. It requires to solve local problems in small patches. These computations can be perfectly parallelized and are cheap to perform. Using these local results, we construct a low dimensional "generalized" mixed finite element space for solving the original saddle point problem in an efficient way.

MS-Th-BC-30 10:00–12:00 VIP2-2

Numerical approaches in optimization with PDE constraints: recent progress and future challenges - Part III of VII

For Part 1, see MS-We-D-30
For Part 2, see MS-We-E-30
For Part 4, see MS-Th-D-30
For Part 5, see MS-Th-E-30
For Part 6, see MS-Fr-D-30
For Part 7, see MS-Fr-E-30

Organizer: Yan, Ningning Chinese Acad. of Sci.
Organizer: Hinze, Michael Universität Hamburg

Abstract: The numerical treatment of optimization problems with PDE constraints is a very active field of mathematical research with great importance for many practical applications. To achieve further progress in this field of research, the development of tailored discretization techniques, adaptive approaches, and model order reduction methods has to be intertwined with the design of structure exploiting optimization algorithms in function space.
This minisymposium covers mathematical research in PDE constrained optimization ranging from numerical analysis and adaptive concepts over algorithm design to the tailored treatment of optimization applications with PDE constraints. It thereby forms a platform and fair for the exchange of ideas among young researchers and leading experts in the field, and for fostering and extending international collaborations between research groups in the field.

▶ MS-Th-BC-30-1 10:00–10:30

Analysis and Optimal Control of A Gradient Enhanced Damage Model

Susu, Livia TU Dortmund
Meyer, Christian TU Dortmund

Abstract: The talk is concerned with a damage model including two damage variables, a local and a non-local one, which are coupled through a penalty term in the free energy functional. After introducing the precise model, we prove existence and uniqueness for the viscous regularization thereof. Moreover, we rigorously study the limit for penalization parameter tending to infinity. It turns out that in the limit both damage variables coincide and satisfy a classical viscous damage.

▶ MS-Th-BC-30-2 10:30–11:00

Reduced-order Control Design for the Monodomain Equations

Breiten, Tobias Karl-Franzens-Universität Graz
Kunisch, Karl Univ. of Graz

Abstract: The monodomain equations represent a reasonably accurate model for the electric potential of the human heart. The PDE-ODE structure of the linearized model leads to a system that is not null controllable but that can still be stabilized by finite dimensional controllers. This allows for constructing the controller based on model reduction techniques. While the reduced model is obtained from the linearized system, it is shown that it locally stabilizes the nonlinear system as well.

▶ MS-Th-BC-30-3 11:00–11:30

Computational Optimal Control of the Current Profile Evolution in Fusion Plasmas

Xu, Chao Zhejiang Univ.

Abstract: The central task of current profile control during the ramp-up phase of a tokamak discharge is to find the actuator trajectories that are necessary to achieve certain desired current profile at some time between the end of the ramp-up phase and early stage of the flattop phase. We solve open loop optimal control problems with respect to the magnetic diffusion PDE models the dynamics of the poloidal magnetic flux profile of fusion plasma in tokamaks.

▶ MS-Th-BC-30-4 11:30–12:00

Liquidity Adjusted Futures Pricing Model

Zhang, Yongmin Univ. of Nottingham Ningbo China

Abstract: This paper proposes a new model introducing liquidity risk factor into the futures pricing model. Empirically, we find that the liquidity adjusted futures pricing model is more accurate than the classical model and the improvement rate is around 30%. More importantly, unlike the existing model, our model can be applied in both spot price predictions and futures price predictions purely based on historical market information. The model does an impressive work since all prediction errors are less than 1.6%, which is well below the historical oil return volatility. As a result, the model is likely useful in studies of asset pricing with liquidity risk but also has price forecasting research implications. We also discover a coupling effect of liquidity and maturity through a theoretical study on solutions of partial differential equations with various inputs of liquidity levels and maturities. Our two dimensional PDE models can be extended to solve American type derivative products with liquidity adjustment.

MS-Th-BC-31 10:00–12:00 405

Integration, Approximation and Discrepancy - Part III of III

For Part 1, see MS-We-D-31
For Part 2, see MS-We-E-31

Organizer: Ullrich, Mario Johannes Kepler Univ.
Organizer: Gnewuch, Michael Christian-Albrechts-Universität zu Kiel

Abstract: Numerical methods for high dimensional integration and approximation play a crucial role in a number of applications. This session brings together experts from the areas of integration, approximation, discrepancy theory, information-based complexity, potential theory, and partial differential equations (PDE) to discuss numerical methods for these types of problems. In this context, well distributed point sets are important. The generation of good point sets for various problems as well as bounds for their discrepancy and integration error will be covered in the minisymposium. Particular emphasis is given to the dependence of the results on the dimension. Approximation of functions is intimately related with the integration problem and the proposed minisymposium should stimulate the exchange between both communities.

▶ MS-Th-BC-31-1 10:00–10:30

Fully Discrete Needlet Approximation on the Sphere

Wang, Yuguang Univ. of New South Wales

Abstract: Spherical needlets provide a multiscale decomposition of real square integrable functions on the unit sphere. The original spherical needlet decomposition has its coefficients defined by inner product integrals. We use an additional quadrature rule to construct a fully discrete version of the original

needlet approximation and prove the convergence error for smooth spherical functions. The theory is illustrated numerically by the approximation for a function of known smoothness, using symmetric spherical designs.

▶MS-Th-BC-31-2 10:30–11:00
Best Restriction Approximation of Sobolev Classes by Entire Functions of Exponential Type
Ling, Bo — Xidian Univ.

Abstract: We consider the best restriction approximation of some generalized Sobolev classes using entire function of exponential type, as well as the relative average width of these classes, and obtain some asymptotic results.

▶MS-Th-BC-31-3 11:00–11:30
Construction of Low-discrepancy Sequence According to An Unnormalized Density
Zhu, Houying — The Univ. of New South Wales
Dick, Josef — The Univ. of New South Wales

Abstract: Generating samples from a probability distribution is a common problem occurring in mathematics, statistics and computer science. For an unnormalized target distribution, we propose sampling methods based on optimization when direct simulation is not possible or expensive. We are interested in the discrepancy properties of point sets constructed this way. It can be shown that these points have the correct distribution and small discrepancy. This is a joint work with Josef Dick.

▶MS-Th-BC-31-4 11:30–12:00
The Sharp Jackson Inequality for L^2 Approximation on the Cylinder
Gu, Yi — Yunnan Univ.

Abstract: We consider Jackson inequality in $L^2(B^d \times \mathbb{T}, W^B_{\kappa,\mu})$, where the weight function $W^B_{\kappa,\mu}(x)$ is defined on the ball B^d and related to reflection group, and obtain the sharp Jackson inequality.

MS-Th-BC-32 10:00–12:00 307A
Structured-mesh methods for interface problems. - Part IV of VIII
For Part 1, see MS-Tu-E-32
For Part 2, see MS-We-D-32
For Part 3, see MS-We-E-32
For Part 5, see MS-Th-D-32
For Part 6, see MS-Th-E-32
For Part 7, see MS-Fr-D-32
For Part 8, see MS-Fr-E-32

Organizer: Chen, Huanzhen — College of Mathematical Sci. Shandong Normal Univ.
Organizer: He, Xiaoming — Missouri Univ. of Sci. & Tech.
Organizer: KWAK, Do Young — Korea Advanced Inst. of Sci. & Tech.
Organizer: Zhang, Xu — Purdue Univ.

Abstract: In many real world applications it is more convenient or efficient to utilize structured meshes for solving different types of interface problems. Since the structured meshes may not fit the non-trivial interfaces, special methods need to be developed to deal with the difficulties arising from the interface problems in order to solve them on these meshes. Therefore, great efforts have been made for solving interface problems and tracing the moving interfaces based on structured meshes in the past decades. This mini-symposium intends to create a forum for researchers from different fields to discuss recent advances on the structured-mesh numerical methods for interface problems and their applications.

▶MS-Th-BC-32-1 10:00–10:30
Adaptive Finite Element Algorithms for Structured-mesh Methods for Interface Problems
Zhang, Shun — City Univ. of Hong Kong

Abstract: In this talk, we will talk about a posteriori error estimates and adaptive algorithms for structured-mesh methods for interface problems. For interface problems, immersed finite elements can handle the un-alignment of interface and computational grids well. On the other hand, such problems often have low regularity near the intersections of interfaces, which need adaptive refinements to handle. We will discuss algorithms combining these two features.

▶MS-Th-BC-32-2 10:30–11:00
Finite Element Method for Stokes Interface Problem.
SANCHEZ-URIBE, MANUEL — Brown Univ.
Guzman, Johnny — Brown Univ.

Abstract: We present higher-order piecewise continuous finite element methods for solving the Stokes interface problem in two dimensions. We develop the method based on corrections added to the standard Stokes variational formulation, allowing us to implement and analyze a variety of finite element spaces. We prove optimal error estimates of the method on general quasi-uniform and shape regular meshes in maximum norms.

▶MS-Th-BC-32-3 11:00–11:30
Computation of the Schroedinger Equation in the Semiclassical Regime on Unbounded Domain
Jiwei, Zhang — Beijing Computational Sci. Research Center
YANG, XU — Univ. of California, Santa Barbara

Abstract: The study of this paper is two-fold: (1) local absorbing boundary conditions (ABCs) are generlized to compute the Schroedinger equation on unbounded domain; then (2) a new asymptotic method based on the frozen Gaussian approximation. The ABCs are dealt that all effects of the Gaussian functions which contribute to the outgoing waves will be eliminated by stopping Hamiltonian flow of their centers when they get out of the domain of interest.

▶MS-Th-BC-32-4 11:30–12:00
Immersed Finite Element Methods for Interface Problems
Lin, Tao — Mathematics
He, Xiaoming — Missouri Univ. of Sci. & Tech.

Abstract: This is a brief introduction to immersed finite element (IFE) methods which can use interface-independent (Cartesian) meshes to solve interface problems even for interfaces with non-trivial geometries. Starting with basic ideas of IFE methods, we will discuss fundamental analysis for IFE methods, highlighting some essential differences between FE and IFE methods. We will then illustrate features of IFE methods with applications. We will conclude with a list of future research topics for IFE methods.

MS-Th-BC-33 10:00–12:00 406
Mathematical Modelling, Analysis and Computation for Bose-Einstein condensation - Part III of III
For Part 1, see MS-We-D-33
For Part 2, see MS-We-E-33

Organizer: Wang, Hanquan — Yunnan Univ. of Finance & Economics

Abstract: Recently, modeling and simulation of Bose-Einstein condensates (BEC) at zero temperature are one of most interesting research topics in physics as well as applied mathematics. At such low temperature, different kinds of BEC can be modeled by the famous Gross-Pitaevskii equation (GPE) or coupled GPEs or nonlocal GPE(s). How to analyze and solve the GPE(s) for understanding the physics of BEC is interested by mathematicians and physicists . In this minisymposium, we aim to discuss the mathematical properties of these nonlinear Schrodinger type models, find solutions to those models both analytically and numerically, do numerical analysis for efficient numerical methods, and show their applications into simulation of BEC and related physics. This minisymposium can be helpful to design efficient numerical methods for nonlinear Schrodinger type equation. It can be also helpful for applied mathematician to share their latest research work with physicists who are working on research of BEC and related physics.

▶MS-Th-BC-33-1 10:00–10:30
On Multichannel Solutions of Nonlinear Schrödinger Equations: Algorithm, Analysis and Numerical Explorations
Zhao, Xiaofei — National Univ. of Singapore

Abstract: We apply the method of modulation equations to numerically solve the NLS with multichannel dynamics, given by a trapped localized state and radiation. This approach employs the modulation theory of Soffer-Weinstein, which gives a system of ODE's coupled to the radiation term, which is valid for all times. We comment on the differences of this method from the well-known method of collective coordinates.

▶MS-Th-BC-33-2 10:30–11:00
Numerical and Asymptotic Results for Modified GP Equation
Ruan, Xinran — National Univ. of Singpore

Abstract: The Gross-Pitaevskii(GP) equation plays a central role in the understanding of BEC. The two-body nonlinear term is parameterized by the s-wave scattering length. However, higher order corrections are needed for better approximations in some cases. With the correction, we get the modified GP model: $i\partial_t\psi = -\frac{1}{2}\Delta\psi + V(x)\psi + \beta|\psi|^2\psi - \delta\Delta(|\psi|^2)\psi$ In my talk, I will discuss some numerical and asymptotic results for the model. Two special kinds of potentials are considered. I will also study the dimension reduction problem.

▶CP-Th-BC-33-3 11:00–11:20
Bifurcation Diagrams of Positive Solutions of A Prescribed Mean Curvature Problem

Hung, Kuo-Chih National Chin-Yi Univ. of Tech.

Abstract: We study global bifurcation diagrams and exact multiplicity of positive solutions for the one-dimensional prescribed mean curvature problem arising in Microelectromechanical systems (MEMS).

▶ CP-Th-BC-33-4 11:20–11:40

Simulations of Particle Structuring Driven by Electric Fields

Hu, Yi Northwestern Univ.
Vlahovska, Petia Brown Univ.
Miksis, Michael Northwestern Univ.

Abstract: Recent experiments (Ouriemi & Vlahovska, 2014) show intriguing surface patterns when a uniform electric field is applied to a droplet covered with colloidal particles. Depending on the particle properties and the electrical field intensity, particles organize into an equatorial belt, pole-to-pole chains, or dynamic vortices. Here we present simulations of the collective particle dynamics, which account for electrohydrodynamic flow and dipole-dipole interactions. Our results provide insight into the various particle assembles observed in the experiments.

MS-Th-BC-34 10:00–12:00 112

Advances in optimal experimental design

Organizer: Huan, Xun Massachusetts Inst. of Tech.
Organizer: Long, Quan King Abdullah Univ. of Sci. & Tech.
Organizer: Marzouk, Youssef Massachusetts Inst. of Tech.
Organizer: TEMPONE, RAUL KING ABDULLAH Univ. OF Sci. & Tech.

Abstract: The challenge of optimal information gathering-for the purpose of inference, prediction, design, or control-pervades fields ranging from geophysics to chemical engineering and beyond. These questions can be formalized through the framework of optimal experimental design. Yet extending classical design methodologies to tackle problems of greater scale and dynamic complexity, and to find optimal sequential designs, requires new algorithms and formulations. This minisymposium will gather a wide variety of approaches focusing on design for large-scale inverse problems and nonlinear models, design in the presence of model error, and the approximation and optimization of information metrics. Relevant techniques include surrogate modeling, model reduction, sparse quadrature, asymptotic approximations, PDE-constrained optimization, stochastic optimization, and approximate dynamic programming. We invite contributions focused on methodology and motivated by engineering and science applications.

▶ MS-Th-BC-34-1 10:00–10:30

Computational Methods for Parameter Estimation and Optimal Experimental Design

Chung, Matthias Virginia Tech
Krueger, Justin Virginia Tech

Abstract: Experimentalists face the dilemma of choosing between the accuracy and costs of an experiment. Optimization methods form the basic computational tools to address fundamental questions of optimal experimental design. Driven by its application, optimal experimental design leads to challenging Bayes risk minimization problems. We address challenges such as ill-posedness of the parameter estimation problem and large scales of ODE systems. We present a design framework for dynamical systems and illustrate its performance on biological models.

▶ MS-Th-BC-34-2 10:30–11:00

Optimal Sequential Experimental Design Using Dynamic Programming and Transport Maps

Huan, Xun Massachusetts Inst. of Tech.
Marzouk, Youssef Massachusetts Inst. of Tech.

Abstract: How to select a sequence of experiments that maximizes value of experimental data? We formulate this optimal sequential experimental design problem by maximizing expected information gain under continuous parameter, design, and observation spaces using dynamic programming. We solve the problem numerically by using transport maps to represent posteriors and enable fast approximate Bayesian inference, and adaptive one-step look-ahead method to find the optimal policy. Results are demonstrated on sequential sensing problem for source inversion.

▶ MS-Th-BC-34-3 11:00–11:30

Scalable Methods for Optimal Experimental Design and Optimal Control for Systems Governed by PDEs with Uncertain Parameters

Alexanderian, Alen The Univ. of Texas at Austin

Abstract: We formulate an A-optimal experimental design criterion for infinite-dimensional nonlinear Bayesian inverse problems. Our method aims to minimize the average variance of a Gaussian approximation to posterior law of inversion parameters by solving a bi-level PDE-constrained optimization problem. I will also discuss risk-averse optimization under uncertainty with application to optimal control of PDEs with uncertain parameter fields. We use numerical results for a porous medium flow problem with uncertain permeability to illustrate the methods.

▶ MS-Th-BC-34-4 11:30–12:00

Fast Bayesian Optimal Experimental Design and Its Applications

Long, Quan King Abdullah Univ. of Sci. & Tech.

Abstract: We analyze Laplace method in the context of optimal Bayesian experimental design and extend this method from the classical scenario, where a single dominant mode of the parameters can be completely-determined by the experiment, to the scenarios where a non-informative parametric manifold exists. While Laplace method requires a concentration of measure, multi-level Monte Carlo method can be used to tackle the problem when there is a lack of measure concentration.

MS-Th-BC-35 10:00–12:00 408

Monte Carlo Methods for Solving Partial Differential Equations - Part III of III

For Part 1, see MS-We-D-35
For Part 2, see MS-We-E-35

Organizer: Mascagni, Michael Florida State Univ. CS Dept
Organizer: Cai, Wei Univ. of North Carolina at Charlotte

Abstract: Monte Carlo Methods (MCMs) have been used extensively in diverse computational applications in the sciences, engineering, and finance. This is due to their natural parallelism, data parsimony and locality, and their capability to tackle high dimension problems that are otherwise intractable. In this mini-symposium, we will present several talks that study the use of MCMs to solve partial differential equations (PDEs). These include using the Feynman-Kac formula to develop MCMs for PDEs, using polynomial chaos for solving stochastic PDEs, Monte Carlo linear solvers that arise from PDEs, algorithmic issues of the walk-on-sphere method, fault tolerance in multilevel MCMs, stability analysis of MCMs for mixed type PDEs, estimation of diffusion process sensitivities, as well as the application of MCMs in capacitance calculation of microchip ICs and multi-asset finance options.

▶ MS-Th-BC-35-1 10:00–10:30

A Highly Scalable Communication-free Domain Decomposition BIE-WOS (Boundary Integral Equation-Walk on Spheres) Method for Laplace Equations

Yan, Changhao Fudan Univ.
Cai, Wei Univ. of North Carolina at Charlotte

Abstract: A hybrid approach for solving Laplace equation in 3-D domains is presented. It bases on a local method for the Dirichlet-Neumann (DtN) mapping of a Laplace equation by combining a deterministic boundary integral equation and the probabilistic Feynman – Kac formula for solutions of elliptic partial differential equations. This hybridization produces a parallel algorithm where bulk of the computation has no data communication between processors. Numerical results show the robustness and parallel performance of the proposed method.

▶ MS-Th-BC-35-2 10:30–11:00

Stochastic Collocation Method for Solving PDEs with Random Coefficients

Shalimova, Irina ICM&MG SB RAS
Sabelfeld, Karl Inst. of computational mathematics & mathematical geophysics, Russian Acad. of Sci.

Abstract: We develop a technique based on a polynomial chaos expansion for solving Darcy equation in stochastic porous media. For the input hydraulic conductivity random field we use Karhunen-Loeve expansion. To determine the coefficients of the polynomial chaos expansion we use probabilistic collocation method. We present the numerical results for different Eulerian and Lagrangian statistical characteristics of the flow calculated by both Monte Carlo and probabilistic collocation methods.

▶ MS-Th-BC-35-3 11:00–11:30

Stability Issues in MC Integration of SDEs

Petersen, Wes ETH Zurich

Abstract: One often encounters difficulties in Monte-Carlo simulations of complex stochastic processes. For example, sometimes hyperbolic components appear in a formal diffusion matrix. In this talk, two issues will be discussed: (1) keeping oscillating functionals of complex processes on stable orbits, and (2) filtering away unstable hyperbolic components. In the first situation, we will examine simple complex linear oscillators. The second case will be a coherent states representation for the Bose-Einstein Hamiltonian treated as quantum noise.

MS-Th-BC-36 10:00–12:00 409
Boundary and interior layers: analysis and simulations - Part II of II
For Part 1, see MS-We-E-36

Organizer: Shih, Yin-Tzer National Chung Hsing Univ.
Organizer: HUANG, ZHONGYI Tsinghua Univ.

Abstract: Recently there are several computational techniques have been successively implemented in dealing with non-smooth solutions for modeling of many physical phenomena such as fluid flows, semiconductor device simulation or in financial models etc. The mini-symposium will be concerned with in cases of where the solution contains deep gradients exhibiting the boundary layers or interior layers. For such problems, standard discretization methods such as a Galerkin finite element method or classical finite difference methods yield inaccurate oscillatory solutions. These layers are characterized by rapid transitions in the solution, and thus are very difficult to capture the solutions accurately without using a large number of unknowns or using fitted meshes in the layer regions. The aim of this minisymposium is to exchange ideas and explore novel techniques for resolving the boundary or interior layers while simulating the non-smooth model problems.

▶MS-Th-BC-36-1 10:00–10:30
Some DG Methods for Singularly Perturbed Volterra Integro-Differential Equations
Xie, Ziqing Hunan Normal Univ.

Abstract: To our knowledge, there are much less works on the uniform convergence of numerical methods for singularly perturbed Volterra integro-differential equations (VIDES) compared with those on singularly perturbed differential equations.. In this talk, some DG methods are implemented for solving singularly perturbed Volterra VIDES. Some interesting phenomenon are observed from our numerical experiments and then verified theoretically. More importantly, combined with some local grid-refinement strategies, the uniform convergence or super-convergence of our approaches are rigorously,

▶MS-Th-BC-36-2 10:30–11:00
Jump Discontinuity of Compressible Viscous Flows: Existence and Regularity
KWEON, JAE RYONG Pohang Univ. of Sci. & Tech.

Abstract: I will talk about existence and regularity of compressible viscous Navier-Stokes flows on polygonal domains. Also we introduce an interior layer which is a streamline emanating from a grazing vertex. The density function has a jump across the curve. The Rankine-Hugoniot jump condition is derived.

▶MS-Th-BC-36-3 11:00–11:30
A Cartesian Grid Method for A Singularly Perturbed Reaction-diffusion System from Computational Cardiology
XinDan, Gao Department of Mathematics, ShangHai Jiao Tong Univ.
Ying, Wenjun Shanghai Jiao Tong Univ.

Abstract: This talk presents a Cartesian grid-based boundary integral method for a singularly perturbed reaction-diffusion system on complex domains, which arises from computer modelling of electrical dynamics in the heart. The method avoids generation of unstructured body-fitted grids for the complex domain and takes good advantages of the well-conditioning of the reformulated Fredholm boundary integral equation of the second kind as well as fast elliptic solvers on Cartesian grids. This is joint work with Wenjun Ying.

▶MS-Th-BC-36-4 11:30–12:00
A Numerical Far Field Boundary Condition for Anisotropic Laplace Operators
Wang, Wei-Cheng Department of Mathematics, National TsingHua Univ.

Abstract: We propose a numerical far field boundary condition for anisotropic Laplace operator on arbitrary star-shaped domains. With a proper change of variable in the radial direction, the far field equation reduces to a quadratic eigenvalue problem on the boundary of the domain. Since the dimension of the eigenvalue problem is significantly lower than the original problem, the first few eigenfunctions provides an accurate and efficient approximation of the exterior solution. Numerical examples are provided to validate the proposed approach.

MS-Th-BC-37 10:00–12:00 301B
Control for multi-agent systems in engineering

Organizer: Sun, Changyin Southeast Univ.

Abstract: This minisymposium presents control on multi-agent system (MAS) capabilities in engineering applications. It describes essential concepts of multi-agent systems that are related to the control systems and presents an overview on the most important control engineering issues which MAS can be explored. We will present some results of the localization/navigation methodologies for micro UAV in GPS-denied environment. Also, fault tolerant control for interconnected systems with aerospace applications is also discussed. Some comments and new perspectives for design and implementation of agent-based control systems are presented.

▶MS-Th-BC-37-1 10:00–10:30
A PDE-based Approach to Consensus Analysis and Control Design of Multi-Agents Systems
Jun-Wei, Wang Univ. of Sci. & Tech. Beijing
Sun, Changyin Southeast Univ.

Abstract: This presentation first introduces the control problem of distributed parameter systems and its application background. Some certain unique challenges, like non-collocated, collocated control design (assuring the separate locations for sensors and actuators) and optimal actuator/sensor location, are also discussed in this presentation. Then, this presentation reviews the recent progresses in this area. Some open areas of research and possible directions are also outlined. Finally, the authors introduce their recent work which provides a PDE-based approach to formation control design for a swarm of vehicles.

▶MS-Th-BC-37-2 10:30–11:00
Localization and Nonlinear Control for Small Rotary Unmanned Aerial Vehicles
Xian, Bin xbin@tju.edu.cn

Abstract: Comparing with fixed wing unmanned aerial vehicles, the miniature rotary unmanned aerial vehicle has a simpler and compacter mechanical configuration, and is able to perform more agile flight tasks such as vertical taking off and landing in a small and restrained environment. But due to the limited payload ability, the miniature rotary unmanned aerial vehicle can not take the traditional on-board sensor for fight state measurement, and it is very sensitive to external disturbances due to its light body frame. Thus, the navigation and control of this class of unmanned aerial vehicle is a challenging tasks. This report will briefly introduce some results we have achieved, such as (1) autonomous localization and control for a very small quadrotor unmanned aerial vehicle (2) development for a low-cost hardware in loop testbed for miniature unmanned aerial vehicle (3) nonlinear adaptive control design for miniature quadrotor unmanned aerial vehicle

▶MS-Th-BC-37-3 11:00–11:30
Fault Tolerant Control for Interconnected Systems with Aerospace Applications
Yang, Hao Nanjing Univ. of Aeronautics & Astronautics

Abstract: The report aims to present some fault tolerant control methods for interconnected systems with physical and/or networking connections, their applications to aircraft and spacecraft control are also discussed.

MS-Th-BC-38 10:00–12:00 302A
Complex System Control and Applications I

Organizer: TCCT Technical Committee on Control Theory, CAA

Abstract: It's arguable that complex systems have been studied for thousands of years, but only after the discovery of chaos in deterministic systems did people realize that the "complexity" of complex systems is rooted into the fundamental laws of physics. Some features, such as cascading failures, coupling, nonlinearity and emergent phenomena, make the analysis and control of complex systems theoretically challenging. This mini-symposium aim to present some recent theoretical progresses in several brunches of complex systems analysis and some further applications: 1) Study of haze generation and diffusion with cellular automata method; 2) Event-trigger control for systems with saturation nonlinearity; 3) The accurate identification under set-valued data and adaptive control of set-valued systems; 4) Stochastic extremum seeking for discrete-time linear systems.

▶MS-Th-BC-38-1 10:00–10:30
The Simulation of Haze Generation and Diffusion Within Beijing Based on Cellular Automata
Deng, Fang Beijing Inst. of Tech.
Ma, Liqiu Beijing Inst. of Tech.
Jie, Chen Beijing Inst. of Tech.

Abstract: Cellular automata can imitate complex discrete model just through repeating simple action. In particular, for the dissemination and diffusion problems, it provides a quick and easy way. In this paper, cellular automata model is utilized to simulate the formation and diffusion of haze. The results demonstrate that without large amount of environmental data and super-computing power, cellular automata model can still simulate pollutant dispersion.

▶MS-Th-BC-38-2 10:30–11:00
Event-trigger Control for Systems with Saturation Nonlinearity

Zuo, Zhiqiang Tianjin Univ.

Abstract: This talk discusses the event-triggered control for systems in the presence of saturation nonlinearities. The state/output feedback controllers and the anti-windup scheme for saturated systems using event-triggered strategy under different trigger conditions are presented. It is shown that the domain of attraction has close relationship to trigger conditions and there is a tradeoff between the size of domain of attraction and the communication burden. Some future research directions are finally discussed.

▶ MS-Th-BC-38-3 11:00–11:30

Identification and Adaptive Control under Set-Valued Data

Zhao, Yanlong Acad. of Mathematics & Sys. Sci., CAS

Abstract: This talk introduces the accurate identification and control under set-valued data, which is a type of inaccurate data emerged with the development of industrialization, informatization and biological techniques. The main difficulty is that the classic methods don't work since the information of set-valued observation is only whether the measurement is in some sets. This talk contains a series of work on the identification and adaptive control of set-valued systems.

MS-Th-BC-39 10:00–12:00 302B

Extremum Seeking and its Applications

Organizer: Liu, Shu-Jun Sichuan Univ.

Abstract: Extremum seeking (ES)is a real-time non-model based optimization approach and also a method of adaptive control. In recent years, many great progresses have been made in both theoretical developmentof extremum seeking and its engineering applications. The minisymposium aims to present recent advances in the ES, including 1) fast extremum seeking in dynamic systems; 2) improvement of extremum seeking control; 3) source seeking scheme via discrete-time extremum seeking ; 4) applications of extremum seeking in non-cooperative games.

▶ MS-Th-BC-39-1 10:00–10:30

Fast Extremum Seeking in Dynamic Systems

Manzie, Christopher Univ. of Melbourne

Abstract: In this presentation, extensions to extremum seeking that enable faster convergence to the steady state optimum performance of dynamic systems will be developed. Partial system information, which is reasonable in the context of most engineering applications, will be used to lessen the time scale separation requirements of the components of traditional extremum schemes. The theoretical results will be supported by simulation and application examples.

▶ MS-Th-BC-39-2 10:30–11:00

The Removal of Time-scale Separation in Extremum-seeking Control

Guay, Martin Queen's Univ.

Abstract: In this talk, we will discuss a new approach to address the removal of time-scale separation in the design of extremum-seeking controllers for unknown non-linear dynamical systems. A proportional integral extremum seeking controller design approach is proposed to minimize the impacts of time-separation on the transient performance of control systems. The application of the proportional-integral approach to feedback stabilization and observer design will be discussed.,

▶ MS-Th-BC-39-3 11:00–11:30

Multi-agent Source Seeking via Discrete-time Extremumseeking Control

Ying, Tan The Univeristy of Melbourne

Abstract: Recent developments in extremum seeking theory have established a general framework for the methodology, although the specific implementations, particularly in the context of multi-agent systems, have not been demonstrated. In this work, a group of sensor-enabled vehicles is used in the context of the extremum seeking problem using both local and global optimisation algorithms to locate the extremum of an unknown scalar field distribution.

▶ MS-Th-BC-39-4 11:30–12:00

Discrete-time Stochastic Extremum Seeking and Its Applications

Liu, Shu-Jun Sichuan Univ.

Abstract: We employ our recently developed discrete-time stochastic averaging theorems and stochastic extremum seeking to iteratively optimize open-loop control sequences for unknown but reachable discrete-time linear systems with a scalar input and without known system dimension, for a cost that is quadratic in the measurable output and the input.

MS-Th-BC-40 10:00–12:30 303A

Modeling, Analysis, and Control for Distributed Parameter Systems

Organizer: Yao, Pengfei AMSS, Chinese Acad. of Sci.

Abstract: Distributed parameter systems are systems whose state space is infinite-dimensional. Modeling, analysis, and control of distributed parameter systems are theoretically challenging and technically important in real-world applications. The minisymposium aim to present the state-of-the-art progress in modeling, analysis, and control of several distributed parameter systems, including 1) modeling for cavitation of membrane shells ; 2) boundary proportional and integral control/regulation of a fluid flow system governed by hyperbolic partial differential equations;3) maximum regularity principle for conservative evolutionary partial differential Equations; 4) dissipativity of switched systems using multiple storage functions.

▶ MS-Th-BC-40-1 10:00–10:30

Radial Deformations and Cavitation in Riemannian Manifolds with Applications to Nonlinear Membrane Shells

Yao, Pengfei AMSS, Chinese Acad. of Sci.

Abstract: This study is a geometric version of Ball's work, Philos. Trans. Roy. Soc. London Ser. A 306 (1982), no. 1496, 557-611. Radial deformations in Riemannian manifolds are singular solutions to some nonlinear equations given by constitutive functions and radial curvatures. A geodesic spherical cavity forms at the center of a geodesic ball in tension by means of given surface tractions or displacements. The existence of such solutions depends on the growth properties of the constitutive functions and the radial curvatures. Some close relationships are shown among radial curvature, the constitutive functions, and the behavior of bifurcation of a singular solution from a trivial solution. In the incompressible case the bifurcation depends on the local properties of the radial curvature near the geodesic ball center but the bifurcation in the compressible case is determined by the global properties of the radial curvatures. A cavity forms at the center of a membrane shell of isotropic material placed in tension by means of given boundary tractions or displacements when the Riemannian manifold under question is a surface of IR3 with the induced metric.

▶ MS-Th-BC-40-2 10:30–11:00

Boundary PI Control and Regulation of A Fluid Flow System Governed by Hyperbolic Partial Differential Equations

Xu, Chengzhong Univ. of Lyon

Abstract: The paper is concerned with the control of a fluid flow system governed by nonlinear hyperbolic partial differential equations. We study local stability of spatially heterogeneous equilibrium states by using Lyapunov approach. We present a strict Lyapunov function for time-invariant hyperbolic systems and establish a necessary and sufficient condition for exponential stability of null equilibrium state. A systematic design of proportional and integral controllers is proposed for the flow system based on the linearized model.

▶ MS-Th-BC-40-3 11:00–11:30

Stochastic Consensus of Multi-Agent Systems with Communication Delays and Multiplicative Noises

Zong, Xiaofeng Acad. of Mathematics & Sys. Sci., Chinese Acad. of Sci.

Abstract: Time delay and noise are commonly encountered in the communication between agents. There is an extensive literature on the stochastic consensus of multi-agent systems with additive noises. However, little is known about the case with communication delays and multiplicative noises. In this report, mean square and almost sure average-consensus of multi-agent systems with communication delays and multiplicative noises are examined, and the positive effect of the noises on the almost sure average-consensus is also revealed.

▶ MS-Th-BC-40-4 11:30–12:00

Analysis on Collective Motion of Flocks

Ge, Chen Chinese Acad. of Sci.

Abstract: A central issue of complex system research is to understand how local interactions among the elements lead to collective behavior of the whole system. To study this problem we consider some self-propelled particle systems and develop some new mathematical tools. Using our methods we get the smallest possible interaction radius for consensus, and show the small noise may diversify collective motion of flocks, such as turn,vortex, bifurcation and merger.

▶ MS-Th-BC-40-5 12:00–12:30

Maximum Regularity Principle for Evolutionary Partial Differential Equations

Zhang, Bingyu Univ. of Cincinnati

Abstract: Evolutionary equations may possess various certain "hidden" regularities and various smoothing properties such dissipative smoothing, dispersive smoothing, ect., which play important roles in analysis and control of evolutionary equations. Naturally one may wonder 1) are there any regularities hidden and 2) where to look for them if there are any? In this talk, a

Maximum Regularity Principle will be proposed to understand where those " hidden regularities" come from and how to ﬁnd them.

MS-Th-BC-41 10:00–12:00 303B
Advanced Control Theory of Complex Systems
Organizer: TCCT Technical Committee on Control Theory, CAA

Abstract: Complex systems are systems formed out of many components whose behavior is emergent, which is, the behavior of the systems cannot be simply inferred from the behavior of their components. The complex nature makes the advanced control of the systems theoretically challenging and technically important in latest control research. The minisymposium aim to reveal the recent progress in advanced control research of several classes of complex systems, including 1) study of equilibrium state control theory; 2) examination for big data in industrial processes analysis and its applications; 3) analysis for uncertain negative-imaginary systems and its applications; 4) a control-theoretic study of iteratively solving nonlinear equations.

▶ MS-Th-BC-41-1 10:00–10:30
Equilibrium State Control Theory
Wang, Qinglin Beijing Inst. of Tech.

Abstract: The Equilibrium State Control Theory is a novel control method for control systems, which considers that the indirect control to state and output can be realized when the movement of equilibrium state is controlled. This idea gives new solutions for the steady-state and transient performance in the state space, and also can be applied in the feedback linearization for the nonlinear time-varying systems. It provides a new point of view for the control systems design.

▶ MS-Th-BC-41-2 10:30–11:00
Fault Detection Using Knowledge
Yingwei, Zhang Northeastern Univ

Abstract: In this paper, a new fault diagnosis method for industrial process is proposed. Knowledge learning is proposed to build the mathematical model and train the offline data. For process monitoring and fault detection, experience is quite important. In this paper, few experience data is used to be labeled data by experts for extracting knowledge, and online process data can be monitored by using the knowledge.

▶ MS-Th-BC-41-3 11:00–11:30
Analysis for Uncertain Negagtive-imaginary Systems and Its Applications
Song, Zhuoyue Beijing Inst. of Techonolgy

Abstract: Negative-imaginary systems have important engineering applications, for example, in lightly damped flexible structures with collocated position sensors and force actuators. In this talk, robustness analysis and controller synthesis methods for uncertain negative-imaginary systems are explored. Some preliminary results about engineering applications of negative-imaginary systems will also be discussed.

▶ MS-Th-BC-41-4 11:30–12:00
A Control-theoretic Study of the Iterative Solutions to Nonlinear Equations
Yang, Ying Peking Univ.
Ding, Steven Univ. of Duisburg Essen

Abstract: In this talk, the fixed point iteration and Newton's methods for iteratively solving nonlinear equations, and the Runge-Kutta methods for sloving nonlinear ordinary differential equations are studied in the control theoretical framework. This work is mainly motivated by the increasing demands on the reliability of integrating the fast converging iterative solutions of nonlinear equations into the embedded control systems.

MS-Th-BC-42 10:00–12:00 301A
Cooperative Control and Multi-Agent Systems III
Organizer: TCCT Technical Committee on Control Theory, CAA

Abstract: Recent advances in sensing, communication and computation technologies have enabled a group of agents, such as robots, to communicate or sense their relative information and to perform tasks in a collaborative fashion. The past few years witnessed rapidly-growing research in cooperative control technology. Multi-agent system (MAS)is a computerized system composed of multiple interacting intelligent agents within an environment. Multi-agent systems can be used to solve problems that are difficult or impossible for an individual agent or a monolithic system to solve. The aim of this minisymposium is to share novel approaches and innovative applications of cooperative control and MAS, including：1)vector space structure of finite games; 2)constrained consensus problem in the presence of communication delays; 3) price analysis of anarchy via smooth games; 4) connectivity preservation control of multiple Euler-lagrange Systems.

▶ MS-Th-BC-42-1 10:00–10:30
Vector Space Structure of Finite Games and Its Applications
Cheng, Daizhan Chinese Acad. of Sci.

Abstract: A vector space structure of the set of finite non-cooperative games is proposed. By providing bases of the subspace of potential games and the subspace of non-strategic games a decomposition is obtained and corresponding algorithms are presented. Its applications to near potential games and networks evolutionary games are discussed.

▶ MS-Th-BC-42-2 10:30–11:00
Certainty Equivalent Principle and Cooperative Control of Multi-agent Systems
Huang, Jie Chinese Univ. of Hong Kong

Abstract: In this talk, we will present a unified framework for handling several cooperative control problems of multi-agent systems such as consensus, formation, flocking, and rendezvous by distributed control laws. Based on the certainty equivalent principle, the distributed control law will be synthesized by combining a purely decentralized control law and a distributed observer. The approach works for linear multi-agent systems and some typical nonlinear multi-agent systems such as multiple Euler-Lagrange systems and multiple rigid-body systems.

▶ MS-Th-BC-42-3 11:00–11:30
Analysis of Price of Anarchy for Dynamic Networks via Smooth Games
Xuehe, Wang Nanyang Technological Univ.
Xie, Lihua Nanyang Technological Univ.
Xiao, Nan SMART

Abstract: The price of anarchy (POA) quantifies the efficiency losses of dynamic networks due to selfish behaviors. We consider a repeated non-cooperative congestion game in which players make their decisions simultaneously. We provide an upper bound of the POA via smoothness argument and prove that the sequence of strategy profiles generated through best response principle with inertia possesses no-regret property. We also give an upper bound of the price of total anarchy.

▶ MS-Th-BC-42-4 11:30–12:00
Constrained Consensus in Unbalanced Networks with Communication Delays
Ren, Wei Univ. of California, Riverside

Abstract: In this talk, a constrained consensus problem is studied for multi-agent systems in unbalanced networks in the presence of communication delays. Here each agent needs to lie in a closed convex constraint set while reaching a consensus. The communication graphs are directed, dynamically changing, and not necessarily balanced and only the union of the graphs is assumed to be strongly connected among each time interval of a certain bounded length.

MS-Th-BC-43 10:00–12:00 VIP4-1
Optimization algorithms and application - Part I of V
For Part 2, see MS-Th-D-43
For Part 3, see MS-Th-E-43
For Part 4, see MS-Fr-D-43
For Part 5, see MS-Fr-E-43

Organizer: Wen, Zaiwen Peking Univ.
Organizer: Yuan, Ya-xiang Inst. of Computational Mathematics & Scientific/Engineering Computing
Organizer: Xia, Yong Beihang Univ.

Abstract: This minisymposium consists 5 sessions. It highlights recent advances in theory, algorithms and applications of mathematical optimization on solving huge problems that are intractable for current methods.

▶ MS-Th-BC-43-1 10:00–10:30
A Proximal Gradient Method for Ensemble Density Functional Theory
Ulbrich, Michael Technische Universitaet Muenchen
Wen, Zaiwen Peking Univ.
Yang, Chao Lawrence Berkeley National Laboratory

Abstract: We present a proximal gradient method to solve the ensemble density functional theory (EDFT) model for electronic structure calculations. The EDFT model is especially well suited for metallic systems. It can be cast as a matrix optimization problem with orthogonality constraints. Our algorithm uses an equivalent reformulation of the EDFT model. Convergence to stationary points is established. Numerical results show that this method can outperform the well-known self-consistent field iteration on many metallic systems.

▶ MS-Th-BC-43-2 10:30–11:00
Methods for Robust PDE-constrained Optimization and Applications
Ulbrich, Stefan TU Darmstadt

Abstract: We consider robust optimization techniques for PDE-constrained

problems involving uncertain parameters. The parameters are assumed to be contained in a given uncertainty set. We propose approximations of the robust counterpart based on linear or quadratic models which leads to a tractable problem. We show applications to the robust optimization of a permanent magnet synchronous motor geometry and to the robust geometry optimization of load-carrying structures governed by the elastodynamic wave equation.

▶ MS-Th-BC-43-3 11:00–11:30

Limited Memory Steepest Descent Methods for Large-Scale Optimization

Curtis, Frank E. Lehigh Univ.

Abstract: We present a limited memory steepest descent method for solving large-scale optimization problems. Building off of well-known Barzilai-Borwein methods and a recently proposed enhancement by Fletcher, our approach is specifically designed to handle challenges that arise when a problem instance may be nonconvex. We also show enhancements of our approach for solving constrained problems within a sequential linearly constrained framework.

▶ MS-Th-BC-43-4 11:30–12:00

A Slightly Changed ADMM for Three Block Separable Convex Optimization

He, Bingsheng Nanjing Univ., China

Abstract: Alternating directions method of multipliers (ADMM) is recognized as a powerful approach for the structured convex optimization with two separable operators. When ADMM is extended directly to a three-block separable convex minimization model, it was recently shown that the convergence is not guaranteed. This talk will give a slightly changed ADMM for solving multi-block separable convex optimization. We show the contraction property, prove the global convergence and establish the worst-case convergence rate of the method.

MS-Th-BC-44 10:00–12:00 VIP2-1

Quantum Computation and Quantum Information

Organizer: Lee, Soojoon Kyung Hee Univ.

Abstract: Quantum information science and technology is a new multidisciplinary research field among mathematics, physics, computer science and engineering. This minisymposium focuses on the research field, in particular quantum computational algorithms, quantum cryptography, quantum information theory and entanglement theory. In this minisymposium, we introduce quantum information science and technology and its related mathematical problems to industrial and applied mathematicians, and present some of recent research results about quantum computation, entanglement theory and quantum information theory.

▶ MS-Th-BC-44-1 10:00–10:30

On the Computational Power of Constant-Depth Exact Quantum Circuits

Takahashi, Yasuhiro NTT Communication Sci. Laboratories

Abstract: We show that constant-depth polynomial-size exact quantum circuits with unbounded fan-out gates, called QNC_f^0 circuits, are powerful. More concretely, we first show that there exists a QNC_f^0 circuit for the OR function. This is an affirmative answer to the question of Hoyer and Spalek. Then, we show that, under a plausible assumption, there exists a classically hard problem that is solvable by a QNC_f^0 circuit with gates for the quantum Fourier transform.

▶ MS-Th-BC-44-2 10:30–11:00

Strong Monogamy of Quantum Entanglement for Multi-party Quantum Systems

Kim, Jeong San Kyung Hee Univ.

Abstract: We provide a strong evidence for strong monogamy inequality of multi-qubit entanglement. We consider a large class of multi-qubit generalized W-class states, and analytically show that the strong monogamy inequality of multi-qubit entanglement is saturated by this class of states. We will also talk about a possible generalization of this result in higher dimensional quantum systems.

▶ MS-Th-BC-44-3 11:00–11:30

Stability Theorem of Depolarizing Channels for the Minimal Output Quantum Renyi Entropies

Bae, Eunok Kyung Hee Univ.

Abstract: The stability theorem of the depolarizing channel in terms of the maximal output purity provides us with various applications in quantum information science, which bridge seemingly disconnected research areas, quantum information theory and quantum complexity theory. In particular, as an application of the stability theorem, the complexity class QMA(k) is equal to QMA(2) for k¿2. In this work, we show that the stability theorem holds for the same channel for the minimal output Renyi entropies.

▶ MS-Th-BC-44-4 11:30–12:00

Concentrated Information of Tripartite Quantum States

Lee, Soojoon Kyung Hee Univ.

Abstract: We introduce the concentrated information of tripartite quantum states. For three parties Alice, Bob, and Charlie, it is defined as the maximal mutual information achievable between Alice and Charlie via local operations and classical communication performed by Charlie and Bob. The gap between classical and quantum concentrated information is proven to be an operational figure of merit for a state merging protocol involving shared mixed states and no distributed entanglement. We derive upper and lower bounds on the concentrated information, and obtain a closed expression for arbitrary pure tripartite states in the asymptotic setting. We show that distillable entanglement, entanglement of assistance, and quantum discord can all be expressed in terms of the concentrated information, revealing the fundamental role of this concept in quantum information theory. (Joint work with Alexander Streltsov and Gerardo Adesso.)

MS-Th-BC-45 10:00–12:00 213A

Optimization Methods for Inverse Problems - Part I of V

For Part 2, see MS-Th-D-45
For Part 3, see MS-Th-E-45
For Part 4, see MS-Fr-D-45
For Part 5, see MS-Fr-E-45

Organizer: LIU, XIN AMSS

Organizer: WANG, YANFEI The Inst. of Geology & Geophysics, CAS

Abstract: In this minisymposium, inverse problems arisen from various areas such as geoscience and petroleum engineering, related optimization models like L1 norm regularization, and advanced optimization methods for solving these models such as first order methods, subspace methods, alternating direction method of multipliers and distributed optimization approaches are discussed.

▶ MS-Th-BC-45-1 10:00–10:30

A Parallel Line Search Subspace Correction Method for Composite Convex Optimization

LIU, XIN AMSS

Abstract: We investigate a parallel subspace correction framework for composite convex optimization. The variables are divided into blocks. At each iteration, the algorithms solve a subproblem on each block simultaneously, construct a search direction by combining their solutions on all blocks, then identify a new point along this direction. Their convergence is established under mild assumptions. Numerical results illustrate that our algorithms can run fast and return solutions no worse than those from the state-of-the-art algorithms.

▶ MS-Th-BC-45-2 10:30–11:00

Numerical Algorithms for Inverse Boundary Value Problems: Stability, Convergence and Applications in Textile Material Design

Xu, Dinghua Zhejiang Sci-Tech Univ.

Abstract: We focus on an inverse problem of reconstructing the left boundary values for parabolic problems (IPLB) given right boundary values. An implicit finite difference (FD) method is firstly employed to solve the IPLB directly, and the stability, convergence rate are derived. A novel forward collocation (FC) method with Chebyshev nodes is presented to deal with the corresponding quasi-solution problems. More importantly, the above numerical methods are applied to solve the industrial problems of textile material design in mathematical way.

▶ MS-Th-BC-45-3 11:00–11:30

Algorithms for Sum Rate Maximization Problems in Wireless Communications

Sun, Cong Beijing Univ. of Posts & Telecommunications

Abstract: Consider the sum rate maximization problem for MIMO relay networks in wireless communications. A new approach is proposed as the lower bound of achievable sum rate. The alternating minimization method is applied. Efficient methods are proposed for the subproblems as nonconvex quadratic constrained quadratic programming and those with orothogonality constraints, where KKT points or optimal solutions are guaranteed. Simulations show the superior performances of our proposed models and algorithms.

▶ MS-Th-BC-45-4 11:30–12:00

A Variational Model for PolSAR Data Speckle Reduction Based on the Wishart Distribution

Zhang, Bo Acad. of Mathematics & Sys. Sci., CAS

Abstract: In this talk, we propose a variational model for polarimetric synthetic aperture radar (PolSAR) data speckle reduction, which is based on the complex Wishart distribution of the covariance or coherency matrix and multichannel total variation (TV) regularization defined for complex-valued matrices. By assuming the TV regularization to be a prior and taking the statistical distribution of the covariance matrix in each resolution element into account, the variational model for PolSAR covariance data speckle suppression, named WisTV-C, is derived from the maximum a posteriori estimate. A similar variational model for PolSAR coherency data speckle reduction, named WisTV-T, is also obtained. As far as we know, this is the first variational model for the whole PolSAR covariance or coherency matrix data despeckling. Since the models are non-convex, a convex relaxation iterative algorithm is designed to solve the variational problem, based on the variable splitting and alternating minimization techniques. Experimental results on both simulated and real PolSAR data demonstrate that the proposed approach notably removes speckles in the extended uniform areas and, meanwhile, better preserves the spatial resolution, the details such as edges and point scatterers, and the polarimetric scattering characteristics, compared with other methods. This is a joint work with X Nie and H Qiao.

MS-Th-BC-46 10:00–12:00 306B

Inverse Problems for Image Reconstruction and Processing - Part III of IV

For Part 1, see MS-We-D-46
For Part 2, see MS-We-E-46
For Part 4, see MS-Th-D-46

Organizer: Wei, Suhua — Inst. of Applied Physics & Computational Mathematics
Organizer: Nikolova, Mila — CMLA, CNRS - ENS Cachan
Organizer: Tai, Xue-Cheng — Department of Mathematics, Univ. of Bergen
Organizer: Shi, Yuying — North China Electric Power Univ.

Abstract: Many image reconstruction tasks amount to solve ill-posed inverse problems. Indeed, measurement devices typically cannot record all the information needed to recover the sought-after object; furthermore, the operators that model these devices are seldom accurate and data are corrupted by various perturbations. A common approach to find an approximate to the unknown object is regularization. The key points are the correct choices of the data fidelity term and the regularization term, as well as the trade-off between these terms. This is a challenging problem since the optimal solutions of the whole functional should correctly reflect the knowledge on the data-production process and the priors on the unknown object. The optimal solutions usually cannot be computed explicitly and iterative schemes are used. This symposium focus on imaging inverse problems' mathematical models, numerical algorithms, theoretical analysis and various applications, especially, applied to CT reconstruction and some processing techniques for images.

▶ MS-Th-BC-46-1 10:00–10:30

High-order Total Variation Regularization Approach for Axially Symmetric Object Tomography from A Single Radiograph

Chan, Raymond — The Chinese Univ. of Hong Kong
Wei, Suhua — Inst. of Applied Physics & Computational Mathematics
Nikolova, Mila — CMLA, CNRS - ENS Cachan
Tai, Xue-Cheng — Department of Mathematics, Univ. of Bergen

Abstract: We consider Abel transform based density reconstruction for axially symmetric objects from a single radiograph by fan-beam x-rays. All contemporary methods assume that the density is piecewise constant or linear. This is quite a restrictive approximation. Our proposed model is based on high-order total variation regularization. Its main advantage is to reduce the staircase effect and enable the recovery of smoothly varying regions. We compare our model with other potential methods by giving numerical tests.

▶ MS-Th-BC-46-2 10:30–11:00

On Some Refined Variational Models for Restoration of Blurred Images

Chen, Ke — Univ. of Liverpool
Williams, Bryan — Univ. of Liverpool
Zhang, Jianping — Univ. of Liverpool

Abstract: I first discuss how to impose positivity constraint in the variational total variation model for restoration of images with noise and blur, highlighting our new method of implicitly imposing the constraint. Then, to simultaneously restore both the image and the kernel, I present our blind deconvolution work where positivity is crucial and such models will not work otherwise. Finally I show some work on fractional order derivatives and their advantage of preserving smoothness without staircasing.

▶ MS-Th-BC-46-3 11:00–11:30

A Nonlinear Variational Approach to Motion-Corrected Reconstruction of Density Images

Suhr, Sebastian — Univ. of Muenster

Abstract: We tackle the reconstruction problem of density images from indirect measurements with a novel variational approach: By implementing an appropriate modelling of the mass-conserving density transformation in the reconstruction process we obtain the first building block of our variational method. Suitable regularization for images with edges (total variation) and for reasonable deformations (hyperelastic) without self folding completes the functional. We focus on obtaining analytical results and conclude the talk with applications to cardiac PET.

▶ MS-Th-BC-46-4 11:30–12:00

Tomography from Few Projections: Weak Guarantees and Applications

Petra, Stefania — Univ. of Heidelberg

Abstract: We investigate conditions for unique signal recovery based on sparse and cosparse signal models from few tomographic projections. Although certain industrial tomographic sensors do not fulfil typical Compressed Sensing conditions, we show that the transition from non-recovery to recovery is sharp for specific sparse images. The signal class covered by both sparse and cosparse models seems broad enough to cover relevant industrial applications of non-standard tomography, like particle image velocimetry and contactless quality inspection.

MS-Th-BC-47 10:00–12:00 108

Numerical methods for compressible multi-phase flows - Part IV of VI

For Part 1, see MS-Mo-D-08
For Part 2, see MS-Mo-E-08
For Part 3, see MS-We-E-47
For Part 5, see MS-Th-D-47
For Part 6, see MS-Th-E-47

Organizer: Deng, Xiaolong — Beijing Computational Sci. Research Center
Organizer: Wei, Suhua — Inst. of Applied Physics & Computational Mathematics
Organizer: Tian, Baolin — Insitute of Applied Physics & Computational Mathematics
Organizer: Tiegang, Liu — Beihang Univ.
Organizer: Sussman, Mark — Florida State Univ.
Organizer: Wang, Shuanghu — IAPCM

Abstract: Compressible multi-phase flows appear in many natural phenomena, and are very important in many applications, including space science, aerospace engineering, energy, homeland security, etc. Numerical calculation is a key for understanding many related problems. More and more numerical methods are being developed and improved. In this mini-symposium, novel numerical methods will be presented to show the progress in the area of compressible multi-phase flows, including interface capturing/tracking methods, phase change calculations, mixing methods, fluid-structure interaction methods, multi-physics calculations, adaptive mesh refinement, and high performance computing.

▶ MS-Th-BC-47-1 10:00–10:30

A Conservative Front-tracking Method on General Quadrangular Grids

Mao, De-kang — Shanghai Univ.

Abstract: We have developed a front-tracking method for compressible fluids(described by the Euler system), which is within the ALE framework, runs on general quadrangular grids, and is based on the conservation properties of the fluids. The method allows the interface to cut grid cells, and inside the cut cells the locations of the interface segments are computed using the conservation properties of the fluids. Numerical results show that the method can simulate interfaces with large deformation

▶ MS-Th-BC-47-2 10:30–11:00

High-order ADER Schemes for Compressible Multiphase Flows. Eleuterio. Toro

Toro, Eleuterio — Univ. of Trento

Abstract: We first review some typical mathematical models for compressible multiphase flows and point out some mathematical and numerical difficulties, such as hyperbolicity and conservation. We then put forward approaches for designing first-order monotone (for the scalar case) schemes based on the centred, the Godunov and the flux vector splitting approaches. Finally, on the basis

▶ MS-Th-BC-47-3 11:00–11:30

A Kinetic Scheme for Compressible Multi-phase Flows

Chen, Yibing — Beijing Inst. of applied physics & computational mathematics
Liu, Na — Inst. of applied physics & computational mathematics

Abstract: An kinetic scheme is developed to solve the Baer-Nunziato model

of compressible two-phase flows. Based on the kinetic theory, the conservative flux function of the model were split by the movement of micro-particles. A well-balance condition is then introduced to determined the numerical scheme of non-conservative terms. Thus both the conservative and nonconservative terms were discreted in the same manner. A number of numerical results show the robustness and good resolution of the new scheme.

MS-Th-BC-48 10:00–12:00 212B
Regularization methods for biomedical image analysis on manifolds - Part I of II
For Part 2, see MS-Th-D-48
Organizer: Chen, Chong — Chinese Acad. of Sci.
Organizer: Dong, Guozhi — Univ. of Vienna
Abstract: Inverse problems of functions defined on manifolds and Image analysis with data on surfaces are emerging topics, while the biomedical image and many other biological data analysis provide one the main sources of these problems. This minisymposium will be devoted to recent advances of regularization methods and the related topics, with respect to biomedical image analysis in the context of a manifold domain. The aim is to provide a platform to researchers and scientists for exchanging ideas and developing new research topics. It is supposed to contain two sections, and speakers consist of both leading experts and young researchers.

▶MS-Th-BC-48-1 10:00–10:30
A New Framework for the Statistical Analysis of Geometric-functional Datasets' Variability.
Charon, Nicolas — Johns Hopkins Univ.
Abstract: In this talk, we will be interested in the problem of statistical analysis and classification on populations of functional shapes, i.e geometrical shapes that carry additional scalar signal. The main difficulty is to model and estimate joint variations in shape and signal together. For that purpose, we propose a mathematical and numerical framework to estimate atlases on such datasets and simple tools to analyze resulting inter-subject variability among a population.

▶MS-Th-BC-48-2 10:30–11:00
A Multi-scale Geometric Flow Method for Molecular Structure Reconstruction
Chen, Chong — Chinese Acad. of Sci.
Abstract: The aim of this study was to further upgrade both the computational efficiency and accuracy of the L2-gradient flow method. In a finite-dimensional space spanned by the radial basis functions, a minimization problem, combined a fourth-order geometric flow with an energy decreasing constraint, is solved by a bi-gradient method. The experimental results showed that the proposed method yields more desirable results.

▶MS-Th-BC-48-3 11:00–11:30
Parameter Estimation of An Adapted Mean-curvature Flow Model of Shape Evolution
Lefevre, Julien — Aix-Marseille Universite
Abstract: This work has been initiated through the visual analogy between the early cortical folding process and the smoothing of a brain surface by mean curvature flow. We introduce a new geometric flow with one-parameter and propose an efficient optimization strategy for parameter estimation involving an energy depending only on volume and total area of the closed surface. Our model is trained on brain data and reveals promising predictions for developmental neuroscience.

▶MS-Th-BC-48-4 11:30–12:00
Computational Evolving Manifolds in Biomedical Image Analysis
Mikula, Karol — Slovak Univ. of Tech., Bratislava
Abstract: We present Lagrangean and Eulerian evolving manifold models and computational approaches used for 3D and 4D image segmentation, 3D point cloud surface reconstruction and 4D cell tracking with application in biomedical image analysis and developmental biology.

MS-Th-BC-49 10:00–12:00 107
Mathematical Theory of System and Control III: controllability and estimation of partial differential equations, and stochastic dynamic programming
Organizer: Tang, Shanjian — Fudan Univ.
Organizer: Zhang, Xu — Sichuan Univ.
Abstract: The minisymposium concerns control of partial differential equations, analysis of stochastic systems and a population dynamic model. It is one of the series of minisymposia on the mathematical theory of systems and control.

▶MS-Th-BC-49-1 10:00–10:30
Exact Controllability of Networks of Nonlinear Strings and Beams
Leugering, Guenter — Univ. Erlangen-Nuremberg
Abstract: We consider networks of nonlinear strings and Timoshenko beams as well as Cosserat networks. We provide the modeling, the analysis of equilibrium solutions and show that the models can be reformulated in the framework of the theory of Tatsien Li. We then provide local and local-global controllability results and also consider observability problems. This is joint work with Tatsien Li and Quilong Gu.

▶MS-Th-BC-49-2 10:30–11:00
On the Controllability of Viscous Fluid Equations with Non-constant Density.
Ervedoza, Sylvain — Institut de Mathematiques. de Toulouse
Abstract: In this talk, I will report on recent works on the local exact controllability to trajectories of viscous fluids when the density is assumed to be non-constant. This includes in particular the case of compressible Navier-Stokes equations or density dependent incompressible Navier-Stokes equations. In both cases, the main trick is to develop Carleman estimates adapted to the parabolic equation satisfied by the velocity field and to the transport equation satisfied by the density.

▶MS-Th-BC-49-3 11:00–11:30
A Primal-Dual Method for Stochastic Dynamic Programming
Chen, Nan — The Chinese Univ. of Hong Kong
Abstract: We use the information relaxation technique to develop a primal-dual iterative approach to solve stochastic dynamic programming problems. In each iteration, we obtain confidence intervals for the optimal value so that we can assess the quality of the currently used policy. We show the method will converge to the true value in finite number of iterations.

▶MS-Th-BC-49-4 11:30–12:00
Lp Theory for Linear Backward Stochastic Partial Differential Equations with VMO Coefficients
Zhang, Fu — Fudan Univ.
Abstract: Backward SPDEs arise in many applications of probability theory and stochastic processes. The lack of the solution's regularity brings huge difficulty to study the property of the BSPDE. We study the L^p theory of the solution to the BSPDE with measurable coefficients. The dual method, by which Du, Qiu, and Tang [2012, AMO] study the L^p theory in the case that the coefficients of the equation are Lipschitz continuous, could not be applied here. We use the Green function representation of the linear BSPDE and the technique of sharp function, to study the BSPDE directly, obtain a partial $L^p(p \geq 2)$ estimate in the VMO coefficients case.

MS-Th-BC-50 10:00–12:00 207
Mathematical and Numerical Aspects of Electronic Structure Theory - Part I of V
For Part 2, see MS-Th-D-50
For Part 3, see MS-Th-E-50
For Part 4, see MS-Fr-D-50
For Part 5, see MS-Fr-E-50
Organizer: Lin, Lin — Univ. of California at Berkeley
Organizer: Lu, Jianfeng — Duke Univ.
Abstract: Electronic structure theory and first principle calculations are among the most challenging and computationally demanding science and engineering problems. This minisymposium aims at presenting and discussing new developments of mathematical analysis, and numerical methods for achieving ever higher level of accuracy and efficiency in electronic structure theory. This includes ground state and excited state density functional theory calculations, wavefunction methods, together with some of their applications in computational materials science and quantum chemistry. We propose to bring together experts on electronic structure theory, which include not only mathematicians, but also physicists working actively in the field.

▶MS-Th-BC-50-1 10:00–10:30
Large-scale Real-space Electronic Structure Calculations
Gavini, Vikram — Univ. of Michigan
Abstract: This talk presents the development of a real space approach to perform efficient large-scale Kohn-Sham density functional theory calculations using an adaptive higher-order spectral finite-element discretization. Further, the development of a sub-quadratic scaling subspace projection method that treats both metallic and insulating systems in a single framework, and is applicable to both pseudopotential and all-electron calculations, will be presented.

▶MS-Th-BC-50-2 10:30–11:00
Solving the Kohn-Sham Eigenproblem Within A Common Library Approach to Software Development in Electronic Structure

Corsetti, Fabiano CIC nanoGUNE

Abstract: The Electronic Structure Library (ESL) is a new initiative to create an online repository of software for use within electronic structure codes. One of the aims of the ESL is to give members of the community access to a diverse range of Kohn-Sham eigensolvers, in the form of fully functioning libraries. We focus on the libOMM library implementing the orbital minimization method, and discuss its efficiency for codes using a basis of finite-range atomic orbitals.

▶ MS-Th-BC-50-3 11:00–11:30

Numerical Approaches for Solving the Optimal Transport Problem in the Strong-interaction Limit of Density Functional Theory

Mendl, Christian Stanford Univ.

Abstract: For strongly interacting electronic systems, the Kohn-Sham formulation of density-functional theory leads to an optimal transport problem with Coulomb cost function. In this framework of ”strictly correlated electrons” (SCE), we explore numerical approaches for solving the optimal transport problem based on finite-element discretizations of the electron density.

▶ MS-Th-BC-50-4 11:30–12:00

Sparse Correction for Coupled Cluster Calculations

Yang, Chao Lawrence Berkeley National Laboratory

Abstract: The coupled-cluster method is a highly accurate wavefunction method solving a many-body Schrodinger's equation. However, its computational complexity scales as $O(N^6)$, where N is the number of electrons. In this talk, we discuss a technique for reducing the cost of coupled-cluster calculation by exploiting the sparsity of the correction tensor in an inexact Newton method for solving the coupled-cluster nonlinear equation.

MS-Th-BC-51 10:00–12:00 209A

Dynamics and information coding in neuronal systems - Part I of II

For Part 2, see MS-Th-D-51

Organizer: Zhou, Douglas Shanghai Jiao Tong Univ.

Abstract: Computational neuroscience has experienced explosive growth over last two decades. It has helped to explain or even predict many neurophysiological phenomena in experiment over scales ranging from molecular, single cellular to neuronal circuits. As more realism is incorporated into these models, novel dynamical features often arise which further enrich our understanding of the brain. This minisymposium explores this theme by discussing recent work in the modeling of both individual neuron dynamics and network topology, focusing upon implications on network behavior and information coding. The speakers will draw particular attention to new mathematical approaches in explaining sensory processing and information propagation.

▶ MS-Th-BC-51-1 10:00–10:30

Subthreshold Oscillations, Multiple Delays, and Rhythms in the Olfactory System

Karamchandani, Avinash Northwestern Univ.
Graham, James Northwestern Univ.
Meng, Hongyu Northwestern Univ., ESAM
Riecke, Hermann Northwestern Univ.

Abstract: Olfactory processing in the brain exhibits a number of rhythms, which signify enhanced coherence among many neurons. While the faster gamma rhythm is generated within the olfactory bulb, the slower beta rhythm requires communication between the olfactory bulb and piriform cortex. We investigate how the interplay between the mixed-mode-like oscillations of the bulbar principal cells and the two different delays of their interaction within the bulb and via the cortex may generate these rhythms.

▶ MS-Th-BC-51-2 10:30–11:00

Kinetic Dissection of Recycling Vesicle Pool at the Calyx of Held Synapse

Sun, Jianyuan Inst. of Biophysics, Chinese Acad. of Sci.

Abstract: In combination of electrophysiology and theoretical analysis, we developed a novel approach to quantify the kinetics of vesicle recycling with exquisite signal and temporal resolution. Using this approach combined with electron-microscopic observations, we kinetically dissected vesicle recycling in the calyceal terminal, defined a novel concept of the readily-priming pool, and proposed a realistic kinetic model to quantify the basic properties of vesicle recycling.

▶ MS-Th-BC-51-3 11:00–11:30

The Neural Mechanism of Optimal Limb Coordination in Crustacean Swimming

Lewis, Tim UC Davis

Abstract: Long-tailed crustaceans swim by rhythmically moving limbs called swimmerets. Over the entire biological range of animal size and paddling frequency, movements of adjacent swimmerets maintain an approximate quarter-period phase-difference with posterior limbs leading the cycle. We show that this frequency-invariant stroke-pattern is the most mechanically efficient paddling rhythm across a wide range of Reynolds numbers and that the organization of the neural circuit underlying limb coordination provides a robust mechanism for generating this stroke-pattern.

▶ MS-Th-BC-51-4 11:30–12:00

Bilinearity in Spatiotemporal Integration of Synaptic Inputs

Zhou, Douglas Shanghai Jiao Tong Univ.

Abstract: Based on asymptotic analysis of a passive cable model, we derive a bilinear spatiotemporal dendritic integration rule for a pair of time-dependent synaptic inputs. Further simulations of a realistic pyramidal neuron model and electrophysiological experiments of rat hippocampal CA1 neurons verifies our rule. We demonstrate that the integration of multiple synaptic inputs can be decomposed into the sum of all possible pairwise integration with each paired integration obeying a bilinear rule.

MS-Th-BC-52 10:00–12:00 212A

Recent Development of Mathematical Models in Computational Biology - Part I of V

For Part 2, see MS-Th-D-52
For Part 3, see MS-Th-E-52
For Part 4, see MS-Fr-D-52
For Part 5, see MS-Fr-E-52

Organizer: Zhang, Lei Peking Univ.
Organizer: Ge, Hao Peking Univ.
Organizer: Lei, Jinzhi Tsinghua Univ.

Abstract: One of the central problems in biology is to understand the design principles of complex biological systems. Mathematical and computational models of biological processes can be characterized both by their level of biological detail and by their mathematical complexity. In this minisymposium, we focus on recent findings of computational models and methods to gain insights of the complexity of cellular life and efficiently analyze the experimental observations. Topics of interests include stem cells, developmental patterning, gene regulatory networks, neuron networks, uncertainty quantification of biological data, etc.

▶ MS-Th-BC-52-1 10:00–10:30

Kinetic Monte Carlo Simulations of Multicellular Aggregate Self-Assembly in Biofabrication

Sun, Yi Univ. of South Carolina
Wang, Qi Univ. of South Carolina & Beijing Computational Sci. Research Center

Abstract: We present a 3D lattice model to study self-assembly of multicellular aggregates by using kinetic Monte Carlo (KMC) simulations. This model is developed to describe and predict the time evolution of postprinting structure formation during tissue or organ maturation in a novel biofabrication technology–bioprinting. Here we simulate the self-assembly and the cell sorting processes within the aggregates of different geometries including vascular networks, which can involve a large number of cells of multiple types.

▶ MS-Th-BC-52-2 10:30–11:00

A Stochastic Multiscale Model That Explains the Segregation of Axonal Microtubules and Neurofilaments in Neurological Diseases

Xue, Chuan Ohio State Univ.

Abstract: The shape and function of an axon is dependent on its cytoskeleton, including microtubules, neurofilaments and actin. Neurofilaments accumulate abnormally in axons in many neurological disorders. An early event of such accumulation is a striking radial segregation of microtubules and neurofilaments. This segregation phenomenon has been observed for over 30 years now, but the underlying mechanism is still poorly understood. I will present a stochastic multiscale model that explains these phenomena and generates testable predictions.

▶ MS-Th-BC-52-3 11:00–11:30

Stochastic Dynamical Descriptions of Living Processes and Nonequilibrium Thermodynamics and Steady-State Cycle Kinetics

Qian, Hong Univ. of Washington, Applied Mathematics

Abstract: Nonequilibrium thermodynamics (NET) concerns with transport processes. On a mesoscopic level and in terms of statistical descriptions of dynamics, various transport phenomena can all be quantitatively described in terms of a single entity: the flux that transports probabilities following Chapman-Kolmogorov equation. This explains why mesoscopic stochastic NET attains a universal formulation and appears as a branch of applied probability in its abstract form. We introduce this new theory through simple example from biochemistry.

▶ MS-Th-BC-52-4 11:30–12:00

Simulated Evolution on Fitness Landscape Constructed by Constraint Satisfaction Problems

Hu, Yucheng Tsinghua Univ.

Abstract: The complex structures of all proteins in nature are outcomes of random walk driven by mutation and selection. Reconstructing the fitness landscape from experimental measurements is difficult. Alternatively, in this paper we turn the popular Sudoku game into an artificial fitness landscape and use it as a model system to study sequence evolution under constraint. Insights gained from this prototype-protein may help us understand the complex evolutionary process of tightly folded proteins.

MS-Th-BC-53 10:00–12:00 311B

Modeling in Finance beyond classical paradigms

Organizer: Ludkovski, Mike UC Santa Barbara
Organizer: Teichmann, Josef ETH Zurich
Organizer: Cuchiero, Christa Univ. of Vienna

Abstract: Moving beyond the classical frameworks, like purely semimartingale based models, or no arbitrage theory with fixed probability spaces and a small number of assets, this minisymposium presents new directions to robust financial modeling: novel empirically sound approaches to model volatility, robust pricing to quantify model uncertainty and (no) arbitrage considerations in large financial markets.

▶ MS-Th-BC-53-1 10:00–10:30

Volatility is Rough

Rosenbaum, Mathieu Univ. Paris 6

Abstract: Estimating volatility from recent high frequency data, we revisit the question of the smoothness of the volatility process. Our main result is that log-volatility behaves essentially as a fractional Brownian motion with Hurst exponent of order 0.1, at any reasonable time scale. This leads us to build a "Rough Fractional Stochastic Volatility model", for which various applications are provided. This is joint work with Jim Gatheral and Thibault Jaisson.

▶ MS-Th-BC-53-2 10:30–11:00

Robust Pricing by Informed Investors

Acciaio, Beatrice LSE

Abstract: Well-informed agents can hedge more efficiently than poorly informed agents, even if they have access to the same set of traded securities. In a robust framework with semi-static trading opportunities, we study super-hedging prices obtained by agents with different filtrations. We find that informed agents compute super-hedging prices using only those probability measures that render the additional information inconsequential. The theory of filtration enlargement and the notion of semi-static completeness play an important role.

▶ MS-Th-BC-53-3 11:00–11:30

A New Perspective on the Fundamental Theorem of Asset Pricing for Large Financial Markets

Cuchiero, Christa Univ. of Vienna

Abstract: In the context of large financial markets we formulate the notion of "no asymptotic free lunch with vanishing risk" (NAFLVR), under which we can prove a version of the fundamental theorem of asset pricing in markets with an (even uncountably) infinite number of assets, as it is for instance the case in bond markets. (NAFLVR) turns out to be an economically meaningful "no arbitrage" condition and is equivalent to the existence of a separating measure.

▶ MS-Th-BC-53-4 11:30–12:00

Model-Independent Finance, Optimal Transport and Skorokhod Embedding

Stebegg, Florian Universität Wien

Abstract: Motivated by problems in model-independent finance, different Brenier-type martingale transport plans have been discovered by Hobson-Neuberger, Beiglböck-Julliet, Henry-Labordere-Touzi. We will discuss a new, unifying approach that allows to strengthen the original results and establishes a novel connection with the Skorokhod embedding problem.

MS-Th-BC-54 10:00–12:00 VIP1-2

Global Value Chain Research and its extensions

Organizer: Yang, Cuihong Acad. of Mathematics & Sys. Sci., CAS

Abstract: The expansion of global trade in the several past decades is characterized by increasing international fragmentation of production, where production processes are sliced into many stages that can be completed in different countries. The value of certain products is thus sliced up globally-global value chains (GVCs). Not only the value chain of certain products, but also other production factors, emission contents, income distribution have to be distributed correspondingly at a global perspective. We are facing with challenges in how to look at the global economy, thus it is very important to understand how GVCs work, how they affect the economic performance, how the economies benefit from GVCs, and so on. In this special session, we would like to answer some of the questions from several perspectives, including globalization and regional income inequality in China; Processing trade, heterogeneous technologies, and the structure of China's DPN CGE model; emissions considering regional and firm heterogeneity in global value chains, trade-off between economic growth and quality.

▶ MS-Th-BC-54-1 10:00–10:30

Processing trade, heterogeneous technologies, and the structure of China' s DPN CGE model

Pei, Jiansuo Univ. of International Business & Economics
Yang, Cuihong Acad. of Mathematics & Sys. Sci., CAS

Abstract: China' s dual trade regime is featured by heterogeneous production technologies. Processing trade uses higher proportion of imported goods in production composite; Whereas, production for normal exports and other domestic uses absorb relatively smaller share of imported intermediates in the production recipe. One of the consequences is that, production technologies exhibit distinct heterogeneity, which is in line with heterogeneous firms' theory. This paper constructs a DPN CGE model and its potential applications are discussed.

▶ MS-Th-BC-54-2 10:30–11:00

Trade-off between Economic Growth Speed and Efficiency

Fan, Jin Jiangsu Administration Inst.

Abstract: Historical data of economic development show that, there exists an inverse relationship between value-added growth rate (VGR) and value-added rate (VAR), reflecting a trade-off between economic growth speed and efficiency. This paper tries to construct a growth model with intermediate goods taken into consideration, in the neoclassical growth framework to explain it. The proceeding numerical simulation shows that the trade-off fact is also influenced by the substitution elasticity and linkages among firms.

▶ MS-Th-BC-54-3 11:00–11:30

Globalization and Regional Inequality Within China: A Domestic Value Chain Analysis

Duan, Yuwan Central Univ. of Finance & Economics

Abstract: We propose a new accounting framework to quantify the respective contributions of processing exports and ordinary exports to the regional income inequality from a value chain perspective. This is based on a newly developed Chinese interregional input-output table, which separates the processing exports from the other products at regional level.

▶ MS-Th-BC-54-4 11:30–12:00

Spillover Effects of TTIP on BRICS Economies: A Dynamic GVC-Based CGE Model

Cai, Songfeng State Information Center
Zhang, Yaxiong State Information Center
Meng, Bo Inst. of Developing Economies, Japan External Trade Organization

Abstract: This paper employs the Global Trade Analysis Project (GTAP) model to assess the impact of Transatlantic Trade and Investment Partnership (TTIP) between the two largest developed economies, namely the U.S. and the European Union (EU), on their main trading partners who are mainly engaged at the low end in the division system of global value chains (GVCs), such as Brazil, Russia, India, China, and South Africa (BRICS) countries. Compared with the traditional GTAP model in

MS-Th-BC-55 10:00–12:00 106

New advances in model order reduction: methods, algorithms, and applications - Part II of II

For Part 1, see MS-We-E-55

Organizer: Feng, Lihong Max Planck Inst. for Dynamics of Complex Technical Sys.

Abstract: This minisymposium intends to bring together new progresses in different aspects of model order reduction (MOR): methods, algorithms and applications. The topics include various MOR methods: interpolatory method, reduced basis method, POD, for various complex systems: linear, nonlinear, parametric, and for various applications: flow control, population balance system, neutral delayed system, chromatography, uncertainty quantification, electromagnetcs, vibro-acoustics systems, coupled systems. The speakers are quite international and have senior research experiences in MOR.

▶ MS-Th-BC-55-1 10:00–10:30

Using Model Order Reduction for Computing Fast Frequency Sweeps of Vibro-acoustic Systems Described by Indirect Boundary Element Models

Lefteriu, Sanda — Ecole des Mines de Douai
Beriot, Hadrien — Siemens Industry Software
Souza Lenzi, Marcos — Universidade Federal do Parana

Abstract: The matrices arising from boundary element discretizations of the Helmholtz equation are fully populated and their calculation is demanding, particularly for industrial applications. We propose a two-step algorithm for computing frequency sweeps with fine increments of vibro-acoustic systems. First, matrices are computed only at a few master frequencies, the rest being interpolated after an appropriate scaling. Second, we extrapolate the response by using derivative information and constructing Pade approximants via Well-Conditioned Asymptotic Waveform Evaluation (WCAWE).

▶ MS-Th-BC-55-2 10:30–11:00

Interpolatory Model Reduction for Flow Control

Gugercin, Serkan — Virginia Tech
Borggaard, Jeff — Virginia Tech

Abstract: In this talk, we propose an interpolation framework for model reduction and describe a well studied flow control problem that requires model reduction of a large scale system of differential algebraic equations. We show that interpolatory model reduction produces a feedback control strategy that matches the structure of much more expensive control design methodologies.

▶ MS-Th-BC-55-3 11:00–11:30

Circuit Model for Electromagnetics via the Reduced-Basis Method

De La Rubia, Valentin — Universidad Politecnica de Madrid

Abstract: In this work, the electromagnetic behaviour in microwave devices is described in terms of circuit theory. A transversal coupling matrix gathering all electromagnetic phenomena within a frequency band is found. As a result, further insight from the microwave point of view arises. A Finite Element Method approach is carried out for the electromagnetic analysis and a reliable reduced-order model for fast frequency sweep is proposed via the Reduced-Basis Method.

▶ MS-Th-BC-55-4 11:30–12:00

Model Order Reduction for Uncertainty Quantification in Inverse and Risk Analysis

Chen, Peng — ETH Zurich (Swiss Federal Inst. of Tech. in Zurich)
Rozza, Gianluigi — SISSA, International School for Advanced Studies
Quarteroni, Alfio — EPFL

Abstract: We present some new advances of the development of model order reduction (MOR) techniques in the field of uncertainty quantification (UQ), in particular for inverse problems and risk analysis. We develop a goal-oriented MOR technique with effective a posteriori error estimation in order to choose the most representative reduced basis functions. The proposed technique for large computational reduction are demonstrated by two examples, Bayesian inversion for heat conduction and risk analysis for crack propagation.

MS-Th-BC-56 10:00–12:00 403

Modeling, Applications, Numerical Methods, and Mathematical Analysis of Fractional Partial Differential Equations II - Part IV of IV

For Part 1, see MS-Tu-E-56
For Part 2, see MS-We-D-56
For Part 3, see MS-We-E-56

Organizer: Karniadakis, George — Brown Univ.
Organizer: Wang, Hong — Univ. of South Carolina

Abstract: Fractional Partial Differential Equations (FPDEs) are emerging as a new powerful tool for modeling many difficult complex systems, i.e., systems with overlapping microscopic and macroscopic scales or systems with long-range time memory and long-range spatial interactions. They offer a new way of accessing the mesoscale using the continuum formulation and hence extending the continuum description for multiscale modeling of viscoelastic materials, control of autonomous vehicles, transitional and turbulent flows, wave propagation in porous media, electric transmission lines, and speech signals. FPDEs raise modeling, computational, mathematical, and numerical difficulties that have not been encountered in the context of integer-order partial differential equations. The aim of this minisymposium is to cover the recent development in mathematical and numerical analysis, computational algorithms, and applications in the context of FPDEs and related nonlocal problems.

▶ MS-Th-BC-56-1 10:00–10:30

A Fast Gradient Projection Method for A Constrained Fractional Optimal Control

Du, Ning — Shandong Univ.
Wang, Hong — Univ. of South Carolina

Abstract: Fractional control problem introduces significantly increased computational complexity and storage requirement than the corresponding classical control problem due to the nonlocal nature of fractional differential operators. We develop a fast gradient projection method which greatly reduce the computational cost and memory requirement for a pointwise constrained optimal control problem governed by a time-dependent space-fractional diffusion equation. Numerical experiments show the utility of the method.

▶ MS-Th-BC-56-2 10:30–11:00

Valuation of American Option under A Fractional Diffusion Model

GUO, Xu — Hong Kong Baptist Univ.

Abstract: We concentrate on the analytical study of American options under a particular exp-Lévy jump diffusion model, namely CGMYe model. The decomposition formula of the American option and the integral equation of the optimal-exercise boundary are derived. Moreover, an analytical approximation formula is obtained for the option value, which is valid for both short and long maturities. Numerical simulations are also provided for the European options and the optimal-exercise boundary for American options.

▶ MS-Th-BC-56-3 11:00–11:30

A Fast Numerical Method for Space-fractional PDEs on A General Convex Domain

Jia, Jinhong — School of Mathmatics, Shandong Univ.

Abstract: Because of the nonlocal property of fractional differential operators, the numerical methods for FPDEs often generate dense coefficient matrices, which often requires computational work of $O(N^3)$ to invert per time step and memory of $O(N^2)$. We develop a fast numerical method for space-fractional diffusion equations on a general convex domain, which have computational cost of $O(N \log^2 N)$ per time step and memory of $O(N)$, while retaining the same accuracy and approximation property of the underlying numerical methods.

▶ MS-Th-BC-56-4 11:30–12:00

A High-accuracy Preserving Spectral Galerkin Method for Space-fractional Partial Differential Equations

Zhang, Xuhao — Shandong Univ.

Abstract: Fractional diffusion equations were shown to provide an adequate and accurate discription of transport processes exhibiting anomalous behavior. We developed a high-accuracy preserving spectral Galerkin method for the Dirichlet boundary-value problem of one-sided variable-coefficient conservative fractional diffusion equations. Numerical experiments substantiate the theoretical analysis and show that the method exhibits an exponential convergence provided the diffusivity coefficient and the right-hand source term have the desired regularity.

MS-Th-BC-57 10:00–12:00 402A

Modeling, Applications, Numerical Methods, and Mathematical Analysis of Fractional Partial Differential Equations I - Part I of V

For Part 2, see MS-Th-D-57
For Part 3, see MS-Th-E-57
For Part 4, see MS-Fr-D-57
For Part 5, see MS-Fr-E-57

Organizer: Wang, Hong — Univ. of South Carolina
Organizer: Karniadakis, George — Brown Univ.

Abstract: Fractional Partial Differential Equations (FPDEs) are emerging as a new powerful tool for modeling many difficult complex systems, i.e., systems with overlapping microscopic and macroscopic scales or systems with long-range time memory and long-range spatial interactions. They offer a new way of accessing the mesoscale using the continuum formulation and hence extending the continuum description for multiscale modeling of viscoelastic materials, control of autonomous vehicles, transitional and turbulent flows, wave propagation in porous media, electric transmission lines, and speech signals. FPDEs raise modeling, computational, mathematical, and numerical difficulties that have not been encountered in the context of integer-order partial differential equations. The aim of this minisymposium is to cover the recent development in mathematical and numerical analysis, computational algorithms, and applications in the context of FPDEs and related nonlocal problems.

▶ MS-Th-BC-57-1 10:00–10:30

Physical Implications of Fractional Diffusion Models

Hilfer, R — Univ. Stuttgart

Abstract: Fractional Bochner-Levy-Riesz diffusion arises from ordinary diffusion by replacing the Laplacean with a noninteger power of itself. Bochner-

Levy-Riesz diffusion as a mathematical model leads to nonlocal boundary value problems. As a model for physical transport processes it seems to predict phenomena that have yet to be observed in experiment.

▶ MS-Th-BC-57-2 10:30–11:00

Fractional Diffusion in Bounded Domains

Del-Castillo-Negrete, Diego Oak Ridge National Laboratory

Abstract: Practical applications of fractional diffusion require the formulation of models in bounded spatial domains. Here we present mathematically well-posed models that incorporate physically meaningful generic boundary conditions. Our approach is based on the regularization of the fractional derivatives singularities at the boundaries. Following the construction of models in 1-dimensional and 2-dimensional bounded domains, we present finite-different numerical methods to solve the regularized models, and present examples of nonlocal heat transport in controlled nuclear fusion plasmas.

▶ MS-Th-BC-57-3 11:00–11:30

Recent Developments of Fast Numerical Methods and Associated Analysis of FPDEs

Wang, Hong Univ. of South Carolina

Abstract: FPDEs provide very powerful alternatives to integer-order PDEs for modeling anomalous transport and long-range interactions. However, FPDEs involve complex and singular integral operators. Consequently, corresponding numerical methods generate dense stiffness matrices, for which direct solvers require O(N2) memory and O(N3) complexity for a problem of size N. This renders three-dimensional FPDE simulations computationally intractable. Furthermore, FPDEs with smooth coefficients may generate solutions with strongly local singularity and poor regularity. We go over the recent advances in the development of accurate and efficient numerical methods for FPDEs with optimal memory requirement and almost linear computational complexity. We will repore our recent progress in the associated mathematical and numerical analysis.

▶ MS-Th-BC-57-4 11:30–12:00

A Fourth-order Alternating Direction Method for A Fractional FitzHugh-Nagumo Monodomain Model

Liu, Fawang Queensland Univ. of Tech.
Turner, Ian Queensland Univ. of Tech.
Chen, Shiping Quanzhou Normal Univ.

Abstract: In this paper, a novel fourth-order alternating direction method is derived for the approximation of the Riesz space fractional nonlinear reaction-diffusion model. Stability and convergence of this method are proved. Finally, some numerical examples are given to support our theoretical analysis and these numerical techniques are employed to simulate a two-dimensional fractional Fitzhugh-Nagumo model.

MS-Th-BC-59 10:00–12:00 402B

Optimal Design of Inhomogeneous Anisotropic Materials and the Shape Forming Methods - Part II of II

For Part 1, see MS-We-E-59

Organizer: Rybka, Piotr The Univ. of Warsaw
Organizer: Lewinski, Tomasz Warsaw Univ. of Tech.

Abstract: The origin of topology optimization is the relaxation by homogenization – the problem of an optimal layout of two sotropic materials of fixed amounts to achieve given aims. Here minimization of the compliance plays a crucial role. Admitting void as a material one paves the way towards the shape forming theory. Alternatively, in the Free Material Design (FMD) all components of Hooke tensor are design variables. The stress-based FMD is a method of a simultaneous material and shape design.
Our aim is to gather experts in the field to analyze links between these methods and develop rigorous results on topology optimization.

▶ MS-Th-BC-59-1 10:00–10:30

Doing Topology Optimization Explicitly and Geometrically — A New Moving Morphable Components Based Framework

Xu, Guo Dalian Univ. of Tech., Department of Engineering Mechanics

Abstract: A new computational framework for structural topology optimization based on the concept of moving morphable components is proposed. Optimal structural topology is obtained by optimizing the layout of morphable structural components. The approach can combine both the advantages of explicit and implicit geometry descriptions for topology optimization. It also has the great potential to reduce the computational burden associated with topology optimization substantially. Some representative examples are presented to illustrate its effectiveness.

▶ MS-Th-BC-59-2 10:30–11:00

Shape Optimization in Engineering Problems

Rybka, Piotr The Univ. of Warsaw

Abstract: We study the shape optimization of a conductor in a stationary heat conduction problem, which leads to minimization of a functional of linear growth among divergence-free vector fields satisfying a given boundary data. Hence, minimizers are measures, not functions.
Exploiting the fact that the above question may be reduced to the least gradient problem simplifies a detailed analysis of solutions. Our consideration is confined to specific cases, like the three point sources problems

▶ MS-Th-BC-59-3 11:00–11:30

Some Considerations about the Small Amplitude Homogenization Method for Optimal Design

Gutierrez, Sergio Universidad Catolica de Chile

Abstract: The considered method was introduced by Allaire and Gutierrez in 2007 and it is quite flexible in terms of the objective functions to which it can be applied. It requires, however, the use of H-measures, introduced in the 1990s by Luc Tartar, because there are sequences of functions that converge weakly, but not strongly, which interact nonlinearly. We present the method and concentrate on two successful applications: inverse problems and dam design.

▶ MS-Th-BC-59-4 11:30–12:00

Design of Heterogeneous Structures for Maximum Specific Strength and Stiffness

Lipton, Robert LSU

Abstract: We present a mathematically rigorous theory for the design of composite structures for strength and stiffness. It provides a multiscale relaxation of the original problem involving effective elastic tensors as well as a new multiscale quantity dubbed the macrostress modulation function. This function quantifies the intensity of local stress fluctuations at the scale of the microstructure generated by the homogenized stress. The solution of the relaxed formulation delivers graded microstructures for local stress control.

IM-Th-BC-60 10:00–12:00 310

Industrial Mathematics Around the World - Part VII of VIII Activities on Industrial-Mathematics in North America

For Part 1, see IM-Mo-D-60
For Part 2, see IM-Mo-E-60
For Part 3, see IM-Tu-D-60
For Part 4, see IM-Tu-E-60
For Part 5, see IM-We-D-60
For Part 6, see IM-We-E-60
For Part 8, see IM-Th-D-60

Organizer: Cai, Zhijie Fudan Univ.
Organizer: Chen, Gui-Qiang G. Univ. of Oxford
Organizer: Huang, Huaxiong York Univ.
Organizer: LU, Liqiang Fudan Univ.
Organizer: Ockendon, Hilary Univ. of Oxford
Organizer: Ockendon, John Univ. of Oxford
Organizer: Peng, Shige Shandong Univ.
Organizer: Tan, Yongji Fudan Univ.
Organizer: Wake, Graeme Massey Univ.,
Organizer: Zhu, Yichao The Hong Kong Univ. of Sci. & Tech.
Organizer: CHENG, JIN Fudan Univ.

Abstract: The aim of this section is to boost the use of mathematics as an industrial resource in China and around the world. It will highlight (i) the global experience in industrial mathematics and (ii) the new mathematical ideas that these activities have created as well as the exploitation of existing technologies to new applications. Participants will come from both academia and industry and, for this purpose, the section is proposed to consist of eight minisymposia. Four of them will overview the identification and solution of industrially-driven mathematical problems and the mechanisms that have evolved to deal with them in different regions: China, other Asia-Pacific countries, Europe and North America. Three of the remaining minisymposia will focus on the problems coming from different industrial sectors: financial industry, petroleum industry and industrial areas in which wave propagation is important. The last minisymposium will involve an open discussion on how the global mathematics community can best respond to the increasing demand from industry for applied and computational mathematics; the agenda will include both the mechanisms for academic / industrial collaboration and the areas where it will be most fruitful.

▶ IM-Th-BC-60-1 10:00–10:30

Limitations of the Rotating Disk Reaction Vessel

Bohun, C. Sean — UOIT

Abstract: The rotating disk reaction vessel has a long standing use in the oil and gas industry to help characterize rock samples while drilling. One of the dominant chemical reactions in this sector is the carbonate system which is also seen in many systems in nature. By including the mathematics of this reaction with the dissolution mechanism, a way of understanding and possibly eliminating the the limitations of the rotating disk method is provided.

▶ IM-Th-BC-60-2 — 10:30–11:00

Modelling and Optimizing A System for Testing Electronic Circuit Boards

Marcotte, Odile — CRM & GERAD (HEC Montreal)

Abstract: We consider a difficult combinatorial optimization problem arising from the operation of a system for testing electronic circuit boards (ECB). Because of its diffculty, we first split the problem into a covering subproblem and a sequencing subproblem. We demonstrate that the solution of these two subproblems yields much better plans than those currently used. We conclude by giving a complete model of the test planning problem,

▶ IM-Th-BC-60-3 — 11:00–11:30

Enhanced Training in the Mathematical Sciences: the GSMM Camp

Kramer, Peter — Rensselaer Polytechnic Inst.

Abstract: The Graduate Student Mathematical Modeling (GSMM) Camp is an annual week-long meeting. At the Camp, graduate students work together in teams, with the guidance of faculty mentors, on interdisciplinary problems inspired by industrial applications. The program promotes a broad range of problem-solving skills, and provides the students with a valuable educational and career-enhancing experience outside of the traditional academic setting. The talk will focus on the organization, sample problems and outcomes of the Camp.

▶ IM-Th-BC-60-4 — 11:30–12:00

The Year of Light in Industrial Mathematics: Case Studies from MPI

Moore, Richard — New Jersey Inst. of Tech.

Abstract: The Mathematical Problems in Industry Workshop has for 30 years brought industrial researchers and academics in the mathematical sciences together for the purposes of highlighting the power of mathematical tools to elucidate technical problems and of demonstrating to faculty and graduate students the value of continued research in applied industrial mathematics. We introduce the MPI Workshop, and then present case studies focusing on the optics industry in recognition of the 2015 International Year of Light.

CP-Th-BC-61 — 10:00–12:00 — 101

Control, Dynamic systems

Chair: Kuzmina, Lyudmila — Kazan Aviation Inst.-National Research Univ.

Abstract:

▶ CP-Th-BC-61-1 — 10:00–10:20

Asymptotic Approach in Reduction/decomposition Problems for Multi-scale Systems Dynamics

Kuzmina, Lyudmila — Kazan Aviation Inst.-National Research Univ.

Abstract: The paper is aimed to the different aspects of mathematical modelling and qualitative analysis in dynamics of complex multi-scale systems, that are generated by applied problems of engineering practice. Main goals are the problems of optimal mechanical-mathematical modelling and the regular schemes of decomposition in engineering design. The generalization of reduction principle, well-known in A.M.Lyapunov stability theory, is important goal for engineering practice. Uniform methodology, based on Lyapunov扭methods, in accordance with Chetayev扭stability postulate, is developed. The presented approach, with combination of stability theory and asymptotic methods, allows to elaborate the general conception of the modelling, to work out the regular schemes of engineering level for decomposition-reduction of full systems and dynamic properties. This approach enables to obtain the simplified models, presenting interest for applications, with rigorous substantiation of the acceptability. The conditions of qualitative equivalence between full model and reduced models are determined, with extended estimations of N.G.Chetayev扭type on infinite time interval. In the applications to multi-scales engineering systems dynamics (for mechanical systems with big and small parameters gyroscopes, for electromechanical systems, for robotic systems,? the obtained results enable to decompose initial model and to construct the reduced models by strict mathematical way. The interpretation of these formalized constructions (reduced models) leads to new approximate theories, acceptable in applications of engineering practice. It allows to optimize the analysis process and synthesis, to cut down the engineering design time. As applications the different examples of concrete physical nature are considered.

The author is grateful to the Russian Foundation of Fundamental Investigations for support of research.

▶ CP-Th-BC-61-2 — 10:20–10:40

Robust Control for A Class of Uncertain Dynamical Systems

Rathinasamy, Sakthivel — Sri Ramakrishna Inst. of Tech.

Abstract: This paper addresses the problem of robust sampled-data H∞control for a class of uncertain dynamical systems (Mechanical systems) with uncertainty. By constructing a proper Lyapunov functional involving the lower and upper bounds of the delay, a new set of sufficient conditions are obtained in terms of linear matrix inequalities (LMIs) for the existence of H∞control law which ensures the robust stabilization of the uncertain dynamical systems about its equilibrium point for all norm bounded parameter uncertainties. Finally, a numerical example with simulation result is provided to illustrate the applicability and effectiveness of the proposed sampled-data control law.

▶ CP-Th-BC-61-3 — 10:40–11:00

INTEGRABLE VARIABLE DISSIPATION DYNAMICAL SYSTEMS AND SOME APPLICATIONS

Shamolin, Maxim V. — Lomonosov Moscow State Univ.

Abstract: This activity is a survey of integrable cases in dynamics of a lower- and multi-dimensional rigid body under the action of a nonconservative force field. We review both new results and results obtained earlier. Problems examined are described by dynamical systems with so-called variable dissipation with zero mean.

As exhibits we research dynamical equations of motion arising in studying the plane and spatial dynamics of a rigid body interacting with a medium and also a possible generalization of the obtained methods for studying to general systems arising in qualitative theory of ordinary differential equations, in theory of dynamical systems, and also in oscillation theory.

▶ CP-Th-BC-61-4 — 11:00–11:20

On Certain Dynamic Inequalities and Its Applications on Time Scale

Pachpatte, Deepak — Dr. Babasaheb Ambedkar Marathwada Univ.

Abstract: The main objective of the paper is to study explicit bounds of certain dynamic integral inequalities on time scales. Using these inequalities we prove the uniqueness of some partial intrgrodifferential equations on time scales.

▶ CP-Th-BC-61-5 — 11:20–11:40

Bifurcational Geometric Methods for the Global Qualitative Analysis of Low-Dimensional Polynomial Dynamical Systems

Gaiko, Valery — National Acad. of Sci. of Belarus

Abstract: The global qualitative analysis of low-dimensional polynomial dynamical systems is carried out. Using new bifurcational geometric methods, we solve Hilbert's Sixteenth Problem on limit cycles for the general 2D Liénard polynomial system with an arbitrary number of singular points. Applying these methods, we study also 3D polynomial systems and complete the strange attractor bifurcation scenario for the classical Lorenz system connecting globally the homoclinic, period-doubling, Andronov-Shilnikov, and period-halving bifurcations of its limit cycles.

▶ CP-Th-BC-61-6 — 11:40–12:00

Numerical Null Controllability of Fractional Dynamical Systems

Govindaraj, Venkatesan — Indian Inst. of Space Sci. & Tech.

Abstract: Many systems are better characterized using a non-integer order dynamic model based on fractional calculus. The fractional order integration and differentiation represent a rapidly growing field both in theory and in applications to real world problems. Controllability is one of the fundamental concepts in control theory which means that it is possible to steer a dynamical system from an arbitrary initial state to arbitrary final state using a set of admissible controls. Specifically this paper considers the problem of steering the state of a linear time invariant fractional dynamical systems to the origin when the control used is minimum energy admissible control. Sufficient conditions are given for the null controllability of nonlinear fractional dynamical systems. Moreover numerical aspects of the problem are discussed.

CP-Th-BC-62 — 10:00–12:00 — 102

Linear Algebra

Chair: Ratemi, Wajdi — Univ. of Tripoli

Abstract:

▶ CP-Th-BC-62-1 — 10:00–10:20

Tripoli Polynomials and Its Accompanying Differential Equations

Ratemi, Wajdi — Univ. of Tripoli

Abstract: This paper introduces Tripoli polynomials that generate Waterloo

Numbers. The W-Numbers are related to Pascal's Triangle and they represent the number of coefficients in r-nomials expansions raised to power n. The T-Polynomials of degree m has two interesting properties; one is that its roots are -1, -2, -3,⋯-m, while the other is that the sum of its coefficients always add to an integer equals to m+1. The accompanying differential equations to those polynomials are introduced.

▶CP-Th-BC-62-2 10:20–10:40

Computing Symmetric Positive Definite Solutions of Three Types of Nonlinear Matrix Equations

Bagherpour, Negin — Sharif Univ. of Tech.
Mahdavi-Amiri, Nezam — Sharif Univ. of Tech.

Abstract: Nonlinear matrix equations arise in many practical contexts related to control theory, dynamical programming and finite element methods for solving some partial differential equations. In most of these applications, it is needed to compute a symmetric and positive definite solution. Here, we propose new iterative algorithms for solving three different types of nonlinear matrix equations. We have recently proposed a new algorithm for solving positive definite total least squares problems (poster submission 56). Making use of an iterative process for inverse of a matrix, we convert the nonlinear matrix equation to an iterative linear one, and, in every iteration, we apply our recent algorithm to solve the linear subproblem and update the newly defined variables and the matrix inverse terms using appropriate formulas. Our proposed algorithms have a number of useful features including lower computing times and error values comparing to existing methods.

▶CP-Th-BC-62-3 10:40–11:00

A Kinetic Ising Model and the Spectra of Some Jacobi Matrices

Fonseca, Carlos — Kuwait Univ.

Abstract: One-dimensional statistical physics models play a fundamental role in understanding the dynamics of complex systems in a variety of fields, from chemistry and physics, to social sciences, biology, and nanoscience. Due to their simplicity, they are amenable to exact solutions that can lead to generalizations in higher dimensions. In 1963, R. Glauber solved exactly a one-dimensional spin model, known in literature as the kinetic Ising chain, KISC, that led to many applications and two-temperature generalizations. In this talk we consider a case of temperature distributions, extracting information regarding the physical properties of the system from the spectrum analysis of matrix certain Jacobi matrix. We also analyze the eigenvalues of some perturbed Jacobi matrices. The results contain as particular cases the known spectra of several classes of tridiagonal matrices studied recently. This is a join work with S. Kouachi, D.A. Mazilu, and I. Mazilu.

▶CP-Th-BC-62-4 11:00–11:20

Estimates for the Structured Eigenvalue Backward Error of Any T-palindromic Matrix Polynomial

Sharma, Punit — Indian Inst. of Tech. Guwahati

Abstract: We study the backward error of approximate eigenvalues of T-palindromic polynomials of higher degree with respect to structure preserving perturbation. We derive a lower bound for the eigenvalue backward error of any T-palindromic polynomial with respect to structure preserving perturbation which is also an upper bound for the backward error with respect to arbitrary perturbation. We also give a choice of vectors to obtain a upper bound for T-palindromic eigenvalue backward error. The tightness of these bounds are illustrated by numerical experiments. Similar estimates are also obtained for T-antipalindromic and T-alternating matrix polynomials of any degree.

▶CP-Th-BC-62-5 11:20–11:40

Blind Image Deconvolution Through Bezoutains

Belhaj, Skander — Manouba Univ. (ISAMM)
Diaz-Toca, Gema — Univ. of Murcia

Abstract: In this paper, we introduce a fast algorithm for computing the univariate GCD of several polynomials (not pairwise) based on the generalized Bezout matrix by using Barnett's method. This novel approach is devoted to presenting an algorithm that permits to solve the problem of blind image deconvolution by computing greatest common divisors (GCD) of several polynomials. Specifically, we design a specialized algorithm for computing the GCD of bivariate polynomials of blurred images which correspond to z-transforms to recover the original image. All algorithms have been implemented in Matlab and experimental results with synthetically blurred images are included to illustrate the effectiveness of our approach.

CP-Th-BC-63 10:00–12:00 103

Discrete Mathematics

Chair: Pirzada, Shariefuddin — Univ. of Kashmir

Abstract:

▶CP-Th-BC-63-1 10:00–10:20

Applications of Oriented Graphs-tournaments and Football Sequences

Pirzada, Shariefuddin — Univ. of Kashmir

Abstract: One of the popular ranking methods is the pairwise comparison of the objects with applications: biological, chemical, network modeling, economical, human relation modeling. We consider sports applications and use oriented graphs and tournaments.

▶CP-Th-BC-63-2 10:20–10:40

On Hajós Conjecture

Lai, Chunhui — Minnan Normal Univ.

Abstract: Hajós conjectured that every simple even graph on n vertices can be decomposed into at most $n/2$ cycles (see L. Lovasz, On covering of graphs, in: P. Erdos, G.O.H. Katona (Eds.), Theory of Graphs, Academic Press, New York, 1968, pp. 231 - 236). This talk summarizes some results on this problem and the conjectures that relate to this. We do not think Hajós conjecture is true.

▶CP-Th-BC-63-3 10:40–11:00

Trends in Polar Orthogonal Polynomilas

Abdelhamid, Rehouma — Department of Mathematic Univ. of Eloued Algeria

Abstract: We aim studying a new corresponding set of monic polynomials corresponding to a General orthogonal polynomials wich called polar general orthogonal polynomials. We speaking some open question relating to asymptotic behavior and recurrence relations and other comparison question between this general orthogonal polynomials and its polar polynomials.More special cases was taken into account as : polar monic orthogonal polynomials with respect to the measure supported on the unit circle.

▶CP-Th-BC-63-4 11:00–11:20

Total Edge Product Cordial Labeling of Generalized Prism and Toroidal Grid

Siddiqui, Muhammad Kamran — Department of Mathematics Comsats Inst. of Information Tech. Sahiwal, Pakistan
Siddiqui, Muhammad Kamran — Department of Mathematics Comsats Inst. of Information Tech. Sahiwal, Pakistan

Abstract: For a graph $G = (V(G), E(G))$, an edge labeling function $\varphi : E(G) \to \{0, 1, ..., k-1\}$ where k is an integer, $2 \le k \le |E(G)|$, induces a vertex labeling function $\varphi^* : V(G) \to \{0, 1, ..., k-1\}$ such that φ^* is the product of the labels of the edges incident to v(mod k). This function φ is called k-total edge product cordial labeling of G if $|(v_\varphi(i) + e_\varphi(i)) - (v_\varphi(j) + e_\varphi(j))| \le 1$ for all $i, j \in \{0, 1, ..., k-1\}$. In this paper, we investigated 3-total product cordial labeling of generalized prism and toroidal grid.

▶CP-Th-BC-63-5 11:20–11:40

On Intuitionistic L-Fuzzy Finite Automata

Abdullah, Saleem — Quaid-i-Azam Univ., Islamabad

Abstract: In this article, we introduce the concept of intuitionistic L-fuzzy automata, where L is a lattice ordered monoid. The given concept is a generalization of Fuzzy automata, L-fuzzy automata and intuitionistic fuzzy automata. We further define the source operator, successor operator and strong successor operators and some interesting results. We also define intuitionistic L-fuzzy submachine and intuitionistic L-fuzzy subsystems of intuitionistic L-fuzzy automata (finite state machine) and their characterizations.

▶CP-Th-BC-63-6 11:40–12:00

SKEW EQUIENERGETIC DIGRAPHS

K C, NANDEESH — KARNATAK Univ. DHARWAD KARNATAKA STATE INDIA

Abstract: Let D be a digraph with skew-adjacency matrix S(D). The skew energy of D is defined as the sum of the norms of all eigenvalues of S(D). Two digraphs are said to be skew equienergetic if their skew energies are equal. We establish an expression for the characteristic polynomial of the skew adjacency matrix of the join of two digraphs and for the respective skew energy, and thereby construct non-cospectral, skew equienergetic digraphs on n vertices, for all n greater than or equal to 6. Thus we arrive at the solution of some open problems proposed in [X. Li, H. Lian, A survey on the skew energy of oriented graphs, arXiv: 1304.5707].

CP-Th-BC-64 10:00–12:00 104

Other Mathematical Topics and their Applications

Chair: Ramesh, Ramasamy — Dr. Mahalingam College of Engineering & Tech.

Abstract:

▶CP-Th-BC-64-1 10:00–10:20

Formulation of A New Field of Spherical Trigonometric and Its Application to

Physical Sciences

Ramesh, Ramasamy — Dr. Mahalingam College of Engineering & Tech.
Kalimuthu, Sennimalai — Center for inner study

Abstract: The foundations of classical euclidean geometry and trigonometry are widely applied in the all field of science, engineering and technology. Riemann geometry and its relevant trigonometry are the basics in general relativity theory. The formulas of spherical trigonometry are one of the main concepts of cosmology. In this work, the authors formulate a entirely new type of spherical triangles and its trigonometry and apply to particles, gravitational physics, block holes and dark matter.

▶ CP-Th-BC-64-2 10:20–10:40

ITERATIVE ALGORITHM FOR ZEROS OF BOUNDED M-ACCRETIVE NON-LINEAR OPERATORS

DJITTE, Ngalla — Gaston Berger Univ.

Abstract: An iteration process is proved to converge *strongly* to a solution of the equation $Au = 0$ where A is a bounded m-accretive operator on L_p spaces, $1 < p \le 2$. The ideas of the iteration process are applied to approximate fixed points of uniformly continuous pseudocontractive maps.

▶ CP-Th-BC-64-3 10:40–11:00

Graphs with Non-concurrent Longest Cycles in Lattices

Shabbir, Ayesha — Univ. College of Engineering, Sci. & Tech.,Lahore Leads Univ., Lahore, Pakistan

Abstract: In 1966 T. Gallai asked whether connected graphs with empty intersection of their longest path do or do not exist . After examples of such graphs were found, the question was extended to graphs of higher connectivity, and to cycles instead of paths. Examples being again found, for connectivity up to 3, the question has been asked whether there exist such graphs in geometric lattices. And, response was again positive. Here we are presenting examples of graphs embeddable in the (infinite) triangular, square and hexagonal lattices, and (finite) lattices defined on surfaces in which any pair of vertices is missed by some longest cycle.

▶ CP-Th-BC-64-4 11:00–11:20

Pressure Anisotropy and Dark Energy Cosmological Models in Scale Invariant Theory of Gravitation

Mishra, Bivudutta — Birla Inst. of Tech. & Sci.-Pilani, Hyderabad Campus

Abstract: The problem of an anisotropic universe in the form of a diagonal Bianchi type V space-time is investigated in scale invariant theory with dark energy. The matter field is considered in the form of perfect fluid. Pressure anisotropy is considered along different spatial directions. From the constructed cosmological models, we found a dynamic pressure anisotropy which continues along with the cosmic expansion. At a late phase of cosmic evolution, the model enters into a phantom region.

▶ CP-Th-BC-64-5 11:20–11:40

Wavelet Multiplicity Function on Local Fields of Positive Characteristics

SHUKLA, NIRAJ KUMAR — INDIAN Inst. OF Tech. INDORE

Abstract: The concepts of shift invariant spaces and multiresolution analysis are extensively studied in Euclidean spaces. In this article we extend the theory of shift-invariant spaces to the context of local fields of positive characteristics having non-archimedean metric and show that the concepts of range function, multiplicity function and spectral function are also valid analogous to the Euclidean case. As a consequence of this generalization we make a connection between the dimension function and the multiplicity function associated to an orthonormal wavelet. Further, we prove that the wavelet multiplicity function satisfies a consistency equation. This is a joint work with S.C. Maury.

CP-Th-BC-65 10:00–12:00 105

Dynamical Systems and Nonlinear Analysis

Chair: Ishwar, Bhola — BRA Bihar Univ., Muzaffarpur

Abstract:

▶ CP-Th-BC-65-1 10:00–10:20

NONLINEAR STABILITY IN GENERALIZED PHOTOGRAVITATIONAL RESTRICTED THREE BODY PROBLEM

Ishwar, Bhola — BRA Bihar Univ., Muzaffarpur

Abstract: We have discussed the nonlinear stability of triangular equilibrium points in generalized photogravitational restricted three body problem. The problem is generalized in the sense that both primaries are taken as oblate spheroid. We have applied Arnold's theorem to examine the condition of nonlinear stability. We have found three critical mass ratios where this theorem fails. The stability condition is different from cllasical case due to radiation and oblateness of the primaries.

▶ CP-Th-BC-65-2 10:20–10:40

Evaluation of Vertical Transmission and Vaccination Impacts Concerning Hepatitis B Disease in A Pygmy Group in the East of Cameroon.

Yannick, Kouakep Tchaptchie — Univ. of Ngaoundere

Abstract: We formulate an age-strutured model for HBV including the vertical transmission and a vaccination strategy and study their impacts on stability of equilibria (disease free equilibrium and endemic equilibrium). An application is done on a set of data for a «Baka» pygmy group in the East of Cameroon. We see numerically also the fact that ignoring the vertical transmission and vaccination doesn't lead to a good approximation of reality.

▶ CP-Th-BC-65-3 10:40–11:00

Fixed Point Results and Its Applied Aspects in Generalized Metric Spaces

Jha, Kanhaiya — Kathmandu Univ.

Abstract: The fixed point theory as a part of non-linear analysis, is a study of function equation in metric or non-metric setting. The classical Banach contraction principle in metric space is one of the fundamental results in metric space with wide applications. The main purpose of this presentation is to discuss some developments of generalized classical metric sub-spaces in functional analysis with applications to other disciplines.

▶ CP-Th-BC-65-4 11:00–11:20

Solutions of Nonlinear Volterra Integro-Differential Equations for Generalized Contraction Mappings

NASHINE, HEMANT KUMAR — Amity School of Applied Sci., Amity Univ.

Abstract: We propose coincidence and common fixed point results for a quadruple of self-mappings satisfying compatibility and subsequentially continuity (alternately subcompatibility and reciprocally continuity) in metric space X under a generalized Φ-contractive condition. An example and an application, for the solution of certain nonlinear Volterra integro-differential equations, are given to illustrate the usability of the obtained results.

▶ CP-Th-BC-65-5 11:20–11:40

How Far Zooplankton's Selectivity Affects Plankton Dynamics and Bloom Phenomenon: A Mathematical Study

Bairagi, Nandadulal — Jadavpur Univ.

Abstract: Harmful Algal Bloom (HAB) is a global problem in marine biology. HABs have adverse effects on fisheries, tourism, ecosystem and environment. Several studies have shown that a number of phytoplankton species (called toxin producing phytoplankton or TPP) have the ability to produce toxic substances and the others have not (called non toxic phytoplankton or NTP). These toxin producing phytoplankton are some times less preferred or avoided by herbivorous zooplankton. Therefore, it may be interesting to observe the plankton dynamics with zooplankton's preference or selectivity. The objective of our study will be to propose a mathematical model that incorporates zooplankton's selectivity on NTP over TPP and observe how far this selectivity plays role on plankton dynamics and blooms.

▶ CP-Th-BC-65-6 11:40–12:00

Far Field Behavior to Study Planar Shock Waves in Radiative Magnetogasdynamics

Yadav, Sanjay — ITM Univ. Gurgaon Haryana
Arora, Rajan — Indian Inst. of Tech. Roorkee

Abstract: In this paper, an asymptotic equation is derived which describes the far-field behavior of the governing system of partial differential equations for a one dimensional planar symmetric flow in radiative magnetogasdynamics. This evolution equation is inviscid Burger's equation. A Lie group of transformations method is used to obtain the solution of this evolution equation. This method is based on the differential equation being invariant under a family of transformations depending on a small parameter. The invariant transformation allows one to obtain an ordinary differential equation, or reduces the order of partial differential equation.

CP-Th-BC-66 10:00–12:00 VIP4-3

Computer Science, Applied, Algebraic, and Computational Geometry, Chemistry, Chemical Engineering, General

Chair: Trofimov, Vyacheslav — Lomonosov Moscow State Univ.

Abstract:

▶ CP-Th-BC-66-1 10:00–10:20

Two-step Iteration Process for Numerical Solution of 2D Nonlinear Equations with Arbitrary BC

Trofimov, Vyacheslav — Lomonosov Moscow State Univ.
Loginova, Maria — Lomonosov Moscow State Univ.
Egorenkov, Vladimir — Lomonosov Moscow State Univ.

Denisov, Anton Lomonosov Moscow State Univ.

Abstract: We propose two-step iteration process for numerical solution of the 2D nonlinear problems with arbitrary BC. In opposite to the split-step method, our method allows us to realize a conservatism property of finite-difference scheme as well as its asymptotic stability. In current report we demonstrate efficiency of the proposed iteration method by considering two problems. First one is a femtosecond laser pulse propagation in semiconductor under the action of an external electric field. This process is described by the set of 2D non-stationary partial differential equations concerning the concentration of both free electrons and ionized donors, and potential of electric field, and its intensity. The second problem is nonlinear propagation of 2D laser beam, which is described by nonlinear Schrodinger equation with artificial BC. Proposed iteration process can be easy generalized for the numerical solution of the multi-dimensional nonlinear problems.

▶ CP-Th-BC-66-2 10:20–10:40

Hemi-slant Submanifolds as Warped Products in A Nearly Kaehler Manifold

Khan, Kamran Aligarh Muslim Univ., Aligarh

Abstract: Warped product manifolds provide a natural frame work for time dependent mechanical system and have applications in Physics. The studies on warped product manifolds with extrinsic geometric point of view intensified after B.Y. Chen's work on CR-warped product submanifolds of Kaehler manifolds. In the present article, we study hemi-slant submanifolds as warped products in nearly Kaehler manifolds. Particularly, some characterizations are worked out under which a hemi-slant submanifold reduces to hemi-slant warped submanifold.

▶ CP-Th-BC-66-3 10:40–11:00

Scale-bridging Massively Parallel Molecular Simulation with Ls1 Mardyn

Horsch, Martin Thomas Univ. of Kaiserslautern
Langenbach, Kai Univ. of Kaiserslautern
Bernreuther, Martin High Performance Computing Center Stuttgart
Glass, Colin High Performance Computing Center Stuttgart
Eckhardt, Wolfgang Technical Univ. Munich
Neumann, Philipp Technical Univ. Munich
Bungartz, Hans-Joachim Technical Univ. Munich
Eckelsbach, Stefan Univ. of Paderborn
Vrabec, Jadran Univ. of Paderborn
Hasse, Hans Univ. of Kaiserslautern

Abstract: Molecular modelling and simulation has become a powerful tool which can be applied to many physical processes and properties of fluids on the molecular level. A shift in the accessible length and time scales due to massively parallel high-performance computing has greatly increased its potential. The novel molecular dynamics code ls1 mardyn, which scales excellently on up to 146 000 cores, is presented, highlighting the emergence of computational molecular engineering as a discipline.

▶ CP-Th-BC-66-4 11:00–11:20

Conservative Discrete Velocity Method for Non-equilibrium Flows

Zhang, Yonghao Univ. of Strathclyde

Abstract: Rapid advances have been made for micro/nano-fluidic technology, which demands computationally efficient design simulation tools that can capture non-equilibrium flow phenomena. Our recent development of conservative discrete velocity method for modelling gas flows beyond the Navier-Stokes hydrodynamics will be discussed. With a moderate discrete velocity set, we find our model can accurately recover steady and transient solutions of the kinetic equation in the slip-flow and early transition regimes.

EM-Th-D-01 13:30–15:30 311A

Third Workshop on Hybrid Methodologies for Symbolic-Numeric Computation - Part VIII of VIII

For Part 1, see EM-Mo-D-01
For Part 2, see EM-Mo-E-01
For Part 3, see EM-Tu-D-01
For Part 4, see EM-Tu-E-01
For Part 5, see EM-We-D-01
For Part 6, see EM-We-E-01
For Part 7, see EM-Th-BC-01

Organizer: Giesbrecht, Mark Univ. of Waterloo
Organizer: Kaltofen, Erich North Carolina State Univ.
Organizer: Safey El Din, Mohab Univ. Pierre & Marie Curie
Organizer: Zhi, Lihong Acad. of Mathematics & Sys. Sci.

Abstract: Hybrid symbolic-numeric computation methods, which first appeared some twenty years ago, have gained considerable prominence. Algorithms have been developed that improve numeric robustness (e.g., in quadrature or solving ODE systems) using symbolic techniques prior to, or during, a numerical solution. Likewise, traditionally symbolic algorithms have seen speed improvements from adaptation of numeric methods (e.g., lattice reduction methods). There is also an emerging approach of characterizing, locating, and solving "interesting nearby problems", wherein one seeks an important event (for example a nontrivial factorization or other useful singularities), that in some measure is close to a given problem (one that might have only imprecisely specified data). Many novel techniques have been developed in these complementary areas, but there is a general belief that a deeper understanding and wider approach will foster future progress. The problems we are interested are driven by applications in computational physics (quadrature of singular integrals), dynamics (symplectic integrators), robotics (global solutions of direct and inverse problems near singular manifolds), control theory (stability of models), and the engineering of large-scale continuous and hybrid discrete-continuous dynamical systems. Emphasis will be given to validated and certified outputs via algebraic and exact techniques, error estimation, interval techniques and optimization strategies.
Our workshop will follow up on the seminal SIAM-MSRI Workshop on Hybrid Methodologies for Symbolic-Numeric Computation held in November 2010 and the Fields Institute Workshop on Hybrid Methodologies for Symbolic-Numeric Computation, November 16-19, 2011 at the University of Waterloo, Canada. We will provide a forum for researchers on all sides of hybrid symbolic-numeric computation.

▶ MS-Th-D-01-1 13:30–14:00

Classifying Polynomial Systems Using the Canonical Form of A Graph

Yu, Xiangcheng Univ. of Illinois at Chicago

Abstract: We designed a web interface to apply polynomial homotopy continuation to solve polynomial systems. Our problem is to classify the polynomial systems we have already solved. For this problem we represent polynomials by a graph. We store the canonical form of each polynomial system we solved. This is joint work with Nathan Bliss, Jeff Sommars, and Jan Verschelde.

▶ EM-Th-D-01-2 14:00–14:30

Invariants of Finite Abelian Groups and Their Use in Symmetry Reduction of Dynamical Systems

Labahn, George Univ. of Waterloo

Abstract: We describe the computation of rational invariants of the linear action of a finite abelian group in the non-modular case and investigate its use in symmetry reductions of dynamical and polynomial systems. Finite abelian subgroups of GL(n,K) can be diagonalized which allows the group action to be accurately described by an integer matrix of exponents. We can make use of integer linear algebra to compute both a minimal generating set of invariants and the substitution to rewrite any invariant in terms of this generating set. The set of invariants provide a symmetry reduction scheme for dynamical and polynomial systems whose solution set is invariant by a finite abelian group action. A special case of the symmetry reduction algorithm applies to reduce the number of parameters in physical, chemical or biological models.

▶ EM-Th-D-01-3 14:30–15:00

Output-sensitive Algorithms for Sumset and Sparse Polynomial Multiplication

Arnold, Andrew Univ. of Waterloo

Abstract: We consider the complexity of multiplying two univariate polynomials given by their sparse representations. A product of sparse polynomials may have up to quadratically many terms compared to the inputs, but possibly as few as a constant number of terms. We present a randomized algorithm that improves on the bit-complexity of sparse multiplication when the number of terms in the product is sufficiently small. As a subroutine we present a fast probabilistic algorithm for sumset.

▶ MS-Th-D-01-4 15:00–15:30

Approximate Computation with Differential Polynomials: Approximate GCRDs

Giesbrecht, Mark Univ. of Waterloo

Abstract: Differential (Ore) type polynomials with approximate polynomial coefficients are introduced. These provide a useful representation of approximate linear differential operators with a strong algebraic structure, which has been used very successfully in the exact, symbolic, setting. As an entrée to this framework, we present an algorithm for the approximate Greatest Common Right Divisor (GCRD) of two approximate differential polynomials. The GCRD is intuitively the linear differential operator whose solutions are those common to the two input operators. We prove that the problem is well-defined (i.e., nearest polynomials with a GCRD exist), and explore algorithms to compute an approximate GCRD. We work on an appropriately "linearized" differential Sylvester matrix, and extend methods for the approximate GCD of

regular polynomials to this new setting, including SVD-based methods and Newton iteration. This is joint work with PhD student Joseph Haraldson (Waterloo) and Erich Kaltofen (NCSU).

MS-Th-D-02 13:30–15:30 309A
Special session 2 of Chinese Conference of Complex Networks (CCCN) 2015
Organizer: Lu, Jinhu — Acad. of Mathematics & Sys. Sci., Chinese Acad. of Sci.

Abstract: ssion contributes as a part of ICIAM 2015 from the Complex networks and system control TC, which involves two 1-hour speakers as the keynote lectures of CCCN 2015. Two invited speakers are the leading researchers in the involved fields: Prof. Jun-an Lu (Wuhan University) and Prof. Xiang Li (Fudan University). Prof. Jun-an Lu is a full Professor in the School of Mathematics and Statistics, Wuhan University.Prof. Lu received the prestigious National Natural Science Award from the Chinese government in 2008 and First Prize of Natural Science Award from the Ministry of Education of China in 2007. Prof. Xiang Li is a professor in Fudan University . He was the recipient of the IEEE Guillemin - Cauer Best Transactions Paper Award from the IEEE Circuits and Systems Society in 2005, Shanghai Natural Science Award (first class) in 2008, Shanghai Science and Technology Young Talents Award in 2010, the New Century Excellent Talents Program of Chinese Universities from the Ministry of Education, China, in 2009, Shanghai Science and Technology Rising Star in 2005 and 2009, and other awards and honors.

MS-Th-D-03 13:30–15:30 306A
Propagation Phenomena of Reaction-Diffusion Models in Biology - Part I of IV
For Part 2, see MS-Th-E-03
For Part 3, see MS-Fr-D-03
For Part 4, see MS-Fr-E-03
Organizer: Li, Wan-Tong — Lanzhou Univ.
Organizer: Ruan, Shigui — Univ. of Miami

Abstract: With the tide of globalization, biological invasions and pathogen transmission, which in turn can affect ecosystem or threaten public health, become focal spots in literature. In mathematical biology, there are many reaction-diffusion models arising from various applications such as animal dispersal, geographic spread of epidemics. To model/illustrate these problems/phenomena and investigate/evaluate the corresponding control strategy, it has been proved that the corresponding propagation modes are very important and useful. This minisymposium focus on the recent advances of propagation phenomena of different reaction-diffusion models in biology. In particular, the traveling wave solutions, asymptotic spreading, entire solutions, generalized transmission and threshold dynamics with their applications of reaction-diffusion models will be discussed.

▶ MS-Th-D-03-1 13:30–14:00
Entire Solutions in A Nonlocal Dispersal Epidemic Model
Li, Wan-Tong — Lanzhou Univ.

Abstract: This talk is concerned with entire solutions of a nonlocal dispersal epidemic model. Unlike local dispersal problems, a nonlocal dispersal operator is not compact and the solutions of nonlocal dispersal system studied here lack regularity in suitable spaces, which affects the uniform convergence of the solution sequences. A key idea is to characterize the asymptotic behaviors of the traveling wave solutions at infinite. This is the joint work with Li Zhang and Shi-Liang Wu.

▶ MS-Th-D-03-2 14:00–14:30
Asymptotic Behavior of Solutions to Reaction-diffusion Equations with Time-delay
Mei, Ming — McGill Univ.

Abstract: In this talk, we consider a mono-stable reaction-diffusion equation with time-delay, which represents the population model of single species like Australian blowflies. When the system of equations is non-monotone, it possesses some monotone or non-monotone traveling waves dependent on the time-delay to be small or big. We clarify that, for a certain given initial data, the corresponding solution will converge to a certain monotone or non-monotone traveling wave, where the wave speed can be specified.

▶ MS-Th-D-03-3 14:30–15:00
Influence of Boundary Conditions on the Qualitative Property of Reaction Diffusion Equations
Lou, Bendong — Tongji Univ.

Abstract: In this talk we consider reaction diffusion equations with various different boundary conditions. We will study the influence of the boundary conditions on the long time behavior of the solutions. Among others, we present some traveling semi-waves with monotone or non-monotone profiles which characterize the spreading phenomena of a species.

▶ MS-Th-D-03-4 15:00–15:30
Propagation Direction of Bistable Waves in A Nonlocal Reaction-diffusion Equation
Fang, Jian — Harbin Inst. of Tech.

Abstract: In this talk, we investigate the speed of traveling waves for a nonlocal reaction-diffusion equation of bistable type. It turns out that varying the range of symmetric nonlocal interaction may alter the propagation direction of waves.

MS-Th-D-04 13:30–15:30 308
Curves and Surfaces in Computer Aided Geometric Design - Part II of III
For Part 1, see MS-Th-BC-04
For Part 3, see MS-Th-E-04
Organizer: Jia, Xiaohong — Chinese Acad. of Sci.
Organizer: Cheng, Jin-San — Chinese Acad. of Sci.

Abstract: The symposium is aimed at bridging between people who are working theoretically on curves and surfaces in algebraic geometry and those who are endeavoring to seek for suitable modeling forms of curves and surfaces in Computer Aided Geometric Design. Therefore, the symposium includes wide-ranging topics on curves and surfaces from classic theory aspects to their applications in modern industry. The forms of curves and surfaces consist of but are not limited to: algebraic curves and surfaces, parametric curves and surfaces including NURBS as well as triangular surface patches.

▶ MS-Th-D-04-1 13:30–14:00
A Visual and Computational Framework for Evaluating the Effectiveness of Surgery on Infants Born with Craniosynostosis
Goldman, Ron — Rice Univ.
Yuan, Binhang — Rice Univ.
Khechoyan, David — Baylor College of Medicine

Abstract: We provide a computational framework to evaluate the effectiveness of cranial surgery on infants suffering from craniosynostosis. The input consists of a 3D triangle mesh representing the infant's head, captured by a new non-invasive 3DMD imaging system. The computational framework consists of three parts: (i) mesh decimation to simplify the input; (ii) mesh registration to find a correspondence between mesh pairs; (iii) comparison of local mesh features for the same infant before and after surgery.

▶ MS-Th-D-04-2 14:00–14:30
Between Moving Least-squares and Moving Least- ℓ1
Levin, David — Tel-Aviv Universiuty

Abstract: One way of generation smooth approximations using scattered data in high dimension is by the moving least-squares method. We suggest to use an error measure which is between the ℓ1 and the ℓ2 norms, with the advantages of both. Namely, yielding smooth approximations which are not too sensitive to outliers. A fast iterative method for computing the new approximation is discussed and demonstrated and the approximation error is analysed.

▶ MS-Th-D-04-3 14:30–15:00
Precise Kinematic and Robotics Motion Planning Using Algebraic Contact Analysis
Elber, Gershon — Technion, Israel Inst. of Tech.

Abstract: Kinematic and motion analysis has applications and needs in numerous applications. We exploit algebraic tools to map kinematics analysis and configurations space computations to sets of algebraic constraints, only to precisely solve them. A subdivision based solver for (piecewise) polynomial multivariates that we develop is employed to efficient and robustly resolve these constraints. Results demonstrating all these applications will also be presented.
* In collaboration with Myung-Soo Kim and Yong Joon Kim.

▶ MS-Th-D-04-4 15:00–15:30
Problem Reduction to Parameter Space
Kim, Myung-Soo — Seoul National Univ.

Abstract: We present a problem reduction scheme for geometric computations to the parameter space of curves and surfaces. Geometric constraints are often represented with low degrees in x, y, z, but with higher degrees in the curve or surface parameters u, v, s, t. Thus, we eliminate x, y, z, but still represent them as functions of u, v, s, t, which reduces the computation of differential geometric properties to an almost triviality.

MS-Th-D-05 13:30–15:30 215
Applied and Industrial Mathematics in Spain - Part II of II
For Part 1, see MS-Th-BC-05

Organizer: Chacon Rebollo, Tomas Univ. of Sevilla

Abstract: This mini symposium presents an overview of the research in applied and industrial mathematics in Spain. This research has experienced a fast development in the last years, reaching a wide geographical and thematic extension. We present some talks on selected topics with a strong focus on real-world applications: analysis of gears in automotive industry, modeling of shallow water flows, wind turbine modeling and several problems proposed by the industry, solved by finite volume methods. Also, some other talks deal with more basic aspects of applied mathematics: mixed methods in Computational Fluid Dynamics, and reduced order models. This overview is complemented with another mini symposium at ICIAM 2015, that exclusively focuses on the Industrial Mathematics in Spain.

▶ MS-Th-D-05-1 13:30–14:00
Examples of Problems Defined by Enterprises and Institutions and Solved Using Finite Volume Methods
Vazquez-Cendon, Elena Univ. of Santiago de Compostela

Abstract: In this talk we present problems solved using finite volume methods. The problems were defined by enterprises and institutions and the mathematical technology developed is the core of scientific publications and software. In particular the IBER model (http://iberaula.es/web/index.php) is a two-dimensional mathematical model for the simulation of free surface flow in rivers and estuaries.

▶ MS-Th-D-05-2 14:00–14:30
Stabilized Methods and Inf-sup Conditions
Chacon Rebollo, Tomas Univ. of Sevilla

Abstract: Stabilized methods provide low-cost solvers for incompressible flows, making possible the use of equal order interpolation of velocity and pressure. In this talk we review the different inf-sup conditions that yield the stability of the pressure discretization, in accordance to each actual kind of stabilized method: Penalty-based, Residual-based and Projection-based. In particular we study the solution of the Primitive Equations of the Ocean by stabilized methods, in which inf-sup conditions in L^p norms are needed.

▶ CP-Th-D-05-3 14:30–14:50
Non-parametric Frontier Analysis of the Energy Efficiency of Urban Bus Lines and Vehicles
Lozano, Sebastian Univ. of Seville
Eguia, Ignacio Univ. of Seville
Molina, Jose Carlos Univ. of Seville
Racero, Jesus Univ. of Seville

Abstract: Data Envelopment Analysis (DEA) has been applied in many efficiency and benchmarking studies in the transportation sector. In this research, DEA is applied to urban bus lines and vehicles to assess the efficiency of the energy consumption of the different line/vehicle combinations. Since there are different types of vehicles, specific group frontiers as well as a global metafrontier are computed. This allows determining an energy efficiency index associated to each type of vehicle. The proposed approach also allows the estimation of potential energy savings for each bus line due to inefficient vehicle maintenance and driving practices and due to inefficient vehicle type assignment. This energy savings translate immediately into both cost and emissions reductions. Preliminary results of the application of the proposed approach to the city of Seville, Spain, are presented.

▶ CP-Th-D-05-4 14:50–15:10
Elliptic Functions in Simulation of Oil Recovery
Astafev, Vladimir Samara State Technical Univ.

Abstract: The objective of this paper is to simulate the inflow performance of multiple vertical wells producing from and injecting into a closed reservoir of constant thickness under pseudosteady-state conditions. For this case we represent a closed reservoir as an element of unbounded doubly periodic array of wells and use the elliptic Weierstrass functions to describe this inflow performance. This approach allow us for any shape of reservoirs: • to find the distribution of pressure and fluid velocities in the closed reservoir; • to calculate the productivity index and the shape facto; • to establish the influence matrix and the multiwell productivity matrix; • to introduce the multiwell productivity index and to find the optimal placement of producing wells in the closed reservoir; • to introduce the connectivity matrix and to evaluate on the base of this approach the interwell connectivity of injector/producer wells under waterflooding.

▶ CP-Th-D-05-5 15:10–15:30
Signal Denoising Using Local Polynomial Regression Harten's Multiresolution
Yanez, Dionisio F. Universidad Catolica de Valencia

Abstract: In recent years, a new family of Harten's multiresolution schemes [1,3] based on local polynomial regression has been presented [2] and applied to signal and image compression. These techniques present different properties, we analyze the applicability of these schemes to remove noise to digital signals and images. We use several kernel functions and compare our results with the results obtained using classical methods as multiresolution based on piecewise interpolation. Some numerical results are showed. References [1] F. Arandiga and R. Donat. Nonlinear multiscale descompositions: The approach of A. Harten. Numerical Algorithms, 23:175-216, 2000. [2] F. Arandiga and D. F. Yanez. Cell-average multiresolution based on local polynomial regression. application to image processing. Applied Mathematics and Computation, 245:1-16, 2014. [3] A. Harten. Multiresolution representation of data:General framework.SIAM J. Numer. Anal., 33:1205-1256, 1996.

MS-Th-D-06 13:30–15:30 201
Data-driven methods for quantifying uncertainty of multiscale dynamical systems - Part I of IV
For Part 2, see MS-Th-E-06
For Part 3, see MS-Fr-D-06
For Part 4, see MS-Fr-E-06

Organizer: Harlim, John The Pennsylvania State Univ.
Organizer: Sapsis, Themistoklis MIT
Organizer: Giannakis, Dimitrios New York Univ.

Abstract: A major challenge in contemporary applied science is to design efficient models for predicting dynamical behavior resulting from complex interaction of multiple scale processes. This task, implicitly, requires one to account for uncertainties of the models due to initial conditions, boundary conditions, model errors, and observation errors. A promising interdisciplinary approach to address such issue is with a data-driven statistical methods that combine ideas from dynamical systems theory, stochastic processes, statistics, and data analysis. This special session aims to bring together researchers from across the spectrum of disciplines related to data-driven methods to discuss the development and application of emerging ideas and techniques for these important and difficult practical issues.

▶ MS-Th-D-06-1 13:30–14:00
Diffusion Forecast
Harlim, John The Pennsylvania State Univ.

Abstract: I will discuss a nonparametric modeling approach for forecasting stochastic dynamical systems on low-dimensional manifolds. In the limit of large data, this approach converges to a Galerkin projection of the semigroup solution of the backward Kolmogorov equation of the underlying dynamics on a basis adapted to the invariant measure. This approach allows one to quantify evolve the probability distribution of non-trivial dynamical systems with equation-free modeling.

▶ MS-Th-D-06-2 14:00–14:30
Predicting the Cloud Patterns of the Madden-Julian Oscillation Through A Low-order Nonlinear Stochastic Model
Chen, Nan New York Univ.
Giannakis, Dimitrios New York Univ.

Abstract: We assess the limits of predictability of the large scale cloud patterns in the boreal winter MJO. NLSA is applied to define two spatial modes with high intermittency. A 4-D nonlinear stochastic model for the two observed MJO variables and two hidden variables involving correlated multiplicative noise defined through energy conserving nonlinear interaction is proposed. Systematic calibration and prediction experiments show the skillful prediction and the ensemble spread is an accurate indicator of forecast uncertainty.

▶ MS-Th-D-06-3 14:30–15:00
Filtering with Noisy Lagrangian Tracers
Tong, Xin Courant Inst. of Mathematical Sci.
Chen, Nan New York Univ.

Abstract: An important practical problem is the recovery of a turbulent velocity field using Lagrangian tracers that move with the fluid flow. Despite the inherent nonlinearity in measuring noisy Lagrangian tracers, there are exact closed analytic formulas for the optimal filter. These formulas provide a concrete framework for the analysis of filter performance in large tracers number limit, the demonstration of information barrier type of phenomena, and the construction of simplified filters using multiscale structures.

MS-Th-D-07 13:30–15:30 202A

Computational Methods in Ice Sheet Modeling for Next Generation Climate Simulations - Part I of II

For Part 2, see MS-Th-E-07

Organizer: Tezaur, Irina — Sandia national Laboratories
Organizer: Wei, Leng — LSEC
Organizer: Martin, Daniel — Lawrence Berkeley National Laboratory
Organizer: Ng, Esmond — Lawrence Berkeley National Laboratory
Organizer: Perego, Mauro — Sandia National Laboratories

Abstract: Changes in glaciers and ice sheets are expected to have a tremendous influence on sea-level rise and global climate change. Many mathematical challenges in simulating ice sheet dynamics arise: ill-conditioned systems; a wide range of scales; complex evolving geometries; ill-posed inverse problems; sparse observational data; large-scale forward and inverse UQ problems in high-dimensions (“curse of dimensionality”). Speakers in this MS will present recent developments aimed at overcoming these and other difficulties arising in ice sheet modeling. A broad range of topics will be covered, including forward and inverse problems, UQ, solvers/preconditioners, and coupling to global climate models.

▶ MS-Th-D-07-1 13:30–14:00

Mechanical Estimators for Shallow Ice Flow Models

Jouvet, Guillaume — ETH Zurich, VAW

Abstract: In this talk, we will revisit the derivation of shallow ice flow models from the Glen-Stokes one by working on the minimisation formulation instead of the Euler-Lagrange form as usual. This approach substantially shortens the traditional derivation and provides a unified formulation, which allows us to establish a posteriori estimates for the discrepancy between two hierarchically embedded model solutions. Eventually, we perform some modelling experiments to test the efficiency of these estimates.

▶ MS-Th-D-07-2 14:00–14:30

A Parallel Multigrid Solver for Full Stokes Ice Sheet Model

Wei, Leng — LSEC

Abstract: The full Stokes ice sheet problem with Coulomb friction boundary condition is a nonlinear problem, which requires a nonlinear iteration with dozens of steps, and with in each step a linearized boundary condition S-tokes problem with nonlinear coefficient is solved. A two level multigrid solver is proposed to handle the nonlinear boundary condition, and numerical result is presented to shown the efficiency of our solver.

▶ MS-Th-D-07-3 14:30–15:00

Albany/FELIX: A Robust and Scalable Trilinos-Based Finite-Element Ice Flow Dycore Built for Advanced Architectures and Analysis

Tezaur, Irina — Sandia national Laboratories
Demeshko, Irina — Sandia National Laboratories
Eldred, Michael — Sandia National Laboratories
Jakeman, John — Sandia National Laboratories
Perego, Mauro — Sandia National Laboratories
Price, Stephen — Los Alamos National Laboratory
Tuminaro, Raymond — Sandia National Labs

Abstract: This talk focuses on several recent computational advancements involving the Albany/FELIX finite-element dycore for the First-Order Stokes ice flow equations, notably: (1) porting to new architecture platforms using Trilinos templated linear algebra and Kokkos performance-portable kernels, (2) development of scalable and robust solvers for runs on these platforms, and (3) recent work in combining deterministic and Bayesian calibration methods towards formal UQ of uncertain model parameters (e.g., basal traction) influencing sea-level rise.

MS-Th-D-08 13:30–15:30 202B

The Ginzburg-Landau Model and Related Topics - Part IV of IV

For Part 1, see MS-We-D-08
For Part 2, see MS-We-E-08
For Part 3, see MS-Th-BC-08

Organizer: Golovaty, Dmitry — The Univ. of Akron
Organizer: Giorgi, Tiziana — New Mexico State Univ.

Abstract: The focus of the minisymposium is on mathematical problems related to Ginzburg-Landau model with application in physics and materials science including but not limited to: superconductivity, superfluidity, liquid crystals, and polymers. The speakers in this minisymposium will describe their recent research, including the development and structure of singular solutions of the Ginzburg-Landau-type problems and the dynamics of vortex motion. This minisymposium is sponsored by the SIAM Activity Group on Mathematical Aspects of Materials Science (SIAG/MS).

▶ MS-Th-D-08-1 13:30–14:00

About A Family of Harmonic Maps into the Projective Plane

Montero, Alberto — Pontificia Universidad Catolica de Chile

Abstract: In this talk I will present some results concerning some harmonic maps into the projective plane that appear as limits of minimizers of the Landau-de Gennes energy functional when the (one) elastic constant goes to zero. This is Joint work with Dmitry Golovaty.

▶ MS-Th-D-08-2 14:00–14:30

Chevron Structures in Smectic A Liquid Crystals

Giorgi, Tiziana — New Mexico State Univ.

Abstract: We will present an analysis of the chevron structure, which is formed in a Smectic A liquid crystal under the influence of an applied magnetic field. We will start with a two-dimensional de Gennes free energy functional for Smectic A, and use Gamma-convergence to show that in a suitable regime of fields, a chevron structure is favored by the energy. We will next present analogous results for the more general Chen-Lubensky free energy in a one-dimensional setup. This is joint work with Carlos García-Cervera and Sookyung Joo.

▶ MS-Th-D-08-3 14:30–15:00

Global Bifurcations of Vortices and Dipoles in 2D Bose-Einstein Condensates.

Contreras, Andres — New Mexico State Unniversity

Abstract:
We prove the existence of symmetric periodic solutions to

$$iu_t + \varepsilon^2 \Delta u + (1 - (x^2 + y^2) - |u|^2)u = 0.$$

Some of these solutions correspond to dipoles predicted in the physics literature. This is joint work with Carlos Garcia-Azpeitia.

▶ MS-Th-D-08-4 15:00–15:30

Dimension Reduction for the Landau-de Gennes Model in Nematic Thin Films.

Golovaty, Dmitry — The Univ. of Akron
Montero, Alberto — Pontificia Universidad Catolica de Chile
Sternberg, Peter — Indiana Univ.

Abstract: We use the method of Gamma-convergence to study the behavior of the Landau-de Gennes model for a nematic liquid crystalline film in the limit of vanishing thickness. We assume general weak anchoring conditions on the top and the bottom surfaces of the film and the strong Dirichlet boundary conditions on the lateral boundary of the film. We establish a general convergence result and then discuss the limiting problem in several parameter regimes.

MS-Th-D-09 13:30–15:30 203A

Recent advances on computational wave propagation - Part I of II

For Part 2, see MS-Th-E-09

Organizer: Li, Jichun — Univ. of Nevada Las Vegas
Organizer: Huang, Yunqing — Xiangtan Univ.
Organizer: Shu, Shi — Xiangtan Univ.

Abstract: This mini-symposium is organized to provide a forum for fellow researchers working on numerical methods for wave propagation problems to present and discuss their recent advances and achievements. Topics to be covered include but not limited to: hybrid FDTD methods, time-domain finite element methods, spectral methods, high-performance computing, high frequency waves, multiscale methods, novel techniques for metamaterials and cloaking simulations).
Note: All invited speakers are confirmed.

▶ MS-Th-D-09-1 13:30–14:00

Fast Spectral PDE Solvers for Complex Structures: the Fourier-Continuation Method

Bruno, Oscar — Caltech

Abstract: We present new spectral solvers for time evolution of Partial Differential Equations in general domains. Based on the novel Fourier-Continuation (FC) method for the resolution of the Gibbs phenomenon, these methodologies give rise to essentially dispersionless evolution. A variety of applications to linear and nonlinear PDEs, including the Maxwell equations, the Navier-Stokes equations and the elastic wave equation, demonstrate the significant improvements the new algorithms provide over the accuracy and speed resulting from other approaches.

▶ MS-Th-D-09-2 14:00–14:30

A Class of Uncertainty Quantification Algorithms for Stochastic Wave Scattering

Ganesh, Mahadevan — Colorado School of Mines

Abstract: We present an efficient framework for quantifying uncertainties in

the propagation of acoustic waves through a stochastic media. Simulation even for a single deterministic configuration is inherently difficult because of the complex media. The stochasticity leads to a larger dimensional model involving spatial variables and additional stochastic variables, and accounting for uncertainty in key parameters of the input probability distributions leads to substantial computational complexity. (This is a collaborative work with Stuart Hawkins.)

▶ MS-Th-D-09-3 14:30–15:00

Finite Element Analysis and Modeling of Invisibility Cloaks with Metamaterials

Li, Jichun Univ. of Nevada Las Vegas
Huang, Yunqing Xiangtan Univ.

Abstract: Since the pioneering works of Pendry et al and Leonhardt in 2006 (both published inVol.312 of Science, June 23, 2006), many interesting works on cloaks with metamaterials have been published. In this talk, I' ll first give a brief introduction to metamaterials, then I'll focus on some cloaking models and study them from the mathematical and simulation point of view. Both frequency and time-domain models and simulation results will be presented.

▶ MS-Th-D-09-4 15:00–15:30

Radiation Boundary Conditions for the Numerical Simulation of Waves: State of the Art and Prospects for the Future

Hagstrom, Thomas Southern Methodist Univ.

Abstract: As the radiation of energy to the far field is an important feature of most problems in wave theory, accurate and efficient near-field approximate radiation conditions are a necessary component of any comprehensive wave simulation tool. We review the theory and implementation of Complete Radiation Boundary Conditions - optimal methods in the simplest case of homogeneous, isotropic media - and discuss the prospects for extension to general hyperbolic systems and inhomogeneous far fields.

MS-Th-D-10 13:30–15:30 206B

Singular Problems and Integral Dynamical Models in Applied Mathematics - Part II of II

For Part 1, see MS-Th-BC-10

Organizer: Sidorov, Denis Energy Sys. Inst., Russian Acad. of Sci. (SB)

Abstract: This mini-symposium concentrates on the theory of singular equations especially applicable to stability, bifurcation and algorithmic analysis of DE/IEs in mechanics and mathematical physics. Mini-symposium addresses the recent results on existence theorems, regularization, and identification, including asymptotic, numerical and group theoretic methods. The employment of such methods in various problems in modern physics, heat-and-power engineering, and mechanics (plasma, aeroelasticity theory, phase transitions, rheology) has given the authors rich possibilities for creativity and applications. The special attention will be paid to Vlasov-Maxwell systems which are in the core of relativistic models of plasma physics and Maxwell models of photonic crystalls.

▶ MS-Th-D-10-1 13:30–14:00

Mathematical Modelling of Nonlinear Dynamics of Heat Transfer in Packed Beds

Sidorov, Denis Energy Sys. Inst., Russian Acad. of Sci. (SB)

Abstract: This talk concentrates on results of development of mathematical theory applicable for non-Newtonian fluid mechanics models studies. It concentrates on non-classical initial-boundary value problems arising in practical models of packed beds.

▶ MS-Th-D-10-2 14:00–14:30

On Stable Estimation of the Images Gradient Values

Sidorov, Denis Energy Sys. Inst., Russian Acad. of Sci. (SB)
Muftahov, Ildar Irkutsk State Technical Univ.

Abstract: The abstract scheme of regularising equations with vector regularisation parameter for linear operator equations is employed for stable estimation of images gradient. The special auxiliary regularising equation which possesses unique solution is used.

▶ MS-Th-D-10-3 14:30–15:00

Many Parametric Bifurcation Problem of the Deflection of the Elongated Plate in A Supersonic Gas Flow

Loginov, Boris Ulyanovsk State Technical Univ.
Badokina, Tatyana Mordovian State Univ. of N. P. Ogarev

Abstract: Bifurcation problem about buckling of strip-plate in supersonic gas flow under compressed/extended boundary stresses is considered. The dependence on bifurcation parameters (Mach number, compression/extension coefficient) and small normal load, expressed through the roots of the characteristic equation for the linearization, allows to give the problem exact statement, to determine the parameters critical manifolds, to construct (first for aeroelasticity problems) Green functions for the linearizations and bifurcating solutions asymptotics by Lyapounov-Schmidt method.

▶ MS-Th-D-10-4 15:00–15:30

Andronov-Hopf Bifurcation in Equations with Symmetrizable under Group Symmetry Linearization

Kim-Tyan, Luiza National Research Technological Univ. (Moscow Inst. of Steel & Alloys)
Loginov, Boris Ulyanovsk State Technical Univ.

Abstract: For first order differential equations in Banach spaces with densely defined linear Fredholm operator before the derivative and small parameter in nonlinearity in the linearization Andronov-Hoph bifurcation problem is considered. On the base of the suggested by V.A.Trenogin symmetrizability notion for the linear operators in Banach spaces sufficient conditions for Lyapounov-Schmidt branching equation pseudopotentiality types A and B are obtained and at the usage of Conley-Morse index theory the bifurcation existence theorem is proved.

MS-Th-D-11 13:30–15:30 203B

Matrix computations using structures and other innovative techniques - Part I of III

For Part 2, see MS-Th-E-11
For Part 3, see MS-Fr-D-11

Organizer: Xia, Jianlin Purdue Univ.
Organizer: Chen, Jie IBM Thomas J. Watson Research Center

Abstract: This minisymposium is concerned with a wide range of innovative matrix computation techniques, including structures, randomization, splitting preconditioning, etc. The techniques make it feasible to develop new fast and reliable direct or iterative solutions. In particular, certain block or hierarchical structures can be used to obtain effective preconditioners or nearly linear complexity direct solvers for challenging numerical problems. Interesting applications to imaging, PDE/integral equation solutions, optimization, parallel computing, and engineering simulations will also be shown.

▶ MS-Th-D-11-1 13:30–14:00

Randomized Algorithms for Numerical Linear Algebra

Gu, Ming Univ. of California Berkeley

Abstract: We discuss a new class of efficient randomized algorithms for spectrum-revealing LU, Cholesky and QR factorizations. Our algorithms are much more efficient than other approaches for low-rank matrix approximation and we develop a new set of approximation error bounds that suggest that our matrix factorizations are also at least as effective as other low-rank approximation methods.

▶ MS-Th-D-11-2 14:00–14:30

Linear-Cost Storage and Computation with Kernel Matrices

Chen, Jie IBM Thomas J. Watson Research Center

Abstract: Kernel matrices embrace a rich structure that enables more efficient storage and computation than does a usual n-by-n dense matrix. We present an O(n) data structure for compressing a kernel matrix and O(n) algorithms for various matrix operations, including matrix-vector multiplication, matrix inversion, determinant, and square root calculation. We demonstrate the use of this compressed structure in Gaussian process data analysis and kernel machine learning.

▶ MS-Th-D-11-3 14:30–15:00

The Multivariate Eigenvalue Problem

Zhang, Leihong Shanghai Univ. of Finance & Economics

Abstract: The Multivariate Eigenvalue Problem(MEP), arising from the Maximal Correlation Problem (MCP), is an important model in the canonical correlation analysis. In this talk, we shall characterize some distinctive traits of the absolute maximum correlation, and also present several efficient algorithms for MCP/MEP.

▶ MS-Th-D-11-4 15:00–15:30

An Efficient Method for Counting the Eigenvalues Inside A Region of the Complex Plane

Yin, Guojian Shenzhen Inst.s of Advanced Tech., Chinese Acad. of Sci.

Abstract: In many applications, the information about the number of eigenvalues inside a given region is required. In this talk, we give a contour-integral based method for this purpose. The new method is motivated by two important findings. An appealing feature of our method is that it can integrate with recently developed eigensolvers based on contour integrals to determine whether all desired eigenvalues are found by these methods. Numerical ex-

periments are reported to show the viability.

MS-Th-D-12 13:30–15:30 208B
Bifurcation, Stability and Applications - Part II of II
For Part 1, see MS-Th-BC-12

Organizer: Loginov, Boris — Ulyanovsk State Technical Univ.

Abstract: In applications of bifurcation theory the situation arises when the finite-dimensional branching equation (BEqs) is potential, while the original nonlinear equation haven't this property. Three articles are devoted to this phenomenon. Here sufficient conditions for BEq potentiality and pseudopotentiality are obtained, particularly under group symmetry conditions, when the bifurcation point has nontrivial stationary subgroup. For stationary and dynamic bifurcation problems general theorems are proved about the inheritance of the group symmetry of original nonlinear equation by the relevant Lyapounov and Schmidt BEqs moving along the trajectory of the branching point, taking into account the presence of stationary subgroup of the branching point. Theorems on the BEqs reduction (its order lowering) are proved at the action of continuous group symmetry, G-invariant implicit operators theorems are proved for stationary and dynamic bifurcation. Simple, but very technical examples of SO(2) and SH(2) symmetries are considered with the general form of C1-smooth BEq construction on allowed group symmetry. With the aid of Morse-Conley topological index theory it is proved the bifurcation existence theorem for Andronov-Hopf bifurcation. Sufficient conditions for the linearized stability of bifurcating solutions are obtained. The obtained results are applied to bifurcation problems with E. Schmidt spectrum in the linearization. Three communications are devoted to nonlinear equations, their solutions stability and bifurcation theory to problems of hydroaeroelasticity . One of them considers the multiparameter bifurcation problems on the divergence of the elongated plate in supersonic gas flow compressed or extended by external boundary conditions in the exact statement, that is achieved by the representation of the bifurcation manifold through the roots of the characteristic equation of the linearized ODE. Here the most difficulties arise at the analytical proof of the divergence absence. The Fredholm property of these problems is proved also on the base of the usage of the roots of characteristic equations of the linearization. Lyapounov functions and functionals, Lyapounov vector- functions techniques is applied to the investigation of solutions stability in two reports to hydroaeroelasticity problems and two articles on the stabilization of nonlinear systems motions (with digital control and with aftereffect.)

▶MS-Th-D-12-1 13:30–14:00
Direct Lyapounov Method in the Investigation of the Problems on Stability and Stabilization of Nonlinear Systems Motions with Aftereffect
Andreyev, Aleksander — Ulyanovsk State Univ.

Abstract: In the report the problems on stability and stabilization of nonlinear systems with aftereffect is investigated using Lyapunov functionals and nonstationary comparison systems. We present the new theorem on asymptotic stability of zero solution of the system of functional-differential equations with finite delay. The problem on stabilization of program motion of the mechanical system with delayed control is solved.

▶MS-Th-D-12-2 14:00–14:30
Method of Lyapunov Vector Functions in the Investigation of the Problems on the Stabilization of Nonlinear Systems Motions with Digital Control
Peregudova, Ol'ga — Ulyanovsk State Univ.

Abstract: In the report the problem of stabilization of nonlinear time-varying dynamical systems with digital control is investigated using Lyapunov vestor functions and comparison systems. We present a backstepping design based on the Euler approximate discrete-time model of a continuous-time plant. As an example the problem of motion stabilization of three-wheeled mobile robot with two degrees of freedom is solved on the basis of a sampling system and application of backstepping procedure with Lyapunov function.

▶MS-Th-D-12-3 14:30–15:00
Stability of Solutions for One Class of Initial Boundary Value Problems in Hydroaeroelasticity
Vel'misov, Petr — Ulyanovsk State Technical Univ.
Ankilov, Andrey — Ulyanovsk State Technical Univ.

Abstract: The mathematical models in problems about dynamics and stability of deformable elements at external (flying and submersibles, antenna plant, filters) and internal (flowing channels of different function, wind tunnels, nozzles, pipelines, sensors, vibration devices) flows is proposed. The analytical, numericaly analytical and numerical methods of the aerohydroelasticity problems solution are presented, and on their basis the dynamics and stability of the deformable elements at a flow their stream of liquid (gas) are researched.

▶MS-Th-D-12-4 15:00–15:30
Stability Investigation of Fluctuations of Construction Elastic Elements of the Base of Lyapounov Functionals
Ankilov, Andrey — Ulyanovsk State Technical Univ.
Vel'misov, Petr — Ulyanovsk State Technical Univ.

Abstract: For the example the mathematical model of the flow channel with an elastic element on the wall is proposed. The model represents an initial-boundary value problem for system of the differential equations with partial derivatives for determination of two unknown functions- deformation (deflection) of a element and velocity potential of liquid in channel. On the basis of construction of the Lyapunov type mixed functional the sufficient stability conditions of solutions of this problem are received.

MS-Th-D-13 13:30–15:30 VIP3-2
Progress in hyperbolic problems and applications - Part III of VI
For Part 1, see MS-We-E-13
For Part 2, see MS-Th-BC-13
For Part 4, see MS-Th-E-13
For Part 5, see MS-Fr-D-13
For Part 6, see MS-Fr-E-13

Organizer: Wang, Ying — Univ. of Oklahoma
Organizer: Tesdall, Allen — City Univ. of New York, College of Staten Island

Abstract: Hyperbolic conservation laws form the basis for the mathematical modeling of many physical systems, and describe a wide range of wave propagation and fluid flow phenomena, including shock waves in nonlinear situations. For one dimensional systems with small data, a well-posedness theory of entropy weak solutions is well known. Analysis in several space dimensions, however, remains an enormous challenge. In this minisymposium, recent results in the theory and numerical analysis of hyperbolic problems will be presented. A variety of computational techniques, including finite volume, finite element, spectral, WENO, and discontinuous Galerkin methods, will be represented.

▶MS-Th-D-13-1 13:30–14:00
Entropy Stability of Conservative Schemes for Conservation Laws
Li, Jiequan — Beijing Normal Univ.

Abstract: We shall show inherent relations between classical numerical viscosity and entropy dissipation and use them as principles to design high order schemes for convection-dominated fluid dynamical problems.

▶MS-Th-D-13-2 14:00–14:30
Full Compressible Euler Equations with Damping on Bounded Domains
Zhao, Kun — Tulane Univ.
Pan, Ronghua — Georgia Inst. of Tech.

Abstract: In this talk, the global dynamics of small smooth solutions to initial-boundary value problems of the full compressible Euler equations with frictional damping, and a reduced system consisting of a porous medium type equation and a transport equation will be presented. Furthermore, the error of isentropic approximation for the full Euler equations will be discussed.

▶MS-Th-D-13-3 14:30–15:00
Well Posedness and Optimal Control in Structured Population Models
Colombo, Rinaldo M. — Univ. of Brescia

Abstract: This presentation is focused on initial–boundary value problems for systems of balance laws inspired by structured population models. First, particular classes of non-local boundary conditions allow to consider renewal equations on a graph, motivated for instance by juvenile-adult models. In this setting, various control problems can be stated and solved, examples being the optimal management of renewable resources or the optimal mating ratio.

▶MS-Th-D-13-4 15:00–15:30
Krylov Implicit Integration Factor WENO Methods for High Dimensional Convection-diffusion Problems
Zhang, Yong-Tao — Univ. of Notre Dame

Abstract: In this talk, I shall present our recent work on developing efficient Krylov implicit integration factor (IIF) schemes for solving high dimensional convection-diffusion problems. The hyperbolic part of the problems is discretized by WENO schemes. We designed several strategies and their combinations to deal with the computational challenge arising from high spatial dimensions, including Krylov subspace approximations and sparse grid techniques. Extensive numerical experiments were performed to show the high efficiency of the new method comparing with IIF schemes developed in the literature. This is a joint work with Dong Lu at U. of Notre Dame.

MS-Th-D-14 13:30–15:40 111
Eigenvalues of partial differential operators and their applications - Part III of III
For Part 1, see MS-We-E-14
For Part 2, see MS-Th-BC-14

Organizer: Kao, Chiu-Yen Clarmeont McKenna College
Organizer: Osting, Braxton Univ. of Utah

Abstract: Eigenvalues and eigenfunctions are fundamental to the understanding of the dynamics and properties of solutions to partial differential equations. This minisymposium features the latest progress on numerical and theoretical approaches for solving linear and nonlinear eigenvalue problems, eigenvalue optimization, and their applications in several different and important scientific areas including mechanical vibration, optimal conductivity, photonic crystals, and shape classification and recognition.

▶MS-Th-D-14-1 13:30–14:00
Band-Gap Optimization for Two Dimensional Photonic Crystals
Shu, Yu-Chen Department of Mathematics, National Cheng Kung Univ.
CHANG, CHIEN CHENG National Taiwan Univ.

Abstract: In this talk, a hybrid optimization method is presented to maximize band gaps for photonic crystals with transverse magnetic and transverse electric waves simultaneously. The method is based on gradient flow and the gradient is computed from the discrete system. Since photonic crystals are usually made by two or more materials with specific shapes, we search the optimized parameters of the shapes. Some optimal configurations for different bands are shown.

▶MS-Th-D-14-2 14:00–14:30
New Theoretical and Numerical Results Related to Classical Eigenvalue Problems
OUDET, Edouard Universite Joseph Fourier

Abstract: We discuss recent results related to theoretical qualitative informations for optimal shapes associated to eigenvalue problems.

▶MS-Th-D-14-3 14:30–15:00
Maximization of Laplace-Beltrami Eigenvalues on Closed Riemannian Surfaces
Osting, Braxton Univ. of Utah
Kao, Chiu-Yen Clarmeont McKenna College
Lai, Rongjie Rensselaer Polytechnic Inst.

Abstract: We consider the dependence of Laplace-Beltrami eigenvalues on the underlying Riemannian surface. Computational methods are proposed for finding the conformal and topological spectra, which are defined by eigenvalue optimization problems of maximizing the k-th eigenvalue as the surface varies within an admissible class. Several properties of optimizers are studied computationally, including uniqueness, symmetry, and eigenvalue multiplicity.

▶CP-Th-D-14-4 15:00–15:20
A Posteriori Analysis of A Non Linear Gross-Pitaevskii Type Eignevalue Problem with A Rotation Term
LLERAS, Vanessa Univ. of Montpellier2

Abstract: In this presentation, we obtain a posteriori error analysis for variational approximations of the ground state of a non linear problem of the Gross-Pitaevskii type with periodic boundary conditions and with a rotation term. This study is based on a Fourier spectral approximation and on an iterative algorithm used to solve the non-linear problem. The error estimator is composed of two terms: a residue characterizing the error due to the discretization of the space and an iteration residue due to the finite number of iterations to solve the problem numerically. Then we can compare this error estimator with an a posteriori error estimate based on Sobolev gradients.

▶CP-Th-D-14-5 15:20–15:40
Parallel Generalized Eigenvalue Computation with Hybrid Solvers and Their Benchmark on Supercomputers
Imachi, Hiroto Tottori Univ.
Hoshi, Takeo Tottori Univ.

Abstract: New distributed parallel dense solvers for symmetric positive definite generalized eigenvalue problems were constructed as hybrid ones between the three parallel solver libraries of ScaLAPACK, ELPA and EigenExa. The strong scaling benchmark was carried out on the K supercomputer and other supercomputers with matrix sizes of $M = 10^4 \times 10^6$, and it shows high parallel efficiency. The used matrices are constructed from electronic structure calculation problems and available in our matrix data library (http://www.elses.jp/matrix/).

MS-Th-D-15 13:30–15:30 213B
PDEs and applications: theory and computation - Part I of IV
For Part 2, see MS-Th-E-15
For Part 3, see MS-Fr-D-15
For Part 4, see MS-Fr-E-15

Organizer: Wang, Ying Univ. of Oklahoma
Organizer: Nie, Hua Shaanxi Normal Univ.

Abstract: Partial differential equations (PDEs) have been widely used in the mathematical modeling of physical and biological phenomena, including mixed type equations. Many problems of an applied nature reduce to finding specific solutions and properties of PDEs of elliptic, parabolic, or of mixed type; in particular, problems of plane transonic flow of a compressible medium, and problems in the theory of envelopes. In this mini-symposium, recent results in the theory and computation of PDEs and their applications will be presented. The goal of this mini-symposium is to provide a platform for the world experts in the area of PDEs, both theory and computation, to report the recent progresses, exchange ideas and build up collaborative works. We anticipate that our speakers will have expertise in a wide-ranging array of topics, possibly including: (i) qualitative and quantitative properties enjoyed by solutions to nonlinear partial differential equations of elliptic, parabolic, or of mixed type. (ii) numerical schemes derived for various types of PDEs. (iii) physical and biology modeling involving nonlinear partial differential equations of elliptic, parabolic, or of mixed type.

▶MS-Th-D-15-1 13:30–14:00
A Competition Model with Dynamically Allocated Toxin Production in the Unstirred Chemostat
Nie, Hua Shaanxi Normal Univ.

Abstract: This paper deals with a competition model with dynamically allocated toxin production in the unstirred chemostat. First, the existence and uniqueness of positive steady state solutions of the single population model is attained. Second, the structure and stability of nonnegative equilibria to the two-species system are established by the bifurcation theory. The results show that stable coexistence solution can occur with dynamic toxin production that cannot occur with constant toxin production.

▶MS-Th-D-15-2 14:00–14:30
Stationary Patterns of Urban Crime Models with Heterogeneous Near-repeat Victimization Effect
Wang, Qi Southwestern Univ. of Finance & Economics

Abstract: In this talk, we consider 2D urban crime models describing the spatial heterogeneity of the near-repeat victimization effect and the dispersal strategy of criminal agents. We investigate the existence and stability of positive nontrivial stationary solutions to the systems. Our theoretical results provide a selection mechanism of their stable patterns which suggest that large domains support more stable aggregates than small domains. Numerical simulations are presented to support our analysis.

▶MS-Th-D-15-3 14:30–15:00
Variational Method and Index Theory in the N-body Problem
Yan, Duokui Beihang Univ.

Abstract: In this talk, we will introduce our recent work on the existence and linear stability of periodic orbits in the N-body problem.The main tools we use are variational method and Maslov-type index theory.

▶MS-Th-D-15-4 15:00–15:30
Modeling Information Diffusion in Online Social Networks with Partial Differential Equations
Wang, Haiyan Arizona State Univ.

Abstract: In a number of recent works, we propose to use partial differential equation models to study the temporal and spatial characteristics of information diffusion in online social networks. In this talk, I will examine several partial differential equation models for online social networks and discuss their applications in analysis of several social events.

MS-Th-D-16 13:30–15:30 205A
System of Conservation Laws and Related Models - Part I of IV
For Part 2, see MS-Th-E-16
For Part 3, see MS-Fr-D-16
For Part 4, see MS-Fr-E-16

Organizer: Li, Yachun Shanghai Jiao Tong Univ.
Organizer: Wang, Weike Shanghai Jiao Tong Univ.
Organizer: Wang, Yaguang Shanghai Jiaotong Univ.
Organizer: Xie, Chunjing Shanghai Jiao Tong Universit

Abstract: This minisymposium focuses on the analysis for system of conservation laws and related models. It covers the following topics: 1. Multidimen-

sional conservation laws and transonic flows; 2. Compressible Navier-Stokes system and singular limits for fluid dynamics; 3. Free boundary problems arising in fluid mechanics and related models.

▶MS-Th-D-16-1 13:30–14:00

Free Boundary Problems in Shock Reflection/Diffraction and Related Transonic Flow Problems

Bae, Myoungjean POSTECH
Chen, Gui-Qiang G. Univ. of Oxford
Feldman, Mikhail Univ. of Wisconsin-Madison
Xiang, Wei City Univ. of Hong Kong

Abstract: Shock waves are steep-wave fronts that are fundamental in nature, especially in high-speed fluid flows. We will show how several longstanding shock reflection/diffraction problems can be formulated as free boundary problems, discuss some recent progress in developing mathematical ideas and techniques for solving these problems, and present some further open problems in this direction. This talk is also an introduction to the subsequent talks by Feldman, Bae, and Xiang, respectively, in this minisymposium.

▶MS-Th-D-16-2 14:00–14:30

Shock Reflection and Von Neumann Conjectures: Existence and Properties of Solutions

Chen, Gui-Qiang G. Univ. of Oxford
Feldman, Mikhail Univ. of Wisconsin-Madison

Abstract: We discuss free boundary problems for elliptic equations, motivated by shock reflection problem for compressible fluid flow. When a shock hits a convex wedge, shock reflection-diffraction phenomena occur, and various reflection patterns are observed. We will discuss von Neumann conjectures on transition between regular and Mach reflections, and recent results on existence of regular reflection solutions for potential flow equation up to the detachment angle. Joint works with G.-Q. Chen.

▶MS-Th-D-16-3 14:30–15:00

Global Existence of Weak Shocks Past A Solid Ramp

Bae, Myoungjean POSTECH
Chen, Gui-Qiang G. Univ. of Oxford
Feldman, Mikhail Univ. of Wisconsin-Madison

Abstract: In this talk, I present recent result on the Prandtl-Meyer reflection impinging onto a solid wedge. This talk is based on collaboration with Gui-Qiang G. Chen (Univ. of Oxford) and Mikhail Feldman(UW-Madison).

▶MS-Th-D-16-4 15:00–15:30

Convexity of Shocks in the Self-similar Coordinates

Chen, Gui-Qiang G. Univ. of Oxford
Feldman, Mikhail Univ. of Wisconsin-Madison
Xiang, Wei City Univ. of Hong Kong

Abstract: Convexity of shocks is frequently observed in many experimental results and provides better understanding of mathematical problems with the nonlinear wave, the uniqueness for instance. We consider the pseudo-transonic shock governed by the potential flow equation in the self-similar coordinates, and give a framework to show the strict and uniform convexity by a nonlinear and global argument. Finally, several applications are given.

MS-Th-D-17 13:30–15:30 205B

Singular limits in mathematical physics - Part III of V

For Part 1, see MS-We-E-17
For Part 2, see MS-Th-BC-17
For Part 4, see MS-Th-E-17
For Part 5, see MS-Fr-D-17

Organizer: Cheng, Bin Univ. of Surrey
Organizer: Secchi, Paolo Univ. of Brescia
Organizer: Ju, Qiangchang Inst. of Applied Physics & Computational Mathematics (IAPCM)
Organizer: Jiang, Ning Tsinghua Univ., Beijing

Abstract: This minisymposium will address recent advances in analytical and numerical studies of singular limits of multiscale physical models as certain parameters approach zero or infinity. It shall cover such areas as incompressible and fast rotating limits in fluid dynamics, hydrodynamical limits of complex fluid and kinetic models, and relaxations. The singular nature of these models makes it challenging to rigorously justify and quantify their limits and to numerically simulate them in a way consistent with theory. Novel techniques and results in partial differential equations, stochastic differential equations and numerical analysis will be discussed.

▶MS-Th-D-17-1 13:30–14:00

Stability of Supersonic Contact Discontinuities in Three Dimensional Compressible Steady Flows

Wang, Yaguang Shanghai Jiaotong Univ.

Abstract: In this talk, we study the stability of contact discontinuities in three dimensional compressible isentropic steady flows. Both of linear and nonlinear stability shall be studied.

▶MS-Th-D-17-2 14:00–14:30

The Boundary Layer Problem for 2D Incompressible Flows.

Lopes Filho, Milton Universidade Federal do Rio de Janeiro

Abstract: In this talk we examine recent results on the vanishing viscosity limit for incompressible 2D flows in domains with boundary, focusing on Kato's boundary layer criterion and its consequences.

▶MS-Th-D-17-3 14:30–15:00

On the Vanishing Shear Viscosity Limit and the Vanishing Resistivity Limit for One-dimensional Compressible MHD Equations

Zhang, Jianwen Xiamen Univ.

Abstract: In the first part of this talk, the global well-posedness of strong solutions to an initial-boundary value problem of one-dimensional compressible heat-conductive MHD equaitons with constant viscosity, resistivity and heat-conductivity coefficients is established, and the vanishing shear viscosity limit is justified. In the second part, the global existence of strong solutions of an initial-boundary value problem of one-dimensional compressible isentropic MHD equaitons with zero resistivity coefficient is proved, and the vanishing resistivity limit is justified.

▶MS-Th-D-17-4 15:00–15:30

Incompressible Limit of Navier-Stokes Equations in Bounded Domains

Ou, Yaobin Renmin Univ. of China

Abstract: In this paper, we study the sigular limit of compressible Navier-Stokes equations in three-dimensional bounded domains as the Mach number goes to zero. Provided that the initial data are "well-prepared" in the sense that certain Sobolev norms of temporal derivatives are bounded initially, we establish the uniform estimates with respect to the Mach number, which gives the convergence from the compressible Navier-Stokes equations to the incompressible Navier-Stokes equations.

MS-Th-D-18 13:30–15:30 209B

Mathematics and Optics - Part I of IV

For Part 2, see MS-Th-E-18
For Part 3, see MS-Fr-D-18
For Part 4, see MS-Fr-E-18

Organizer: Santosa, Fadil Inst. for Mathematics & its Applications
Organizer: Bao, Gang Zhejiang Univ.
Organizer: Weinstein, Michael Columbia Univ.

Abstract: The importance of optics and is summarized in the 2013 US National Academy of Sciences report "Optics and Photonics: Essential Technology for Our Nation". Envisioned technologies which rely on optics include communications, imaging, sensing, and computing. What is clear from the report is that the Mathematical Sciences is poised to make significant contributions to the progress in technology. Indeed there is a growing research activity at the nexus of the Mathematical Sciences and the Optical Sciences. Together with advances in materials science and nano-structure fabrication, there is a growing role for mathematical tools, both computational and analytical.

The goal of this minisymposium is to highlight research in the mathematical sciences that deal with problems arising in optics and photonics. Topics that will be discussed in the sessions include optics in meta-materials, cloaking, photonic bandgap structures, design and control of optical devices, plasmonics, and nonlinear phenomena in optics. These topics will be emphasized during the Institute for Mathematics and its Applications (IMA) annual thematic program "Mathematics and Optics", 2016-17. The minisymposium is an invitation to mathematical scientists to participate in the IMA program.

▶MS-Th-D-18-1 13:30–14:00

New Insights on Cloaking Due to Anomalous Localized Resonance

Thaler, Andrew Inst. for Mathematics & its Applications

Abstract: We present recent results on cloaking due to anomalous localized resonance for general charge density distributions. We prove that the power dissipated in a superlens diverges as certain dissipation parameters in the superlens tend to zero and when certain charge density distributions are located within a critical distance of the superlens. The critical distance strongly depends on the rate at which the dissipation parameters in the materials surrounding the superlens tend to zero.

▶MS-Th-D-18-2 14:00–14:30

Inverse Scattering Spectroscopy for Fast Sizing Metal Nanoparticles

Bai, Benfeng Tsinghua Univ.

Abstract: Metal nanoparticles have important applications in various fields such as catalysis, medical therapy, and biosensing, due to their strong plasmonic response. In this talk, an optical extinction/scattering spectroscopic (OESS) method is presented for the fast geometric characterization and metrology of gold NR ensembles statistically, in which an inverse scattering problem is solved. Comparison of the OESS measurement results with those obtained by the imaging method shows the effectiveness and reliability of the proposed method.

▶MS-Th-D-18-3 14:30–15:00

Determining Hydrodynamic Boundary Condition from Equilibrium Fluctuations

Sheng, Ping Hong Kong Univ. of Sci. & Tech.

Abstract: We report the use of molecular dynamics to identify from equilibrium thermal fluctuations the hydrodynamic modes in a fluid confined by solid walls, thereby extending the application of the fluctuation-dissipation theorem to yield not only the accurate location of the hydrodynamic boundary at the molecular scale, but also the relevant parameter value(s) for the description of the macroscopic boundary condition. Results on two examples are presented to illustrate the application of this approach.

▶MS-Th-D-18-4 15:00–15:30

Electromagnetic Field Enhancement for Metallic Nano-gaps

Lin, Junshan Department of Mathematics & Statistics, Auburn Univ.

Abstract: Electromagnetic field enhancement and extraordinary optical transmission effect through subwavelength apertures has significant potential applications in biological and chemical sensing, spectroscopy, terahertz semiconductor devices, etc. In this talk, I will present our recent mathematical studies on the field enhancement when an electromagnetic wave passes through a single metallic nano-gap. The ongoing work on the field enhancement of other sub-wavelength metallic structures will also be highlighted.

MS-Th-D-19 13:30–15:30 307B

Women in Applied Mathematics: Recent Advances in Modeling, Numerical Algorithms, and Applications - Part III of IV

For Part 1, see MS-We-E-19
For Part 2, see MS-Th-BC-19
For Part 4, see MS-Th-E-19

Organizer: Li, Fengyan Rensselaer Polytechnic Inst.
Organizer: Cheng, Juan Inst. of Applied Physics & Computational Mathematics

Abstract: This mini-symposium aims at bringing women mathematicians to share recent progress and to inspire new ideas in applied mathematics. Talks may address modeling, theoretical and computational aspects of numerical methods, as well as various applications arising from biomedical problems, fluid dynamics, electromagnetism, rarefied gas dynamics, and constrained optimal control problems etc. Besides the scientific aspects, the fourth part of this mini-symposium is a career panel session, which is to create a platform for women mathematicians at different stages with different career paths to network, to exchange experiences and advices in career advancement, and to discuss challenges and strategies for a successful career.

▶MS-Th-D-19-1 13:30–14:00

Eigenvalues Minimization for Biharmonic Equations

Chen, Weitao Univ. of California, Irvine
Chou, Ching-Shan The Ohio State Univ.
Kao, Chiu-Yen Clarmeont McKenna College

Abstract: we propose a numerical method to find the optimal rearrangement of density distribution in order to minimize a specific eigenvalue. We answer the open question about optimal density configurations for clamped rods with minimal second and above eigenvalues numerically.

▶MS-Th-D-19-2 14:00–14:30

L2 Stable Discontinuous Galerkin Methods for One-dimensional Two-way Wave Equations

Cheng, Yingda Michigan State Univ.
Li, Fengyan Rensselaer Polytechnic Inst.
Chou, Ching-Shan The Ohio State Univ.
Xing, Yulong Oak Ridge National Laboratory & Univ. of Tennessee

Abstract: Simulating wave propagation is one of the fundamental problems in scientific computing. In this talk, we consider one-dimensional two-way wave equations, and investigate a family of L2 stable high order discontinuous Galerkin methods, which is defined through a general form of numerical fluxes. For these L2 stable methods, we systematically establish stability (hence energy conservation), error estimates (in both L2 and negative-order norms), and dispersion analysis.

▶MS-Th-D-19-3 14:30–15:00

Dispersion Reducing Methods for Edge Discretizations of the Electric Vector Wave Equation

Bokil, Vrushali Oregon State Univ.

Abstract: We present a technique called M-adaptation, based on the mimetic finite difference method, for minimizing numerical dispersion error in edge discretizations of the time-domain vector wave equation on square meshes. The temporal discretization uses the Leapfrog scheme, and mass-lumping is performed to obtain an explicit time stepping method. We obtain a method that has fourth order accurate numerical dispersion as well as numerical anisotropy. Numerical simulations are provided to illustrate theoretical results.

▶MS-Th-D-19-4 15:00–15:30

Energy Conserving Local Discontinuous Galerkin Methods for the Nonlinear Schroedinger Equation with Wave Operator

Xu, Yan Univ. of Sci. & Tech. of China

Abstract: In this paper, we present a fully discrete scheme by discretizing the space with the local discontinuous Galerkin (LDG) method and the time with the Crank-Nicholson scheme to simulate the multi-dimensional Schroedinger equation with wave operator. The energy conservation is also a crucial property for long time simulations which will be demonstrated in the numerical experiment. The optimal error estimates of the semi-discrete scheme can be obtained for the linear case. Some numerical experiments in

MS-Th-D-20 13:30–15:30 210B

Computational Inverse Problems - Part I of IV

For Part 2, see MS-Th-E-20
For Part 3, see MS-Fr-D-20
For Part 4, see MS-Fr-E-20

Organizer: Jin, Bangti Univ. College London
Organizer: Lu, Xiliang Wuhan Univ.

Abstract: Inverse problems arise in a wide variety of applications, e.g., medical imaging, tomography, anomalous diffusion and compressed sensing. Their efficient and stable numerical solution is however very challenging due to the ill-posed nature of inverse problems. There have been significant progress in recent years, in novel application, new mathematical techniques and efficient optimization algorithms. In this mini-symposium, we aim to present and discuss recent advances in the area.

▶MS-Th-D-20-1 13:30–14:00

On the Convergence Rate and Some Applications of Regularized Ranking Algorithms.

Pereverzyev, Sergiy Johann Radon Inst., Austrian Acad. of Sci.

Abstract: We study the ranking problem in the context of the regularization theory that allows a simultaneous analysis of a wide class of algorithms. Our analysis gives a better convergence rate compared to the reported in the literature. Theoretical results are supplemented with the application of ranking to the estimation of the risk from errors in blood glucose measurements of diabetic patients. Joint research with Galyna Kriukova and Pavlo Tkachenko supported by Austrian Science Foundation FWF.

▶MS-Th-D-20-2 14:00–14:30

Convex Regularization of Hybrid Discrete-continuous Inverse Problems

Clason, Christian Univ. Duisburg-Essen
Kunisch, Karl Univ. of Graz

Abstract: We consider continuous inverse problems where the unknown distributed parameter is known to take on values only from a discrete given set. This property can be promoted with the aid of a convex penalty. A regularized semismooth Newton method allows the numerical solution of the corresponding Tikhonov functional. Numerical examples illustrate the effectiveness of the proposed approach.

▶MS-Th-D-20-3 14:30–15:00

Full Waveform Inversion for Velocity Based on the Acoustic Wave Equation in the Frequency Domain

Zhang, Wensheng Acad. of Mathematics & Sys. Sci., Chinese Acad. of Sci., Beijing, 100190, P.R.China

Abstract: The wave equation based full waveform inversion is an iterative minimization process between the synthetic data and the observed data. In this talk, we will present the inversion results in the frequency domain. In addition to using the regularization method, we investigate the stepwise inversion s-

trategy to overcome the ill-posedness of the problem. Numerical experiments are implemented for the benchmark Marmousi model. The results show the the effectiveness and correctness of the presented inversion method.

▶ MS-Th-D-20-4 15:00–15:30

A Primal Dual Active Set Algorithm for the Nonconvex Sparse Optimization Problems

Lu, Xiliang — Wuhan Univ.

Abstract: In this talk, we consider the problem of recovering a sparse signal from noisy measurement data. An algorithm of primal-dual active set type for a class of nonconvex sparsity-promoting penalties is proposed. Convergence analysis for some special cases are provided, and numerical examples verifies the efficiency of the given algorithm.

MS-Th-D-21 13:30–15:30 309B

Minisymposium on discontinuous Galerkin method: recent development and applications - Part VI of VIII

For Part 1, see MS-Tu-D-21
For Part 2, see MS-Tu-E-21
For Part 3, see MS-We-D-21
For Part 4, see MS-We-E-21
For Part 5, see MS-Th-BC-21
For Part 7, see MS-Th-E-21
For Part 8, see MS-Fr-D-21

Organizer: Xu, Yan — Univ. of Sci. & Tech. of China
Organizer: Shu, Chi-Wang — Brown Univ.

Abstract: Over the last few years, discontinuous Galerkin (DG) methods have found their way into the main stream of computational sciences and are now being successfully applied in almost all areas of natural sciences and engineering. The aim of this minisymposium is to present the most recent developments in the design and theoretical analysis of DG methods, and to discuss relevant issues related to the practical implementation and applications of these methods. Topics include: theoretical aspects and numerical analysis of discontinuous Galerkin methods, non-linear problems, and applications. Particular emphasis will be given to applications coming from fluid dynamics, solid mechanics and kinetic theory.

▶ MS-Th-D-21-1 13:30–14:00

A Staggered Discontinuous Galerkin Method for the Navier-Stokes Equations

Chung, Eric — The Chinese Univ. of Hong Kong

Abstract: We will present a new staggered discontinuous Galerkin method for the Navier-Stokes equations. The method preserves many of properties arising from the PDE. Numerical results are shown. The research is partially supported by CUHK Direct Grant.

▶ MS-Th-D-21-2 14:00–14:30

Third Order Maximum Principle Preserving Discontinuous Galerkin Method for Convection Diffusion Equations on Unstructured Triangular Meshes

Yan, Jue — iowa state Univ.

Abstract: In this talk, we show the Direct discontinuous Galerkin method and its variations satisfy the strict maximum principle with third order of accuracy on two dimensional unstructured triangle mesh. Sufficient conditions are given to guarantee the piecewise polynomial solutions bounded above and below by the given constants. Numerical examples are carried out to show the optimal 3rd order of accuracy is maintained with the maximum principle limiter. The positivity of the polynomial solutions are preserved.

▶ MS-Th-D-21-3 14:30–15:00

Well-balanced Discontinuous Galerkin Methods for the Euler Equations under Gravitational Fields

Xing, Yulong — Oak Ridge National Laboratory & Univ. of Tennessee

Abstract: Hydrodynamical evolution in a gravitational field arises in many astrophysical problems. Improper treatment of the gravitational force can lead to a solution which oscillates around the equilibrium. In this presentation, we propose a recently developed well-balanced discontinuous Galerkin method for the Euler equations under gravitational fields, which can maintain the hydrostatic equilibrium state exactly. Some numerical tests are performed to verify the well-balanced property, high-order accuracy, and good resolution for smooth and discontinuous solutions.

▶ MS-Th-D-21-4 15:00–15:30

Runge-Kutta Discontinuous Galerkin Method Using WENO Limiters on (un)structured Meshes

Zhu, Jun — Nanjing Univ. of Aeronautics & Astronautics

Abstract: In this talk, we generalize some new limiters based on the weighted essentially non-oscillatory (WENO) finite volume methodologies for the Runge-Kutta discontinuous Galerkin (RKDG) methods solving nonlinear hyperbolic conservation laws on structured and unstructured meshes. Numerical results for both scalar equations and Euler systems of compressible gas dynamics are provided to illustrate the good performance of these procedures.

MS-Th-D-22 13:30–15:30 206A

Recent development and applications of weighted essential non-oscillatory methods - Part II of V

For Part 1, see MS-Th-BC-22
For Part 3, see MS-Th-E-22
For Part 4, see MS-Fr-D-22
For Part 5, see MS-Fr-E-22

Organizer: Qiu, Jianxian — Xiamen Univ.
Organizer: Shu, Chi-Wang — Brown Univ.

Abstract: The spectrum covered by the minisymposium ranges from recent development, analysis, implementation and applications, for the weighted essential non-oscillatory (WENO) methods. The WENO methods provide a practical effective framework to solve out many nonlinear wave-dominated problems with discontinuities or sharp gradient regions, which play an important role arising in many applications of computational fluid dynamics, computational astrophysics, computational plasma physics, semiconductor device simulations, among others. Devising robust, accurate and efficient WENO methods for solving these problems is of considerable importance and, as expected, has attracted the interest of many researchers and practitioners. This minisymposium serves as a good forum for researchers to exchange ideas and to promote this active and important research direction.

▶ MS-Th-D-22-1 13:30–14:00

Hermite WENO Schemes for Hyperbolic Conservation Laws

Qiu, Jianxian — Xiamen Univ.

Abstract: A class of WENO schemes based on Hermite polynomials, termed HWENO schemes, for solving hyperbolic conservation law is presented. Both the function and its first derivative values are evolved in time and used in the reconstruction, while only the function values are evolved and used in WENO schemes. Comparing with WENO schemes one major advantage of HWENO schemes is its compactness in the reconstruction. Numerical results are presented to show the efficiency of the schemes.

▶ MS-Th-D-22-2 14:00–14:30

A Class of Central Compact Schemes with Spectral-like Resolution

Zhang, Shuhai — state key laboratory of aerodynamics

Abstract: In this talk, I will report our recent work of a class of central compact schemes with spectral-like resolution. Combining the technique of Lele' s linear compact scheme and WENO interpolation, we developed a class of central compact scheme including linear and nonlinear scheme. The linear compact scheme has higher order, spectral-like resolution and low dissipation. It is an ideal method for the computation of multi-scale problems, such aeroacoustics. The nonlinear compact scheme has the similar property to compute strong shock wave with WENO scheme. While, the resolution for short wave is much higher than that of WENO scheme.

▶ MS-Th-D-22-3 14:30–15:00

Hybridization of Weighted Essentially Non-oscillatory Finite Difference Scheme for Conservation Law

Don, Wai Sun — Ocean Univ. of China/Brown Univ.
Gao, Zhen — Ocean Univ. of China
Li, Peng — Beijing Inst. of Tech.

Abstract: I will discuss some recent development of hybridization of high order nonlinear WENO FD scheme and classical linear scheme(finite differences, compact) and non-classical scheme (spectral, Fourier continuation) scheme, together with high order shock sensors (multi-resolution, Fourier conjugate) to determine the smoothness of a solution of hyperbolic conservation laws. The pros and cons of the various schemes in terms of accuracy and efficiency and some critical issues will be discussed and illustrated with examples.

▶ MS-Th-D-22-4 15:00–15:30

Hybrid WENO Schemes with Different Indicators on Curvilinear Grids

Li, Gang — Qingdao Univ.

Abstract: In {J. Comput. Phys. 229 (2010) 8105-8129}, we studied hybrid weighted essentially non-oscillatory (WENO) schemes with different indicators for hyperbolic conservation laws on uniform grids for Cartesian domains. In this presentation, we extend the schemes to solve two-dimensional systems of hyperbolic conservation laws on curvilinear grids for non-Cartesian domains. Our goal is to obtain similar advantageous properties as those of the hybrid WENO schemes on uniform grids for Cartesian domains. Extensive numerical results for the Euler equations of gas dynamics as well as the shal-

low water equations all strongly support that the hybrid WENO schemes with discontinuity indicators on curvilinear grids can also save considerably computational cost in contrast to the pure WENO schemes. They also maintain the essentially non-oscillatory property for general solutions with discontinuities and keep the sharp shock transition.

MS-Th-D-23 13:30–15:30 208A

Computational Methods of PDE-based Eigenvalue Problems and Applications in Nanostructure Simulations - Part I of IV

For Part 2, see MS-Th-E-23
For Part 3, see MS-Fr-D-23
For Part 4, see MS-Fr-E-23

Organizer: Bai, Zhaojun Univ. of California, Davis
Organizer: Yang, Chao Lawrence Berkeley National Laboratory
Organizer: Zhou, Aihui Acad. of Mathematics & Sys. Sci., Chinese Acad. of Sci.

Abstract: PDE based eigenvalue problems arise from electronic structure calculations, band structure calculations in photonic crystals and dynamics of electromagnetic fields. This minisymposium brings together researchers working on PDE-based eigenvalue problems from areas of mathematical modeling and analysis, numerical analysis, high-performance computing and applications. This minisymposium features the latest progress on developing adaptive discretizations, stable nonlinear iterations and fast algebraic solvers, code designing and high performance computing on modern computer systems.

▶ MS-Th-D-23-1 13:30–14:00

Low-rank Tensor Methods for High-dimensional Eigenvalue Problems

Kressner, Daniel EPFL

Abstract: This talk is concerned with eigenvalue problems that feature extremely large matrices with Kronecker structure. Such problems arise, for example, from the discretization of high-dimensional PDE eigenvalue problems on tensorized domains or from the simulation of stochastic automata networks. We discuss optimization based methods for achieving low-rank approximations to the solution of such problems and present new a priori approximation results.

▶ MS-Th-D-23-2 14:00–14:30

Eigendecompositions and Fast Eigensolvers for Three Dimensional Maxwell's Equations

Lin, Wen-Wei National Chiao Tung Univ.

Abstract: This talk focuses on discrete double/single-curl operators in Maxwell's equations for 3D photonic crystals, chiral and pseudochiral complex media with face centered cubic lattices. We derive an eigendecomposition of degenerate coeﬃcient matrices and apply it to project the associated GEVP to a SEVP which can be eﬃciently solved by the inverse Lanczos method. We propose efficient matrix-vector multiplications by FFT due to the eigendecomposition to signiﬁcantly reduce the computation cost and develop fast eigensolvers.

▶ MS-Th-D-23-3 14:30–15:00

Eigenvalue Problem in Electron Excitation

Yang, Chao Lawrence Berkeley National Laboratory

Abstract: Single-electron excitation can be described by a nonlinear eigenvalue known as the Dyson's equation in which the Hamiltonian operator is a function of the eigenvalue to be determined. We will describe the nonlinear structure of the eigenvalue problem and examine numerical methods for solving this type of problem. We will examine the Bethe-Salpeter eigenvalue problem that describe the collective excitation of an electron-hole pair.

▶ MS-Th-D-23-4 15:00–15:30

Analysis and Computation for Ground States in Degenerate Quantum Gas

Bao, Weizhu National Univ. of Singapore
Cai, Yongyong Beijing Computational Sci. Research Center

Abstract: The ground state in degenerate quantum gas is defined as the minimizer of the energy functional under a constraint, which is an infinitely dimensional nonconvex minimization problem. In this talk, I will discuss the existence and uniqueness as well as non-existence of the ground state under different parameter regimes; present asymptotic approximations in some limiting parameter regimes; and propose some efficient and accurate numerical methods for computing the ground states.

MS-Th-D-24 13:30–15:30 211

Computational Electromagnetism and Its Engineering Applications - Part I of IV

For Part 2, see MS-Th-E-24
For Part 3, see MS-Fr-D-24
For Part 4, see MS-Fr-E-24

Organizer: Duan, Huoyuan Collaborative Innovation Centre of Mathematics, School of Mathematics & Statistics, Wuhan Univ., Wuhan 430072, China
Organizer: Zheng, Weiying Chinese Acad. of Sci.

Abstract: In recent years, there arises a surge of numerical studies for electromagnetic problems in complex engineering systems, such as large power transformers, electrical machinery, magnetic fusion, etc. The mathematical models turn out to be nonlinear, multiscale, strongly singular, and coupled with multiple physical fields. It brings new challenges to researchers from both mathematical and engineering communities in developing practical mathematical models and effective and efficient numerical methods and solvers. This mini-symposium seeks to bring together researchers in both computational mathematics and electromagnetic engineering that involve the mathematical modeling, analysis, computation, and experimental validation for electromagnetic problems. The main theme will be focused on new efficient numerical methods and fast solvers for Maxwell's equations and magnetohydrodynamic equations and will address their extensive applications to engineering problems. It will promote exchange of ideas and recent developments on mathematical modeling, numerical discretization, solvers and engineering practices of computational electromagnetism.

▶ MS-Th-D-24-1 13:30–14:00

A Consistent, Conforming and Genuinely Nodal-continuous Finite Element Method for 3D Time-harmonic Maxwell Equations with Singular Solution and Singular Data

Duan, Huoyuan Collaborative Innovation Centre of Mathematics, School of Mathematics & Statistics, Wuhan Univ., Wuhan 430072, China

Abstract: This paper has explored a weak form of the 3D time-harmonic Maxwell equations, and by mimicking this weak form we have developed a new finite element method by employing H^1-conforming nodal-continuous elements. The method is coercive, equivalence to the $H(v;\Omega)$-norm, resulting a symmetric, positive definite algebraic linear system, together with a $\mathcal{O}(h^{-2})$ condition number. The quasi-optimal error estimate has been established, leading to a convergence in the $H(v;\Omega)$-norm.

▶ MS-Th-D-24-2 14:00–14:30

A First Order System Least Squares Method for the Helmholtz Equation

Qiu, Weifeng City Univ. of Hong Kong
Chen, Huangxin Xiamen Univ.

Abstract: We present a first order system least squares (FOSLS) method for the Helmholtz equation at high wave number k, which always deduces Hermitian positive definite algebraic system. By utilizing a non-trivial solution decomposition to the dual FOSLS problem, we give error analysis to the FOSLS method where the dependence on h, p, and k is given explicitly. The L2 norm error of the scalar solution is shown to be quasi optimal under reasonable assumption.

▶ MS-Th-D-24-3 14:30–15:00

Analysis of Transient Electromagnetic Scattering from Three-Dimensional Cavities

Li, Peijun Purdue Univ.

Abstract: This talk is concerned with the mathematical analysis of the time-domain Maxwell equations in a three-dimensional cavity. An exact transparent boundary condition is developed to reformulate the open cavity scattering problem in an unbounded domain equivalently into an initial-boundary value problem in a bounded domain. The well-posedness and stability are studied for the reduced problem. Moreover, an a priori estimate is established for the electric field with a minimum regularity requirement for the data.

▶ MS-Th-D-24-4 15:00–15:30

Nonconforming Finite Element Method for Wave Propagation in Metamaterials

Yao, Changhui School of mathematics & statistics

Abstract: Nonconforming mixed finite element method is proposed to simulate wave propagation in metamaterials. The error estimate of the semi-discrete scheme is given by convergence order O(h), which is less than 40 percent of the computational costs comparing with the same effect by using Nédélec-Raviart element. A Crank-Nicolson full discrete scheme is also presented with

$O(\tau^2 + h)$ by traditional discrete formula. Numerical examples of 2D TE, TM casesand a famous re-focusing phenomena are shown.

MS-Th-D-25 13:30–15:30 210A
Emerging PDEs: Analysis and Computation - Part I of IV

For Part 2, see MS-Th-E-25
For Part 3, see MS-Fr-D-25
For Part 4, see MS-Fr-E-25

Organizer: Chen, Zhiming AMSS, Chinese Acad. of Sci.
Organizer: Nochetto, Ricardo Univ. of Maryland
Organizer: Zhang, Chensong Acad. of mathematics & Sys. Sci.

Abstract: Novel models in science and engineering are governed by nonlinear integro-differential equations with increasing complexity which demand innovative techniques in both analysis and computation, such as adaptivity, fast methods and preconditioning, and structure preserving algorithms. Areas of special interest include complex fluids and new materials, electromagnetism and wave propagation, uncertainty quantification, and fractional PDEs, among others.
This minisymposium intends to gather about 16 world experts and young researchers in analysis and computation of PDE to discuss the most recent progress in this exciting field as well as future directions for research.

▶MS-Th-D-25-1 13:30–14:00
A Finite Element Method for Liquid Crystals with Variable Degree of Orientation

Walker, Shawn Louisiana State Univ.
Nochetto, Ricardo Univ. of Maryland
Zhang, Wujun Univ. of Maryland, College Park

Abstract: We present a finite element method (FEM) for computing equilibrium configurations of liquid crystals with variable degree of orientation. The model consists of a Frank-like energy with an additional "s" parameter that allows for line defects with finite energy, but leads to a degenerate elliptic equation for the director field. Our FEM uses a special discrete form of the energy that does not require regularization, and allows us to obtain a stable (gradient flow) scheme.

▶MS-Th-D-25-2 14:00–14:30
Numerical Methods for Large Bending Problems

Bartels, Soeren Univ. of Freiburg

Abstract: Thin elastic bilayer structures arise in various modern applications, e.g., in the fabrication of nanotubes or microgrippers. The mathematical modeling leads to a nonlinear fourth order problem with nonlinear pointwise constraint. We prove the convergence of a finite element discretization within the framework of Γ-convergence and discuss the convergence of an iterative solution method.

▶MS-Th-D-25-3 14:30–15:00
Quasi-interpolants and Local Projections in Isogeometric Analysis

BUFFA, Annalisa IMATI "E. Magenes", CNR
Garau, Eduardo M. Instituto de Matema'tica Aplicada del Litoral (CONICET-UNL) & Facultad de Ingenierı'a Quı'mica (UNL), Argentina
Giannelli, Carlotta INdAM c/o Univ. of Florence
Sangalli, Giancarlo Dipartimento di Matematica, Universita' di Pavia

Abstract: The analysis of the error for isogeometric methods is based on the construction of suitable projection operators onto the space of splines or their generalisations as NURBS, T-splines or hierarchical splines. In this talk, I will review the general theory of quasi interpolates proposed by Lee, Lyche, and Morken in 2000, and design a class of quasi-interpolation operators that can be proved stable in relevant Sobolev spaces and under minimal assumptions on the underlying mesh.

▶MS-Th-D-25-4 15:00–15:30
Asymptotically Compatible Schemes for Parametrized Variational Problems

Du, Qiang Columbia Univ.
Tian, Xiaochuan Columbia Univ.

Abstract: We present the recently developed abstract framework of asymptotically compatible (AC) schemes for robust discretizations of a family of parametrized problems. We discuss a few of its applications, including the characterization of AC schemes for nonlocal diffusion and peridynamic models and their local PDE limits. and the development of a nonconforming discontinuous finite element approximation for nonlocal models.

MS-Th-D-26 13:30–15:30 110
Functional Ito calculus and Path-dependent Partial Differential Equations

Organizer: CONT, Rama Imperial College London

Abstract: The Functional Ito calculus is a non-anticipative functional calculus which extends the Ito calculus to path-dependent functionals of stochastic processes. This recently developed approach has led to new results on the representation of martingales as stochastic integrals, the derivation of Feynman-Kac formulae for path-dependent functionals and a new class of functional equations known as "path-dependent PDEs", which extends the classical Kolmogorov equations to the non-Markovian case. with interesting connections to the theory of Backward stochastic differential equations.
This MiniSymposium presents recent research on Functional Ito calculus and path-dependent PDEs and their applications to stochastic control and simulation of stochastic processes.

▶MS-Th-D-26-1 13:30–14:00
Weak Solutions for Path-dependent Kolmogorov Equations

CONT, Rama Imperial College London

Abstract: Path-dependent Kolmogorov equations naturally arise as the extension of the classical backward Kolmogorov equations to the case of non-Markovian stochastic processes. We introduce a notion of Sobolev-type weak solution for linear and semilinear path-dependent PDEs and show that this notion of weak solution has a natural connection to (backward) stochastic differential equation. In particular, given a reference semimartingale X, any square-integrable (sub)martingale in the filtration of X is characterized as a weak (sub)solution of the path-dependent Kolmogorov equation corresponding to X.

▶MS-Th-D-26-2 14:00–14:30
Viscosity Solutions of Obstacle Problems for Fully Nonlinear Path-dependent PDEs.

Ekren, Ibrahim ETH Zurich

Abstract: In this talk, we adapt the definition of viscosity solutions to the obstacle problem for fully nonlinear path-dependent PDEs with data uniformly continuous in

$$(t, \omega)$$

, and generator Lipschitz continuous in

$$(y, z, \gamma)$$

. We prove that our definition of viscosity solutions is consistent with the classical solutions, and satisfy a stability result. We show that the value functional defined via the second order reflected backward stochastic differential equation is the unique viscosity solution of the variational inequalities.

▶MS-Th-D-26-3 14:30–15:00
Pathwise Ito Calculus for Rough Paths and Applications

Zhang, Jianfeng Univ. of Southern California

Abstract: The functional Itô calculus has been very successful in many applications, particularly in viscosity theory for backward path dependent PDEs. In this talk we extend the theory to pathwise Ito calculus, in the rough path framework with possibly non-geometric rough paths. This is appropriate for forward problems. Some applications on (forward) stochastic PDEs will also be discussed.

▶MS-Th-D-26-4 15:00–15:30
Weak Approximation of Martingale Representations

Lu, Yi Univ. Paris 6

Abstract: We present a systematic method for computing explicit approximations to martingale representations for a large class of Brownian functionals. The approximations are based on a notion of pathwise functional derivative and yield a consistent estimator for the integrand in the martingale representation formula for any square-integrable functional of the solution of an SDE with path-dependent coefficients. Explicit convergence rates are derived for functionals which are Lipschitz-continuous in the supremum norm. The approximation and the proof of its convergence are based on the Functional Ito calculus, and require neither the Markov property, nor any differentiability conditions on the coefficients of the stochastic differential equations involved.

MS-Th-D-27 13:30–15:30 407

Decoupling methods for multi-physics and multi-scale problems - Part V of VIII

For Part 1, see MS-Tu-E-27
For Part 2, see MS-We-D-27
For Part 3, see MS-We-E-27
For Part 4, see MS-Th-BC-27
For Part 6, see MS-Th-E-27
For Part 7, see MS-Fr-D-27
For Part 8, see MS-Fr-E-27

Organizer: He, Xiaoming — Missouri Univ. of Sci. & Tech.
Organizer: Xu, Xuejun — Inst. of Computational Mathematics, AMSS, CAS

Abstract: The inherent multi-physics and multi-scale features of many real world problems accentuate the importance to develop efficient and stable numerical methods for the relevant PDEs, especially the decoupling methods. Although great efforts have been made for solving these problems, many practical and analytical challenges remain to be solved. This mini-symposium intends to create a forum for junior and senior researchers from different fields to discuss recent advances on the decoupling methods for multi-physics and multi-scale problems with their applications.

▶ MS-Th-D-27-1 13:30–14:00

Efficient and Long-time Accurate Algorithms for the Stokes-Darcy System

Chen, Wenbin — School of Mathematical Sci., Fudan Univ.

Abstract: We propose and study implicit-explicit (IMEX) methods for the coupled Stokes-Darcy system that governs flows in karst aquifers and other subsurface flow systems. The algorithms only require the solution of decoupled Stokes and Darcy problems at each time step. Hence, these schemes are very efficient and can be easily implemented using legacy codes. We establish the unconditional and uniform in time stability for both schemes.

▶ MS-Th-D-27-2 14:00–14:30

Time Dependent Stokes Darcy Flows with Defective Boundary Conditions

Cao, Yanzhao — Auburn Univ.

Abstract: In this talk, we focus on finite element approximations of time dependent Stokes-Darcy interface problems with defective boundary conditions and Beavers-Joseph interface condition. In many real world problems, it is difficult or expensive to measure the fluid flow velocity as the boundary conditions, and it is relatively easy and more cost-efficient to obtain flow rates on the boundary, which leads to defective boundary conditions. Well-posedness, error analysis and numerical experiments will be presented.

▶ MS-Th-D-27-3 14:30–15:00

Models for Viscoelastic Fluids-structure Interaction with Applications in Cell Motility

Dillon, Robert — Washington State Univ.

Abstract: While much progress has been made in the development of mathematical models and numerical methods for fluid-structure interactions in a Newtonian fluid, much work needs to be done in the case of complex fluids. We describe a Lagrangian mesh method for modeling complex fluids where the fluid viscoelasticity is represented by a discrete network of linear viscoelastic elements. The rheological properties of the Lagrangian mesh fluid are compared with an Oldroyd-B model in computational rheometry channel flow, and peristaltic pumping. We compare simulation results for sperm motility in Newtonian, Oldroyd-B and Lagrangian mesh fluids.

MS-Th-D-28 13:30–15:30 109

Mathematical Theory of System and Control I: control of partial differential equations

Organizer: Tang, Shanjian — Fudan Univ.
Organizer: Zhang, Xu — Sichuan Univ.

Abstract: The minisymposium is devoted to optimal control of partial differential equations, in particular of Navier-Stokes quations. It is one of the series on Mathematical Theory of System and Control.

▶ MS-Th-D-28-1 13:30–14:00

Analysis and Control of the Kortweg-de Vries Equation on A Bounded Domain with Neumann Boundary Conditions

Zhang, Bingyu — Univ. of Cincinnati

Abstract: In this talk we will consider the the KdV equation posed on a ﬁnite domain with the no homogeneous Neumann boundary conditions. We will ﬁrst show the corresponding initial-boundary value problem is well-posed. Then viewing the boundary value functions as control inputs, we show that the system is locally exactly boundary controllable.

▶ MS-Th-D-28-2 14:00–14:30

Local Stabilization of Fluid-structure Models

RAYMOND, Jean-Pierre — Paul Sabatier Toulouse III Univ.

Abstract: We shall address the problem of stabilizing systems coupling the incompressible Navier-Stokes equations with the Lamé system of linear elasticity. The control is a distributed control acting only in the elasticity equation, localized in a neighborhood of the fluid-structure interface. For regular initial data, small enough, we prove the existence of L^2 controls stabilizing the coupled system with an arbitrarily prescribed exponential decay rate. This is a joint work with M. Vanninathan.

▶ MS-Th-D-28-3 14:30–15:00

Control of PDE Models Involving Memory Terms

Zuazua, Enrique — BCAM & Ikerbasque

Abstract: We analyse controllability issues for PDE models involving memory terms.
We show that, if the support of the control does not move in time, the memory of the system cannot be controlled. We then prove that, if the control moves covering eventually the whole domain, the memory term is also controllable.
We use a decoupling argument allowing to write the memory PDE as the superposition of the PDE with an ODE or transport equation.

▶ MS-Th-D-28-4 15:00–15:30

Random Attractor for Globally Modified Non-autonomous 3D Navier-Stokes Equations with Memory Effects and Stochastic Perturbations

Chen, Zhang — Shandong Univ.
LIN, Wei — Fudan Univ.

Abstract: In this talk, globally modified non-autonomous 3D Navier-Stokes equations with memory effects and noise perturbations will be discussed. This stochastic equations may produce a infinite dimensional random dynamical system in the space of C_H, and theoretical results show that random attractor for this random dynamical system is upper semicontinuous with respect to noise intensity parameter and modified parameter.

MS-Th-D-29 13:30–15:30 305

Numerical Homogenization and Multiscale Model Reduction Methods - Part II of V

For Part 1, see MS-Th-BC-29
For Part 3, see MS-Th-E-29
For Part 4, see MS-Fr-D-29
For Part 5, see MS-Fr-E-29

Organizer: Zhang, Lei — Shanghai Jiao Tong Univ.
Organizer: Peterseim, Daniel — Universität Bonn
Organizer: Jiang, Lijian — Hunan Univ.
Organizer: Chung, Eric — The Chinese Univ. of Hong Kong

Abstract: Problems that transcend a variety of strongly coupled time and length scales are ubiquitous in modern science and engineering such as physics, biology, and materials. Those multiscale problems pose major mathematical challenges in terms of analysis, modeling and simulation. At the same time, advances in the development of multiscale mathematical methods coupled with continually increasing computing power have provided scientists with the unprecedented opportunity to study complex behavior and model systems over a wide range of scales.
This minisymposium is aimed at presenting the state-of-the-art in multiscale modeling, simulation and analysis for the applications in science and engineering. It will focus on the developments and challenges in numerical multiscale methods and multiscale model reduction methods. The lectures will cover the following subjects: - Numerical homogenization methods, e.g. Generalized FEM, MsFEM, FEM-HMM, DG methods, Partition of Unity methods, multiscale domain decomposition etc. - Multiscale model reduction methods for stochastic systems, such as stochastic PDEs and random materials. - Multiscale methods for problems arising in composite materials and heterogeneous porous media. - Multiscale methods for eigenvalue problems, high frequency waves, and multiscale hyperbolic PDEs. - Multiscale modeling in various applications such as reservoir performance prediction, bio-motility, chemical vapor infiltration, etc.

▶ MS-Th-D-29-1 13:30–14:00

Finite Element Heterogeneous Multiscale Method (FE-HMM) for the Helmholtz Equation in Various Complex Materials

Stohrer, Christian — POEMS team, ENSTA ParisTech

Abstract: We present a numerical homogenization method for the Helmholtz Equation using the FE-HMM framework. We first consider composite materials where the wave speed oscillates rapidly on a microscopic length scale, but is uniformly bounded from above and below. We prove convergence of our approximation to the solution of the effective equation which describes the macroscopic behaviour. Afterwards, we apply our scheme to perforated

domains and metamaterials, address required adaptions, and discuss arising difficulties.

▶ MS-Th-D-29-2 14:00–14:30

Computation of Eigenvalues Using Multiscale Techniques

Målqvist, Axel Univ. of Gothenburg

Abstract: We consider numerical approximation of linear and non-linear eigenvalue problems, using the Localized Orthogonal Decomposition (LOD) technique. In this approach a low dimensional generalized finite element space is constructed, by solving localized (in space) independent linear stationary problems. The eigenvalue problem is then solved in the computed low dimensional space at a greatly reduced computational cost.

▶ MS-Th-D-29-3 14:30–15:00

Multiscale Model Reduction for Reservoir Performance Predictions

Wu, Xiao-Hui ExxonMobil Upstream Research Company

Abstract: Model reduction is a key component in a data-driven and/or decision-driven, integrated reservoir modeling and simulation workflow for reliable reservoir performance predictions. An overview of different model reduction approaches, their practical motivations, challenges, and recent progresses is presented. Large-scale application of existing model reduction techniques in practical workflows still faces many challenges, from theoretical analysis, to numerical algorithms, and computing infrastructures. A few of these challenges are highlighted in this talk.

▶ MS-Th-D-29-4 15:00–15:30

A Posteriori Error Estimation for Multiscale Computations Based on MsFEM

Legoll, Frederic ENPC

Abstract: The Multiscale Finite Element Method (MsFEM) is a Finite Element type approach for multiscale PDEs, where the basis functions used to generate the approximation space are precomputed and are specifically adapted to the problem at hand. A priori bounds on the numerical error have been established for several variants of the MsFEM approach. In this work, we introduce a guaranteed and fully computable a posteriori error estimate.
Joint work with L. Chamoin.

MS-Th-D-30 13:30–15:30 VIP2-2

Numerical approaches in optimization with PDE constraints: recent progress and future challenges - Part IV of VII

For Part 1, see MS-We-D-30
For Part 2, see MS-We-E-30
For Part 3, see MS-Th-BC-30
For Part 5, see MS-Th-E-30
For Part 6, see MS-Fr-D-30
For Part 7, see MS-Fr-E-30

Organizer: Yan, Ningning Chinese Acad. of Sci.
Organizer: Hinze, Michael Universität Hamburg

Abstract: The numerical treatment of optimization problems with PDE constraints is a very active field of mathematical research with great importance for many practical applications. To achieve further progress in this field of research, the development of tailored discretization techniques, adaptive approaches, and model order reduction methods has to be intertwined with the design of structure exploiting optimization algorithms in function space.
This minisymposium covers mathematical research in PDE constrained optimization ranging from numerical analysis and adaptive concepts over algorithm design to the tailored treatment of optimization applications with PDE constraints. It thereby forms a platform and fair for the exchange of ideas among young researchers and leading experts in the field, and for fostering and extending international collaborations between research groups in the field.

▶ MS-Th-D-30-1 13:30–14:00

Finite Difference for Pricing American Lookback Options

Zhang, Tie northeastern Univ.

Abstract: we are concerned with the pricing of lookback options with American type constrains. An implicit difference scheme is constructed and analyzed. We show that the difference solution is uniquely existent and unconditionally stable, and it converges uniformly to the viscosity solution of the continuous problem. Furthermore, an $O(\Delta t+h^2)$-order error estimate is derived in the discrete L_2-norm provided that the continuous problem is sufficiently regular.

▶ MS-Th-D-30-2 14:00–14:30

Finite Element Approximation of Time Fractional Optimal Control Problems

Zhou, Zhaojie Shandong Normal Univ.
Gong, Wei Chinese Acad. of Sci.

Abstract: This talk will address Galerkin finite element approximation of optimal control problem governed by time fractional diffusion equations. Piecewise linear polynomials are used to approximate the state, while the control is discretized by variational discretization method. A finite difference method is used to discretize the time fractional derivative. A priori error estimates for the semi-discrete approximations are derived. Numerical example is given to illustrate the theoretical findings.

▶ MS-Th-D-30-3 14:30–15:00

Multiscale Analysis and Algorithms for Optimal Control and Optimal Design in Composite Materials

Liqun, Cao Chinese Acad. of Sci.

Abstract: In this talk, I will introduce the recent advances in multiscale approach for optimal control and optimal design in composite materials. The homogenization method and the multiscale asymptotic method are presented. The associated algorithms and convergence analysis are provided. Finally, numerical examples are carried out to confirm the above theoretical results.

▶ MS-Th-D-30-4 15:00–15:30

An All-at-once Approach to PDE-constrained Optimal Control Problems with Uncertain Inputs

Benner, Peter Max Planck Inst. for Dynamics of Complex Technical Sys.

Abstract: We consider the numerical solution of PDE-constrained optimization problems involving random coefficients. Discretizing such problems by the stochastic Galerkin finite element method leads to prohibitively high-dimensional saddle point systems with Kronecker product structure. We derive robust Schur complement-based preconditioners for solving the resulting optimality systems with all-at-once low-rank solvers. We illustrate the effectiveness of our solvers with numerical experiments for the random heat and Stokes equations. [Joint work with Martin Stoll and Akwum Onwunta.]

MS-Th-D-31 13:30–15:30 405

Advances on Mixed Finite Element Methods for Linear Elasticity - Part I of IV

For Part 2, see MS-Th-E-31
For Part 3, see MS-Fr-D-31
For Part 4, see MS-Fr-E-31

Organizer: Hu, Jun Peking Univ.
Organizer: Zhang, Shangyou Univ. of Delaware

Abstract: The elasticity equations are solved in many scientific and engineering problems where the stress is often more important than the displacement. In this sense, the classical Hellinger–Reissner mixed formulation of the elasticity equations, where the stress tensor is sought in a symmetric H-div space and the displacement in an L2 space, is a natural and important variational formulation for this problem. The approximation of displacement can be taken in the space of discontinuous piecewise polynomials of some degree— but the approximation of the symmetric stress tensor is a long-standing, challenging, and surprisingly hard problem. As a matter of fact, "four decades of searching for mixed finite elements for elasticity beginning in the 1960s did not yield any stable elements with polynomial shape functions" [D. N. Arnold, Proceedings of the International Congress of Mathematicians, Vol. I: Plenary Lectures and Ceremonies (2002), 137-157].
This minisymposium will gather about 16 world experts and young researchers to discuss the most recent advances in this challenging field as well as future directions for research.

▶ MS-Th-D-31-1 13:30–14:00

An HDG Method for Linear Elasticity with Strong Symmetric Stresses

Qiu, Weifeng City Univ. of Hong Kong

Abstract: We present a HDG method for linear elasticity on general polyhedral meshes, based on a strong symmetric stress formulation. The key feature of this method is the use of a special form of the numerical trace of the stresses, which makes the error analysis different from the projection-based error analyzes used for most other HDG methods. We prove optimal orders of convergence for both the stresses and displacements on the elements.

▶ MS-Th-D-31-2 14:00–14:30

Finite Element Approximations of H(div) Symmetric Tensors

Hu, Jun Peking Univ.

Abstract: The design of mixed finite element methods in linear elasticity with symmetric stress approximations has been a longstanding open problem. In this talk, we present mixed finite element methods with symmetric stress approximations on both simplex and product meshes in any space dimension.

▶ MS-Th-D-31-3 14:30–15:00

Superconvergence and Recovery Type A Posteriori Error Estimation for Hybrid Stress Finite Element Method

Xie, Xiaoping Sichuan Univ.

Abstract: Superconvergence and a posteriori error estimators of recovery type are analyzed for the 4-node hybrid stress quadrilateral finite element method proposed by Pian and Sumihara (1984) for linear elasticity problems. Uniform superconvergence with respect to the Lamé constant λ is established. A posteriori error estimators based on the recovered quantities are shown to be asymptotically exact. Numerical experiments confirm the theoretical results. This work is joint with Yanhong Bai and Yongke Wu.

▶ MS-Th-D-31-4 15:00–15:30

Conforming Rectangular Elements and Nonconforming Simplex Elements for Elasticity Problem

Chen, Shao-chun Zhengzhou Univ.

Abstract: First we construct a conforming rectangular element and a conforming cubic element only with the degrees of freedom on an element 8+2 and 18+3 for stress and displacement, respectively. We prove that two elements are convergence on anisotropic meshes. Then we construct a family of simplex nonconforming elements (tetrahedral for 3D and triangular for 2D). These elements only use the degrees of freedom defined on faces and elements.

MS-Th-D-32 13:30–15:30 307A

Structured-mesh methods for interface problems. - Part V of VIII

For Part 1, see MS-Tu-E-32
For Part 2, see MS-We-D-32
For Part 3, see MS-We-E-32
For Part 4, see MS-Th-BC-32
For Part 6, see MS-Th-E-32
For Part 7, see MS-Fr-D-32
For Part 8, see MS-Fr-E-32

Organizer: Chen, Huanzhen College of Mathematical Sci. Shandong Normal Univ.
Organizer: He, Xiaoming Missouri Univ. of Sci. & Tech.
Organizer: KWAK, Do Young Korea Advanced Inst. of Sci. & Tech.
Organizer: Zhang, Xu Purdue Univ.

Abstract: In many real world applications it is more convenient or efficient to utilize structured meshes for solving different types of interface problems. Since the structured meshes may not fit the non-trivial interfaces, special methods need to be developed to deal with the difficulties arising from the interface problems in order to solve them on these meshes. Therefore, great efforts have been made for solving interface problems and tracing the moving interfaces based on structured meshes in the past decades. This mini-symposium intends to create a forum for researchers from different fields to discuss recent advances on the structured-mesh numerical methods for interface problems and their applications.

▶ MS-Th-D-32-1 13:30–14:00

Interface Capturing in A Hybrid Finite Volume/Element Method for Two-Fluid Flow Problems

Tu, Shuang Jackson State Univ.

Abstract: The interface capturing capability is added to our hybrid finite volume/element incompressible ow solver for solving two-fuid flow problems. The interface is captured by solving the level set equation.The zero level set is initialized by the signed distance field. To ensure that the level sets remain as the signeddistance field, reinitialization is implemented by extending the normal speed from the interface to the locationwithin the narrow band surrounding the interface.

▶ MS-Th-D-32-2 14:00–14:30

IMMERSED FINITE ELEMENT METHOD FOR EIGENVALUE PROBLEM

Sim, Imbo National Inst. for Mathematical Sci.
KWAK, Do Young Korea Advanced Inst. of Sci. & Tech.

Abstract: We consider the approximation of elliptic eigenvalue problem with an immersed interface. The main aim of this paper is to prove the stability and convergence of an immersed finite element method (IFEM) for eigenvalues using Crouzeix-Raviart P1-nonconforming approximation. We show that spectral analysis for the classical eigenvalue problem can be easily applied to our model problem. We analyze the IFEM for elliptic eigenvalue problem with an immersed interface and derive the optimal convergence of eigenvalues.

▶ MS-Th-D-32-3 14:30–15:00

A High-Order Method at Material Interface for FDTD Method Solving Maxwell's Equation

Li, Shengtai Los Alamos National Laboratory

Abstract: We present a simple method at material interface to remove numerical oscillations when the finite-difference time domain (FDTD) method is used to solve Maxwell's equation. Fictitious points are added near the material interface and their values are derived using the physical boundary conditions of wave propagation at the interface and high-order FDTD numerical schemes. A hybrid model is proposed to improve the efficiency and achieve high-order accuracy in interested region.

▶ MS-Th-D-32-4 15:00–15:30

A Partially Penalty Immersed Crouzeix-Raviart Finite Element Method for Elliptic Interface Problems

An, Na Graduate School of China Acad. Engineering Physics

Abstract: In this report, we develop a partially penalty immersed finite element method on triangular grids for an elliptic interface problem. On interface elements, the piecewise linear functions are proved to be uniquely determined by edge averages as degrees of freedom. We derive the optimal error estimates in the energy norm. And numerical examples are presented to show the method is valid not only for isotropic elliptic interface problems but also for anisotropic elliptic interface problems.

MS-Th-D-33 13:30–15:30 406

Mathematical and computational methods for coupling local and nonlocal models - Part I of IV

For Part 2, see MS-Th-E-33
For Part 3, see MS-Fr-D-33
For Part 4, see MS-Fr-E-33

Organizer: D'Elia, Marta Sandia National Laboratories
Organizer: Seleson, Pablo Oak Ridge National Laboratory
Organizer: Bochev, Pavel Sandia Labs

Abstract: Nonlocal continuum and atomistic models are used in many scientific and engineering applications, where material dynamics depends on microstructure. The numerical solution of nonlocal models might be prohibitively expensive; therefore, concurrent multiscale methods have been proposed for efficient and accurate solutions of such systems. These methods employ nonlocal models in parts of the domain and use local, macroscopic, models elsewhere. A major challenge is to couple these models at interfaces or in overlapping regions. This minisymposium invites contributions on coupling local and nonlocal continuum models and concurrent multiscale methods for atomistic-to-continuum coupling. Related domain decomposition methods are also considered.

▶ MS-Th-D-33-1 13:30–14:00

Multiscale Methods Based on Coupled Solvers

Abdulle, Assyr EPFL

Abstract: In this talk we will present recent developments of multiscale methods for problems involving different physics at the microscopic and the macroscopic levels [A.Abdulle, O.Budac, An adaptive finite element heterogeneous multiscale method for Stokes flow in porous media, to appear in SIAM MMS 2015] and methods suited for problem without scale separation in subregions of the computational domain [A.Abdulle, O. Jecker, An optimization based heterogeneous to homogeneous coupling method, to appear in Comm. Math. Sci.2015].

▶ MS-Th-D-33-2 14:00–14:30

QM/MM Multiscale Methods for Crystalline Defects

Ortner, Christoph Univ. of Warwick

Abstract: QM/MM methods are a prototypical class of multiscale simulation schemes. They embed a quantum mechanical simulation of a "region of interest" in a bulk region that is modelled by a classical interatomic potential model. In this talk I will present new constructions of QM/MM schemes, both force-based and energy-based, specifically targeted for materials defect simulations. Moreover, I will present a rigorous error analysis of these schemes.

▶ MS-Th-D-33-3 14:30–15:00

Formulation, Analysis and Computation of An Optimization-based Local-to-nonlocal Coupling Method

D'Elia, Marta Sandia National Laboratories
Bochev, Pavel Sandia Labs

Abstract: Nonlocal models are very accurate in modeling materials where the dynamics depends on the microstructure; however, they can be computationally expensive. We formulate the coupling as a control problem where the states are the nonlocal and local solutions, the objective is to minimize their mismatch on the overlap of their domains, and the controls are volume constraints and boundary conditions. We conduct a mathematical and numerical analysis of our method and we provide numerical examples.

▶ MS-Th-D-33-4 15:00–15:30

The Morphing Method for Coupling Local and Nonlocal Continuum Models

Han, Fei King Abdullah Univ. of Sci. & Tech. (KAUST)

Abstract: Recently the Morphing method has been proposed by Lubineau G. et al. for coupling conventional continuum and peridynamic models. The Morphing coupling method is inspired by the homogenization idea. Using the equivalent energy density of both models, it constructs a balance between local stiffness and weighted non-local modulus. Because the Morphing method is simple and easy to use widely, we present here a brief introduction and its latest development in mathematics and applications.

MS-Th-D-34 13:30–15:30 112

Modeling and Simulation of Complex Fluids and Biological Systems - Part I of IV

For Part 2, see MS-Th-E-34
For Part 3, see MS-Fr-D-34
For Part 4, see MS-Fr-E-34

Organizer: Zhang, Hui Beijing Normal Unversity
Organizer: Forest, M. Gregory Univ. of North Carolina at Chapel Hill
Organizer: Wang, Qi Univ. of South Carolina & Beijing Computational Sci. Research Center

Abstract: This mini symposium will bring together researchers in complex fluids and biological systems to exchange ideas and perspectives as well as to share their most recent findings. The goal is to integrate advances in mathematics (theory, modeling, data analytics, algorithms, simulations, high performance computing techniques) with new experimental data from complex fluids and biological systems, and targeted applications. The specific systems represented include single living cells, biofilms, active molecular fluids, and transport properties of biological fluids such as lung mucus.
We would like to invite you to give a talk on your current research at the proposed mini-symposium. The talks are scheduled to be 25 minutes each + 5 minutes for discussion.

▶MS-Th-D-34-1 13:30–14:00

Polymer Models of Interphase Chromosomes

Vasquez, Paula A Univ. of South Carolina
Forest, M. Gregory Univ. of North Carolina at Chapel Hill

Abstract: Organizational patterns on the genome have emerged from the statistics of population studies of fixed cells. However, how these results translate into the dynamics of individual cells remains unexplored. In this talk we use statistical mechanics models derived from polymer physics to study the effects that chromosome properties and their dynamics have in the temporal and spatial behavior of the genome. We explore two modifications of chain behavior: single chain motion and chain-chain interactions.

▶MS-Th-D-34-2 14:00–14:30

Anisotropic Particle in Viscous Shear Flow: Navier Slip, Reciprocal Symmetry, and Jeffery Orbit

Qian, Tiezheng Hong Kong Univ. of Sci. & Tech.

Abstract: The hydrodynamic reciprocal theorem for Stokes flows is generalized to incorporate the Navier slip boundary condition, which can be derived from Onsager's variational principle of least energy dissipation. The hydrodynamic reciprocal relations and the Jeffery orbit, both of which arise from the motion of a slippery anisotropic particle in a simple viscous shear flow, are investigated theoretically and numerically using the fluid particle dynamics method.

▶MS-Th-D-34-3 14:30–15:00

Neck-linking Condition for the Limit State of A Budding Lipid Vesicle

Tu, Zhanchun Beijing Normal Univ

Abstract: When a lipid vesicle is budding, the mean curvatures of two daughter vesicles nearby the neck satisfy a specific identity. This neck-linking condition for the limit state of a budding lipid vesicle was proposed twenty years ago, it is still lack of a general proof without the consideration of the axisymmetrical assumption. This general proof is presented in this talk. A conjecture of minimal geodesic disks is also proposed.

▶MS-Th-D-34-4 15:00–15:30

Kinetic Monte Carlo Simulations of Multicellular Aggregate Self-Assembly in Biofabrication

Sun, Yi Univ. of South Carolina
Wang, Qi Univ. of South Carolina & Beijing Computational Sci. Research Center

Abstract: We present a 3D lattice model to study self-assembly of multicellular aggregates by using kinetic Monte Carlo (KMC) simulations. This model is developed to describe and predict the time evolution of postprinting structure formation during tissue or organ maturation in a novel biofabrication technology–bioprinting. Here we simulate the self-assembly and the cell sorting processes within the aggregates of different geometries, which can involve a large number of cells of multiple types.

MS-Th-D-35 13:30–15:30 408

Analysis, Modeling, and Numerical Methods for High Frequency Waves - Part I of IV

For Part 2, see MS-Th-E-35
For Part 3, see MS-Fr-D-35
For Part 4, see MS-Fr-E-35

Organizer: YANG, XU Univ. of California, Santa Barbara
Organizer: YING, LEXING Stanford Univ.
Organizer: HUANG, ZHONGYI Tsinghua Univ.
Organizer: RUNBORG, OLOF Department of Mathematics, KTH

Abstract: The development of modern techniques has been able to provide accurate studies on the micro- and nano-scale physics. Under this small scale, the objects often appear as a form of waves, and present quantum properties. On the other hand, the observation is often made at macroscopic scale which is closely related to small-scale details, therefore it is necessary to consider problems at multiple scales. Propagation of high frequency waves is one such topic. The major challenge is that one usually needs to handle the disparity between the two length scales: the large domain size and the small wavelength. This means one has to work on a large computational domain that contains thousands to millions of wavelengths, and each of them needs to be resolved if direct numerical methods are applied. Therefore the total number of grid points is huge, which usually leads to unaffordable computational cost. This minisymposium will focus on high-frequency waves and their applications in quantum mechanics and seismology. Topics on analysis, modeling and numerical methods will be discussed.

▶MS-Th-D-35-1 13:30–14:00

Approximate Separability of Green's Function for Helmholtz Equation in the High Frequency Limit

Zhao, Hongkai UC Irvine

Abstract: Approximate separability of Green's functions for differential operators is a basic and important question in analysis of differential equations and development of efficient numerical algorithms. Green's function for coercive elliptic differential operator has been shown to be highly separable. The case of Helmholtz equation in the high frequency limit is more challenging. We develop a new approach to study approximate separability for the Green's function of Helmholtz equation with sharp lower and upper bounds.

▶MS-Th-D-35-2 14:00–14:30

High Frequency Wave Propagation by Fast Gaussian Beams and Huygens Sweeping Methods

Qian, Jianliang Michigan State Univ.

Abstract: I will review some recent algorithms that we have developed for high frequency waves, including fast Eulerian Gaussian beams, fast multiscale Gaussian beams, and fast Huygens sweeping methods.

▶MS-Th-D-35-3 14:30–15:00

Parallel Domain Decomposition Sweeping Preconditioner for the Solution of Time-Harmonic Helmholtz and Maxwell Equations

Geuzaine, Christophe Univ. of Liege

Abstract: We propose an improvement of the double sweep preconditioner for the solution of Helmholtz and Maxwell problems by an optimized Schwarz domain decomposition method. It consists in reducing the sweeping range in order to perform several shorter sweeps in parallel, thereby alleviating a major drawback of the sweeping preconditioner—its sequential nature. This modification leads to a moderate increase in the iteration count, which is largely counterbalanced by the gain in time-to-solution and better resource usage.

▶MS-Th-D-35-4 15:00–15:30

Fast Huygens Sweeping Methods for Schrodinger Equations in the Semi-classical Regime

Leung, Shingyu Hong Kong Univ. of Sci. & Tech.

Abstract: We present fast Huygens sweeping methods for Schrodinger equations in the semi-classical regime by incorporating short-time Wentzel-Kramers-Brillouin-Jeffreys (WKBJ) propagators into Huygens' principle. Even though the WKBJ solution is valid only for a short time period due to the occurrence of caustics, Huygens' principle allows us to construct the global-in-time semi-classical solution. This is a joint work with Susana Serna and Jianliang Qian.

MS-Th-D-36 13:30–15:30 409

Advances in MCMC and related sampling methods for large-scale inverse problems - Part I of IV

For Part 2, see MS-Th-E-36
For Part 3, see MS-Fr-D-36
For Part 4, see MS-Fr-E-36

Organizer: Bui-Thanh, Tan — The Univ. of Texas at Austin
Organizer: Cui, Tiangang — MIT
Organizer: Marzouk, Youssef — Massachusetts Inst. of Tech.

Abstract: Inverse problems convert indirect measurements into useful characterizations of the parameters of a physical system. Parameters are typically related to indirect measurements by a system of partial differential equations (PDEs), which are complicated and expensive to evaluate. Available indirect data are often limited, noisy, and subject to natural variation, while the unknown parameters of interest are often high dimensional, or infinite dimensional in principle. Solution of the inverse problem, along with prediction and uncertainty assessment, can be cast in a Bayesian setting and thus naturally tackled with Markov chain Monte Carlo (MCMC) and other posterior sampling methods. However, designing scalable and efficient sampling methods for high dimensional inverse problems that involve expensive PDE evaluations poses a significant challenge. This mini-symposium presents recent advances in sampling approaches for large scale inverse problems.

▶ MS-Th-D-36-1 13:30–14:00

High Dimensional Non-Gaussian Bayesian Inference with Transport Maps

Spantini, Alessio — MIT
Marzouk, Youssef — Massachusetts Inst. of Tech.

Abstract: Characterizing high dimensional posterior distributions in the context of nonlinear and non-Gaussian Bayesian inverse problems is a well-known challenging task. A recent approach to this problem seeks a deterministic transport map from a reference distribution to the posterior. Thus posterior samples can easily be obtained by pushing forward reference samples through the map. In this talk, we address the computation of the transport map in high dimensions. In particular, we propose a scalable adaptive algorithm

▶ MS-Th-D-36-2 14:00–14:30

Advances in Generalised Metropolis-Hastings Algorithms

Calderhead, Ben — Imperial College London

Abstract: A recent generalization of the Metropolis−Hastings algorithm allows for parallelizing a single chain using existing MCMC methods (Calderhead, PNAS, 2014). The construction involves proposing multiple points in parallel, then defining and sampling from a finite-state Markov chain on the proposed points such that the overall procedure has the correct target density as its stationary distribution. In this talk I'll discuss this algorithm and some of the most recent advances employing this approach.

▶ MS-Th-D-36-3 14:30–15:00

Multilevel Sequential Monte Carlo Samplers

Law, Kody — ORNL
TEMPONE, RAUL — KING ABDULLAH Univ. OF Sci. & Tech.

Abstract: The approximation of the posterior distribution associated to a Bayesian inverse problem is decomposed into a hierarchy consisting of a telescoping sum of increments with decreasing variance and increasing cost, and then probed with a sequential Monte Carlo sampler. The number of samples per level is optimized with respect to cost for a fixed root-mean square error, which then optimally scales as the inverse square-root of the cost.

▶ MS-Th-D-36-4 15:00–15:30

Operator-weighted MCMC on Function Spaces

Cui, Tiangang — MIT
Law, Kody — ORNL
Marzouk, Youssef — Massachusetts Inst. of Tech.

Abstract: Many inference problems require exploring the posterior distribution of high-dimensional parameters, which in principle can be described as functions. We introduce a family of operator-weighted MCMC samplers that can adapt to the intrinsically low rank and locally complex structure of the posterior distribution while remaining well defined on function space. Posterior sampling in a nonlinear inverse problem and a conditioned diffusion process are used to demonstrate the efficiency of these dimension-independent operator-weighted samplers.

MS-Th-D-37 13:30–15:30 301B

Networked Systems and Optimization

Organizer: Li, Shaoyuan — Shanghai Jiao Tong Univ.

Abstract: There is a class of complex large-scale systems which are composed of many physically or geographically divided subsystems. Each subsystem interacts with some so called neighboring subsystems which is interconnected by the commutation networks for their states and inputs information exchange. The distributed (or decentralized) framework, where each subsystem is controlled by an independent controller, has the advantages of error-tolerance, less computational effort, and being flexible to system structure. Thus the distributed control framework is usually adopted in this class of system in spite of the fact that the dynamic performance of centralized framework is better than it. Thus, how to improve global performance under distributed control framework is a valuable problem The minisymposium aim to present the state-of-the-art progress in analysis and control of the networked systems, including 1) the distributed predictive controller design; 2) the control system synthesis for networked control systems; 3) the decentralized tracking algorithms subject to the system constraints; and 4) the applications for the multiphase sea glider.

▶ MS-Th-D-37-1 13:30–14:00

Flexible Distributed Model Predictive Control Coordination Strategies – Several Viewpoints

Zheng, Yi — Eletronic Information & Eletrical Engineering, Shanghai Jiao Tong Univ.
Li, Shaoyuan — Shanghai Jiao Tong Univ.

Abstract: Some Distributed Model Predictive Control (DMPC) coordination strategies for improving the performance of entire closed-loop system are reviewed. Specially the latest researching results, the impacted region optimization based DMPC and the N-step adjcent matrix decomposition based DMPC with high flexibility, are specified. The characteristics and interal relationship between these methods are analyzed for deeply revealing the essence of DMPC strategies and helping the selection of DMPC strategies according to the variant control purposes.

▶ MS-Th-D-37-2 14:00–14:30

Predictive Control Synthesis for Networked Control Systems

Zou, Yuanyuan — East China Univ. of Sci. & Tech.

Abstract: Networked control systems (NCSs) are a class of complex dynamical systems in which the distributed system components are connected over communication networks. Owing to the limited capacities, the synthesis of NCSs involved with network-induced delays, data dropouts, quantization and medium access constraints poses new challenges. In this Minisymposia, the results on predictive control synthesis for NCSs are presented to achieve desired control performance and the event-triggered predictive control scheme is proposed to reduce communication resources.

▶ MS-Th-D-37-3 14:30–15:00

Data-driven Performance Monitoring of Underwater Glider Based on Principal Component Analysis

Yang, Hua — Ocean Univ. of China

Abstract: Gliders are one of the most highly efficient autonomous underwater vehicles for long-range oceanographic sampling that glide by controlling their buoyancy and attitude using internal actuators. This paper considers performance monitoring of an underwater glider system. Based on the PCA model, the Underwater Vehicles are described with lower dimension and better statistical properties. The results of the simulation show the feasibility and validity of the method.

▶ MS-Th-D-37-4 15:00–15:30

Decentralized Tracking Algorithms for Three Manipulators Subject to Motion Constraints

Wang, Lin — Shanghai Jiao Tong Univ.
Wang, Xiaofan — Shanghai Jiao Tong Univ.

Abstract: We consider a tracking problem for three manipulators grasping a rigid object. The control objective is to coordinate the movements of the manipulators using local information in order to align the object attitude with a desired attitude and the object position with a time parameterized reference trajectory. The object rigidity is modelled as a constraint on the motion of the end-effectors saying that the distance between any pair of end-effectors must be constant.

MS-Th-D-38 13:30–15:30 302A

Complex System Control and Applications II

Organizer: TCCT, TCCT — Technical Committee on Control Theory, CAA

Abstract: It' s arguable that complex systems have been studied for many years, but only after the discovery of chaos in deterministic systems did people realize that the "complexity" of complex systems is rooted into the fundamental laws of physics. Some features, such as cascading failures, coupling, nonlinearity and emergent phenomena, make the analysis and control of complex systems theoretically challenging. This mini-symposium aim to present some recent theoretical progresses in several brunches of complex system control and some further applications, including: 1) communication-based fault detection and isolation; 2)rehabilitation robot research; 3) stable strategy of networked evolutionary games; 4) finite time fuzzy control.

▶MS-Th-D-38-1 13:30–14:00
Rehabilitation Robot: A Personal Perspective of Control Theory & Practice.
Zeng-Guang, Hou Inst. of Automation, Chinese Acad. of Sci.

Abstract: This talk will mainly address the system design of a reclining type rehabilitation robot for lower limbs, and also discuss the control strategies and related issues for the passive training, active training and assistance training for the needs of neurological rehabilitation and motor function of lower limbs for SCI or stroke patients.

▶MS-Th-D-38-2 14:00–14:30
Communication-based Fault Detection and Isolation for Multi-agent Systems
Hao, Fang Beijing Inst. of Tech.

Abstract: We propose a communication-based fault detection and isolation framework for multi-agent systems. All the fault processing operation is achieved by controlling the contents of communication. A fault detection scheme based on status information exchanging and gossip algorithm is introduced. Then, we propose a new calculation and compensation algorithm for fault isolation to reduce the restriction of the control protocol. All the schemes are proved to be effective in theory and several simulations are presented.

▶MS-Th-D-38-3 14:30–15:00
On Evolutionarily Stable Strategy of Networked Evolutionary Games
Qi, Hongsheng Chinese Acad. of Sci.

Abstract: This talk will introduce the evolutionarily stable strategy (ESS) of networked evolutionary games (NEGs). Analyzing the ESS of infinite popular evolutionary games and comparing it with networked games, a new verifiable definition of ESS for NEGs is proposed. Then the fundamental evolutionary equation is investigated and used to construct the strategy profile dynamics of homogeneous NEGs. Some illustrative examples are included to demonstrate the theoretical results.

▶MS-Th-D-38-4 15:00–15:30
Finite Time Fuzzy Control Design with PDE State Constraint for A Class of Nonlinear Coupled ODE-PDE Systems
Wu, Huai-Ning Beihang Univ.

Abstract: This paper considers a class of nonlinear systems modeled by ordinary differential equations (ODEs) coupled with a parabolic partial differential equation (PDE). A fuzzy control design is developed in terms of linear matrix inequalities (LMIs), such that the ODE subsystem is finite time quasi-contractively stable with a terminal time as small as possible, while a PDE state constraint is respected. Finally, the proposed method is applied to the control of a hypersonic rocket car.

MS-Th-D-39 13:30–15:30 302B
Optimization and Decision of Complex Systems
Organizer: TCCT, TCCT Technical Committee on Control Theory, CAA

Abstract: Optimization and decision making are central to almost all problems in Complex Systems. The task of decision making entails choosing the "best" between various alternatives. The measure of goodness of the alternatives is described by an objective function or performance index. Optimization theory and methods deal with selecting the best alternative in the sense of the given objective function. This mini-symposium aim to present some recent progresses in analysis and applications of optimization and decision making of complex systems, including 1) the optimal contraction theorem for complex black-box optimization problems; 2) modeling and optimization of power scheduling for a micro-grid system; 3) optimization in rail transportation control systems; 4) optimization in dynamic deployment for networked fire control system.

▶MS-Th-D-39-1 13:30–14:00
Random Sampling and Optimal Contraction Theorem for Black-Box Optimization
Xin, Bin School of Automation, Beijing Inst. of Tech.

Abstract: When dealing with complex black-box search or optimization problems, random sampling is a basic tool for exploring the solution space and finally finding desirable or even optimal solutions. All stochastic search algorithms can be categorized into the group of random sampling methods. What kind of random sampling scheme is the best for given problems? The optimal contraction theorem from the perspective of contraction-based random sampling gives an answer to this question.

▶MS-Th-D-39-2 14:00–14:30
Modeling and Optimization of Power Scheduling for A Micro-grid System with CCHP and PV
Lee, Yijin Hefei Univ. of Tech.
Tang, Hao Hefei Univ. of Tech.
Li, Xiaoqing Hefei Univ. of Tech.

Abstract: A micro-grid system containing a Combined Cooling Heating and Power (CCHP) and Photovoltaic (PV) is considered. First, the model of each subsystem, i.e., the solar system, the CCHP system, the energy storage system and the demanding process is established. Then the stochastic dynamic programming is introduced to optimize the power scheduling for the whole system on the related performance criteria.

▶MS-Th-D-39-3 14:30–15:00
Optimal Control Problem in Rail Transportation Systems
Chen, Yao Beijing Jiaotong Univ.
Dong, Hairong State Key Laboratory of Rail Traffic Control & Safety, Beijing Jiaotong Univ.

Abstract: Energy-saving is a critical issue in rail transportation systems since a small percentage of the energy-saving will lead of remarkable economic effects in the long run. By describing the train dynamics as a differential equation, this talk demonstrates how to transform the energy-saving problem into an optimal control problem. Several important properties of this optimal control problem will be discussed and numerical methods will be given for obtaining the optimal driving strategy.

▶MS-Th-D-39-4 15:00–15:30
Hybrid Optimization of Dynamic Deployment for Networked Fire Control System
Chen, CHEN Beijing Inst. of Tech.
Xin, Bin School of Automation, Beijing Inst. of Tech.

Abstract: Considering a variety of tactical indexes and actual constraints in air defense, a mathematical model is formulated to minimize the enemy target penetration probability. An assistance-based algorithm is put forward which combines the artificial potential field method with memetic algorithm. The constrained optimization problem transforms into an optimization problem of APF parameters adjustment, and the dimension of the problem is reduced greatly. The dynamic deployment is accomplished by generation and refinement of feasible solutions.

MS-Th-D-40 13:30–15:30 303A
Adaptive Control of Complex Systems
Organizer: TCCT, TCCT Technical Committee on Control Theory, CAA

Abstract: In complex systems, one of the faces of complexity is uncertainty, presented ether in the system model or in the properties of the system environment. One of the promising ways to deal with uncertainty is to introduce adaptation into the control system. The adaptation mechanism should adjust the parameters or even the structure of the control law based on measured information about the system behavior. This mini-symposium will present the state-of-the-art progress in adaptive control of several classes of complex systems, including 1) the semi-parametric adaptation; 2) adaptive variable selection for nonlinear nonparametric systems with a Lasso-type algorithm; 3) adaptive control of nonlinear uncertain systems in discrete time; 4) stability and performance analysis of adaptive diffusion filters with distributed least mean square algorithm.

▶MS-Th-D-40-1 13:30–14:00
Semi-Parametric Adaptation: Motivation, Principle, and Examples
Ma, Hongbin Beijing Inst. of Tech.

Abstract: Simultaneous existence of parametric and nonparametric uncertainties can bring challenges to the control design problem. In this talk, some new ideas on semi-parametric adaption, based on the so-called information-concentration (IC) estimators, will be introduced with its motivation, its basic principle as well as some examples of applications in control systems.

▶MS-Th-D-40-2 14:00–14:30
Stability and Dissipativity of Stochastic Nonlinear Systems with Dynamic Inputs
Wu, Zhaojing School of mathematics & informational Sci., Yantai Univ.
Xie, Xuejun Qufu normal Univ.

Abstract: Stability, dissipativity and small-gain theorem for stochastic nonlinear systems with dynamic inputs are researched. ISS-P is initially defined by referring to previous notions of SISS. Conditional dissipativity together with its criterion is then presented regarding non-smooth storage function and a relationship between ISS-P and CD is established. A small-gain theorem based

on dissipativity is established for the interconnected systems and a criterion on ISS-P for cascaded systems is presented.

▶ MS-Th-D-40-3 14:30–15:00

Adaptive Control of Nonlinear Uncertain Discrete-time Systems

Chanying, Li The Chinese Acad. of Sci.

Abstract: This talk is concerned with the adaptive control of nonlinear uncertain systems in discrete time. A series of "stabilization theorems" and "impossibility theorems" have been established, and a new tool called "stochastic imbedding approach" has been developed accordingly in this study.

▶ MS-Th-D-40-4 15:00–15:30

Stability and Performance Analysis of Adaptive Diffusion Filters

Chen, Chen Huawei

Abstract: We will consider the diffusion adaptive filters where a network of sensors is required to collectively estimate time-varying signals (or parameters) from noisy measurements. Stability and performance analysis of the distributed LMS algorithm will be established, which shows that the network of sensors can cooperate to estimate successfully, even though any single sensor does not have such a capability. This is the main difference from the available literatures concerning LMS type distributed algorithms.

MS-Th-D-41 13:30–15:30 303B

Complex Networks and Event-based Control

Organizer: TCCT, TCCT Technical Committee on Control Theory, CAA

Abstract: A complex network is a network with non-trivial topological features —features that do not occur in simple networks such as lattices or random graphs but often occur in real-world networks such as computer networks and social networks. Event-triggered control is an efficient way to reduce the transmitted data in the networks, which can relieve the burden of network bandwidth occupation in comparison with a traditional periodic sampling method. This mini-symposium will present the state-of-the-art progress in theoretical analysis and related applications of complex networks and event-based control, including: 1)Structure and complexity for dynamics analysis of booleannetworks; 2) Co-design of feedback controller, event-triggered condition and the bound of controller perturbations in linear event-triggered control systems; 3) Industrial remote control with the virtual reality networked control systems; 4) A small-gain approach for event-based control of nonlinear systems.

▶ MS-Th-D-41-1 13:30–14:00

Structure of Boolean Networks and Complexity for Dynamics Analysis

Zhao, Qianchuan Tsinghua Univ.

Abstract: As a compact model of natrual and man-made nonlinear dynamical nework systems, Boolean Networks have drawn attentions from wide backgrounds. In this talk, we will discuss the size of feeback vertex set as a measure of complexity for dynamics analysis for Boolean Networks.

▶ MS-Th-D-41-2 14:00–14:30

Stability of Model-Based Event-Triggered Control Systems: the Separation Property

Hao, Fei Beihang Univ.
Yu, Hao School of Automation Sci. & Electrical Engineering, Beihang Univ.

Abstract: To reduce resourse of communication, this paper investigates the combination of model-based control and event-triggered control strategies, namely, the model-based event-triggered control. Two main problems are studied. One is, for a given plant and model, how to design an event condition to guarantee the stability of the system. The other is, how the model influences the stability of the system. By solving the two problems, a separation property of model-based event-triggered control is proposed.

▶ MS-Th-D-41-3 14:30–15:00

3D Virtual Reality for Networked Remote Control Systems

Hu, Wenshan Wuhan Univ.

Abstract: This minisymposium talks about the virtual reality networked control systems which are based on the latest networked control, virtual reality and internet technologies. In the proposed systems, remote industrial scenes are reconstructed in 3D vitual reality interfaces, which are synchronized with the practical processes through internet datalinks. Users are able to monitor and control the remote indutrial devices by operating inside virtual enviroment, with the similar sense of presence as they work locally.

▶ MS-Th-D-41-4 15:00–15:30

Event-Based Control of Nonlinear Systems: A Small-Gain Approach

Liu, Tengfei Northeastern Univ.
Jiang, Zhong-Ping New York Univ.

Abstract: As an alternative to the traditional periodic data-sampling, the aperiodic event-triggered data-sampling depends on the real-time system state, and in this way, takes into account the system behavior between the sampling time instants. In this talk, we present a new small-gain approach to event-based control of nonlinear systems. Applications of the new approach to event-based control of the systems subject to external disturbances and the systems with partial state feedback are discussed.

MS-Th-D-42 13:30–15:30 301A

Cooperative Control and Multi-Agent Systems I

Organizer: TCCT, TCCT Technical Committee on Control Theory, CAA

Abstract: Recent advances in sensing, communication and computation technologies have enabled a group of agents, such as robots, to communicate or sense their relative information and to perform tasks in a collaborative fashion. The past few years witnessed rapidly-growing research in cooperative control technology. Multi-agent system (MAS) is a computerized system composed of multiple interacting intelligent agents within an environment. Multi-agent systems can be used to solve problems that are difficult or impossible for an individual agent or a monolithic system to solve. The aim of this minisymposium is to share novel approaches and innovative applications of cooperative control and MAS, including：1) robust adaptive dynamic programming; 2) global leader-following consensus; 3) event-triggered control for cooperative output regulation; 4) flocking of multi-agent systems with connectivity preservation.

▶ MS-Th-D-42-1 13:30–14:00

Control of Large-scale Dynamic Systems: A Viewpoint from Robust Adaptive Dynamic Programming

Jiang, Zhong-Ping New York Univ.

Abstract: A new approach to decentralized and adaptive optimal control design for large-scale systems is proposed using the framework of robust adaptive dynamic programming developed by the author and his co-workers. Robust adaptive dynamic programming integrates tools from two separate areas - adaptive/approximate dynamic programming and nonlinear control - and aims to design biologically-driven, non-model-based, optimal controllers for systems in the presence of both parametric and dynamic uncertainties. Applications to electric power systems are considered.

▶ MS-Th-D-42-2 14:00–14:30

A General Result on Global Leader Following Consensus of A Group of Linear Systems Using Bounded Controls

Zhao, Zhiyun Shanghai Jiao Tong Univ.
Lin, Zongli Univ. of Virginia

Abstract: For a multi-agent system whose follower agents and leader agent are all described by a general linear system, a bounded state, or output, feedback control law using a multi-hop relay protocol is constructed for each follower agent. These control laws achieve global leader-following consensus when the communication topology among the follower agents is a strongly connected and detailed balanced directed graph and the leader is a neighbor of at least one follower.

▶ MS-Th-D-42-3 14:30–15:00

Event-Triggered Control for Cooperative Output Regulation of Linear Multi-Agent Systems

Feng, Gang City Univ. of Hong Kong
Liu, Lu City Univ. of Hong Kong

Abstract: A solution to cooperative output regulation of heterogeneous linear multi-agent systems by event-triggered control is presented. Simpler leader-following consensus of homogeneous linear multi-agent systems with event-triggered control is first considered. Then an approach to cooperative output regulation of heterogeneous linear multi-agent systems by event-triggered control is developed. To avoid the problem of continuous monitoring of measurements typical for event-triggered control schemes, self-triggered control schemes are also developed. Feasibility of the proposed schemes is finally studied.

▶ MS-Th-D-42-4 15:00–15:30

Flocking of Second-order Multi-agent Systems with Connectivity Preservation Based on Algebraic Connectivity Estimation

Jie, Chen Beijing Inst. of Tech.

Abstract: The problem of flocking of second-order multi-agent systems with connectivity preservation is investigated. First, a new kind of decentralized inverse power iteration algorithm is formulated to estimate the algebraic connectivity as well as the corresponding eigenvector. Furthermore, based on the estimation of the algebraic connectivity, decentralized gradient-based flocking control protocols is built on top of a new class of generalized potential fields.

Simulations are performed to demonstrate the effectiveness of the theoretical results.

MS-Th-D-43 13:30–15:30 VIP4-1
Optimization algorithms and application - Part II of V

For Part 1, see MS-Th-BC-43
For Part 3, see MS-Th-E-43
For Part 4, see MS-Fr-D-43
For Part 5, see MS-Fr-E-43

Organizer: Wen, Zaiwen — Peking Univ.
Organizer: Yuan, Ya-xiang — Inst. of Computational Mathematics & Scientific/Engineering Computing
Organizer: Xia, Yong — Beihang Univ.

Abstract: This minisymposium consists 5 sessions. It highlights recent advances in theory, algorithms and applications of mathematical optimization on solving huge problems that are intractable for current methods.

▶MS-Th-D-43-1 13:30–14:00
Sparse Tucker Tensor Representation for Multidimensional Seismic Data

Ma, Jianwei — Harbin Inst. of Tech.

Abstract: Exploiting multidimensional sparsity structure of seismic data is important for seismic data processing and inversion. In this talk, we will apply a sparse Tucker tensor decompostion for multidimensional seismic data denoising and interpolation. Fast optimization methods will be applied for each dimension simultaneously to obain adaptive filters. We will compare the new method to previous data-driven tight frame (DDTF) method that first uses a vectorization step the high-dimensional seismic data.

▶MS-Th-D-43-2 14:00–14:30
The Trace Ratio Problem

Zhang, Leihong — Shanghai Univ. of Finance & Economics

Abstract: Maximizing the trace ratio over orthogonal constraints has a crucial role in pattern recognition. We shall discuss the characterization of the global optimal solutions of TRP and show the global and high-order convergence of an SCF iteration. We will explain why such SCF iteration is so efficient for TRP and also present perturbation analysis. Numerical experiments are reported and extension of TRP to maximize sum of two trace ratios will be also briefly discussed.

▶MS-Th-D-43-3 14:30–15:00
Behavior Analysis and Greedy Algorithm for Optimal Portfolio Liquidation with Market Impact

XU, FFENGMIN — Xi'an Jiaotong Univ.

Abstract: We analyze a nonconvex portfolio liquidation problem that maximize equity after trading subject to specified liability=equity requirements and box constrains, with no restrictions on the relative magnitudes of permanent and temporary market impact. Through the intuition behind price factor, we naturally endow some important conclusions in Brown et al. (2010) and Chen et al. (2014) with new financial explanations. And the optimal state of this nonconvex problem is revealed through the monotonicity of margin constraint functions, in which the margin constraint is active and the equity and liability after trading reaches the maximum at the same time. That is, it is just beyond the ability to take the risk and holds the most available funds. Meanwhile, a policy recommendation on determining an appropriate asset-liability ratio is al- so given through the feasibility of portfolio liquidation. Further, we prove that this problem is NP-hard, and a greedy algorithm and its general convergence are proposed. Numerical examples are presented to show the effectiveness of the greedy algorithm compared to the Lagrangian algorithm in Chen et al. (2014).

▶MS-Th-D-43-4 15:00–15:30
Stochastic Compositional Gradient Descent: Algorithms for Minimizing Compositions of Expected-Value Functions

Wang, Mengdi — Princeton Univ.

Abstract: We focus on the minimization of a composition of two expected-value functions. In order to solve this stochastic composition problem, we propose a class of stochastic compositional gradient descent (SCGD) algorithms that can be viewed as stochastic versions of quasi-gradient method. The convergence involves the interplay of two iterations with different time scales.We prove that the almost sure convergence and different rates of convergence of SCGD under a variety of assumptions.

MS-Th-D-44 13:30–15:30 VIP2-1
Pseudo-Differential Operators in Industries and Technologies - Part I of IV

For Part 2, see MS-Th-E-44
For Part 3, see MS-Fr-D-44
For Part 4, see MS-Fr-E-44

Organizer: Wong, M.W. — York Univ.

Abstract: Pseudo-differential operators, first appeared in 1960s in the paper by Joseph J. Kohn and Louis Nirenberg in the Communications on Pure and Applied Mathematics, have been used in the explicit descriptions of solutions of Partial Differential Equations. Since wavelet transform and related transforms came to the fore and became understood by scientists and engineers in the physical sciences, biomedical sciences, atmospherical sciences and geological sciences in the context of time/space -frequency representations, pseudo-differential operators and their variants such as Weyl transforms and noncommutative quantization with operator-valued symbols have become instrumental in signal and image analysis in the role of filters. Extensions of classical pseudo-differential operators to Weyl transforms and pseudo-differential operators to H-type groups can be thought of as noncommutative quantization. The aim of this minisymposium is to provide a platform for dialogs on several developments of pseudo-differential operators in some areas of industries and technologies such as information, communication and signals.

▶MS-Th-D-44-1 13:30–14:00
Analysis of In-Core Flux Detector Noise Using the Generalized S Transform

Liu, Cheng — Kinectrics Inc
Zhu, Hongmei — York Univ.
Wallace, Andrew — Kinectrics Inc
Yan, Yusong — Beijing Inst. of Tech.

Abstract: The CANDU reactor is a Canadian-invented, pressurized heavy water reactor. In-core flux detector signal data is routinely acquired from all CANDU reactors, which contains noise, (referred to as neutron noise) that can see a number of mechanical vibrations within the reactor cores. It has been suggested that indirect monitoring of vibration frequency via the "noise" on the in-core flux detector signals could be used to detect abnormal conditions and predict failure. A new form of the generalized S transform is introduced and its mathematical properties have been investigated in the framework of the operator theory. Controlled by the parameters, the generalized S transform is able to vary its time-frequency resolution, which provides a class of multi-resolution representations with distinct resolution. Analysis of in-core flux detector noise using the generalized S transform is performed to reveal the vibration frequencies of major components in the reactor core of CANDU.

▶MS-Th-D-44-2 14:00–14:30
Time-frequency Analysis as An Analysis Tool of Brain Networks

Sejdic, Ervin — Univ. of Pittsburgh

Abstract: Time-frequency representations depict variations of the spectral characteristics of signals as a function of time, which is ideally suited for nonstationary biomedical signals. Many biomedical signals (e.g., swallowing accelerometry signals) are multicomponent, one-dimensional signals. But, modern medical data sets are time-varying, large and/or are stemming from multiple senosrs/electrodes (e.g., electroencephalography systems). In this talk, I will overview some of our recent efforts to adopt time-frequency tools for signals stemming from multinodal imaging systems.

▶MS-Th-D-44-3 14:30–15:00
Pulse Wave Analysis in Time-frequency Domain

Zhu, Hongmei — York Univ.
Jin, Wei — Shandong Acad. of Chinese Medicine
Zhang, Xiling — Shandong Acad. of Chinese Medicine
Zhang, Yuhai — Shangdong Univ.

Abstract: Assessment of the pulse character for disease diagnosis is one of the key medical skills in Traditional Chinese Medicine practice. When and where abnormalities occurred in one's pulse waves provide important information for disease detection and diagnosis. In this talk, we explore the use of time-frequency analysis in analyzing digitally recorded pulse waveforms.

▶MS-Th-D-44-4 15:00–15:30
A Blind Separation Method Based on Multiwavelet Analysis

Ashino, Ryuichi — Osaka Kyoiku Univ.
Mandai, Takeshi — Osaka Electro-Communication Univ.
Morimoto, Akira — Osaka Kyoiku Univ.

Abstract: The purpose of blind source separation is to separate the original sources from the sensor array, without knowing the transmission channel characteristics. A new blind separation method based on multiwavelet analy-

sis is presented. Examples of image separation are demonstrated.

MS-Th-D-45 13:30–15:30 213A
Optimization Methods for Inverse Problems - Part II of V
For Part 1, see MS-Th-BC-45
For Part 3, see MS-Th-E-45
For Part 4, see MS-Fr-D-45
For Part 5, see MS-Fr-E-45

Organizer: LIU, XIN AMSS
Organizer: WANG, YANFEI The Inst. of Geology & Geophysics, CAS

Abstract: In this minisymposium, inverse problems arisen from various areas such as geoscience and petroleum engineering, related optimization models like L1 norm regularization, and advanced optimization methods for solving these models such as first order methods, subspace methods, alternating direction method of multipliers and distributed optimization approaches are discussed.

▶ MS-Th-D-45-1 13:30–14:00
Some Real Problem on Inverse of Optimal Approximation of Water Flow
Yuan, Jinyun Federal Univ. of Parana

Abstract: In Brazil some big river passes inside the city. During the rain season, it causes civil troubles because of water-plant on the surface of river. We like to decide the surface condition of distribution of water-plant to approximate the desired velocity of water flow such that we can reduce civil troubles for society. We shall use optimal approximation model with flow constraints to solve the problem.

▶ MS-Th-D-45-2 14:00–14:30
A Dual Method for Minimizing A Nonsmooth Objective over One Smooth Inequality Constraint
Teboulle, Marc Tel Aviv Univ.

Abstract: We consider the class of nondifferentiable convex problems which minimizes a nonsmooth convex objective over a smooth inequality constraint. Exploiting the smoothness of the feasible set and using duality, we introduce a simple first order algorithm proven to globally converge to an optimal solution with a sublinear rate. The performance of the algorithm is demonstrated by solving large instances of the convex sparse recovery problem. This is joint work with Ron Shefi.

▶ MS-Th-D-45-3 14:30–15:00
A General Inertial Proximal Point Method for Mixed Variational Inequality Problem
Yang, Junfeng Nanjing Univ.

Abstract: We propose inertial variants of the proximal point method and the ADMM. Under certain conditions, we are able to establish the global convergence and $o(1/k)$ convergence rate results (under certain measure). We also demonstrate the effect of the inertial extrapolation step via experimental results on the compressive principal component pursuit problem and some imaging problems.

▶ MS-Th-D-45-4 15:00–15:30
Multidimensional Ill-posed Problems in Applications
Yagola, Anatoly Lomonosov Moscow State Univ.

Abstract: It is very important now to develop methods of solving multidimensional ill-posed problems using regularization procedures and parallel computers. The main purpose of the talk is to show how 2D and 3D Fredholm integral equations of the 1st kind can be effectively solved. We will consider inverse problems of image restoration in electron microscopy and recovery of magnetic target parameters from magnetic sensor measurements. This paper was supported by the RFBR grant 14-01-91151-NSFC-a.

MS-Th-D-46 13:30–15:30 306B
Inverse Problems for Image Reconstruction and Processing - Part IV of IV
For Part 1, see MS-We-D-46
For Part 2, see MS-We-E-46
For Part 3, see MS-Th-BC-46

Organizer: Wei, Suhua Inst. of Applied Physics & Computational Mathematics
Organizer: Nikolova, Mila CMLA, CNRS - ENS Cachan
Organizer: Tai, Xue-Cheng Department of Mathematics, Univ. of Bergen
Organizer: Shi, Yuying North China Electric Power Univ.

Abstract: Many image reconstruction tasks amount to solve ill-posed inverse problems. Indeed, measurement devices typically cannot record all the information needed to recover the sought-after object; furthermore, the operators that model these devices are seldom accurate and data are corrupted by various perturbations. A common approach to find an approximate to the unknown object is regularization. The key points are the correct choices of the data fidelity term and the regularization term, as well as the trade-off between these terms. This is a challenging problem since the optimal solutions of the whole functional should correctly reflect the knowledge on the data-production process and the priors on the unknown object. The optimal solutions usually cannot be computed explicitly and iterative schemes are used. This symposium focus on imaging inverse problems' mathematical models, numerical algorithms, theoretical analysis and various applications, especially, applied to CT reconstruction and some processing techniques for images.

▶ MS-Th-D-46-1 13:30–14:00
A PDE-free Variational Model for Multiphase Image Segmentation
Julia, Dobrosotskaya Case Western Reserve Univ.
Guo, Weihong Case Western Reserve Univ.

Abstract: We introduce a PDE-free variational model for multiphase image segmentation in a modified diffuse interface context. This model uses such features of diffuse interface behavior as coarsening and phase separation to merge relevant image elements (coarsening) and separate others into distinct classes (phase separation). The model has edge-preserving feature that naturally balances out the regularity implemented by wavelet Ginzburg-Landau energy. Numerical experiments show that the model is robust to noise yet can segment fine details.

▶ MS-Th-D-46-2 14:00–14:30
CT Metal Artifacts Reduction by An Iterative Algorithm Based on Inpainting
Lee, Chang-Ock KAIST
Jeon, Soomin KAIST

Abstract: The streaking artifacts in computed tomography (CT) image caused by the metallic objects (dental implants, surgical clips, or steel-hip) limit the applications of CT image. We propose a new algorithm for reducing the streaking artifacts in CT images. We inpaint the corrupted part in sinogram, iteratively, using the basic principle of CT. The numerical experiments show that our algorithm reduces the metal artifacts efficiently. We analyze the simulation results both quantitatively and qualitatively.

▶ MS-Th-D-46-3 14:30–15:00
Meteorological Objects Tracking with Modified Region Scalable Fitting Model and Parallel Computation
Murong, Jiang School of Information Sci. & Engineering, Yunnan Univ.

Abstract: We modify the Region Scalable Fitting (RSF) model by using a phase congruence function as the boundary detection term, and redefine RS-F energy functional by putting a total variance regular function into the gradient descent flow equation. We call this functional as PRSF model. We use PRSF model to segment the meteorological objects with Split Bregman algorithm, implement the meteorological multi-objects tracking fast computation in parallel.

▶ MS-Th-D-46-4 15:00–15:30
Limitations of Splitting Methods for Total Variation-based Image Reconstruction
Hintermueller, Michael Humboldt-Univ. of Berlin

Abstract: Variable splitting schemes for image reconstruction problem with total variation regularization (TV-problem) in its primal and pre-dual formulations are considered. For primal splitting it is shown that quasi-minimizers of the penalized problem are asymptotically related to the solution of the original TV-problem. For the predual formulation, a family of parametrized problems is introduced and a parameter dependent contraction of an associated fixed point iteration is established.

MS-Th-D-47 13:30–15:30 108
Numerical methods for compressible multi-phase flows - Part V of VI
For Part 1, see MS-Mo-D-08
For Part 2, see MS-Mo-E-08
For Part 3, see MS-We-E-47
For Part 4, see MS-Th-BC-47
For Part 6, see MS-Th-E-47

Organizer: Deng, Xiaolong Beijing Computational Sci. Research Center
Organizer: Wei, Suhua Inst. of Applied Physics & Computational Mathematics
Organizer: Tian, Baolin Insitute of Applied Physics & Computational Mathematics
Organizer: Tiegang, Liu Beihang Univ.
Organizer: Sussman, Mark Florida State Univ.
Organizer: Wang, Shuanghu IAPCM

Abstract: Compressible multi-phase flows appear in many natural phenom-

ena, and are very important in many applications, including space science, aerospace engineering, energy, homeland security, etc. Numerical calculation is a key for understanding many related problems. More and more numerical methods are being developed and improved. In this mini-symposium, novel numerical methods will be presented to show the progress in the area of compressible multi-phase flows, including interface capturing/tracking methods, phase change calculations, mixing methods, fluid-structure interaction methods, multi-physics calculations, adaptive mesh refinement, and high performance computing.

▶ MS-Th-D-47-1 13:30–14:00

High-resolution Compact Scheme for Compressible Multifluids

Liu, Na — Inst. of applied physics & computational mathematics

Chen, Yibing — Beijing Inst. of applied physics & computational mathematics

Abstract: In this paper, a high-order, efficient, compact method is developed for multimaterial flow simulation which is an extension of spectral volume method for conservation laws. The idea of quasi-conservation scheme is borrowed to prevent the spurious oscillations in the vicinity of a material contact discontinuity and the PFGM limiter is used to avoid numerical oscillation by high order reconstruction,which can keep high order accuracy at the meantime.

▶ MS-Th-D-47-2 14:00–14:30

High Order Positivity-preserving Discontinuous Galerkin Method for Compressible Multi-medium Flow

Wang, Chunwu — Nanjing Univ. of Aeronautics & Astronautics

Abstract: The positivity of the variables such as density and pressure is very important in the simulation of the multi-medium flow. In this paper a high order accurate positivity-preserving discontinuous Galerkin (DG) scheme is presented. The limiter is constructed and can be proven to maintain high order accuracy and is easy to implement. The extension to higher dimensions is straightforward. Several numerical tests are provided to demonstrate the effectiveness of the method.

▶ MS-Th-D-47-3 14:30–15:00

Wave Number Selectivity in Strongly Accelerated Thin Liquid Layers

Deng, Xiaolong — Beijing Computational Sci. Research Center

Chang, Chih-Hao — Theofanous Co. Inc

Theofanous, Theo — Univ. of California, Santa Barbara

Abstract: We present first-of-a-kind direct numerical simulations of Rayleigh-Taylor instability in thin liquid layers (Atwood number 1) under different kinds of external support—solid wall, slip wall, free interface. The character of wave selectivity (peaking of dispersion plots) is markedly changed with layer thickness (flattening out as thickness decreases), and type of boundary condition (with a free boundary, the maxima essentially disappear into the long-waves range). Agreement with recent experiments on viscous-drop penetration in aerobreakup is noted.

▶ MS-Th-D-47-4 15:00–15:30

What is Wrong with Effective-field and Point-particle Models in High-speed Disperse Flows?

Chang, Chih-Hao — Theofanous Co. Inc

Deng, Xiaolong — Beijing Computational Sci. Research Center

Theofanous, Theo — Univ. of California, Santa Barbara

Abstract: We use experiments and direct numerical simulations to investigate the dynamics of particle clouds subjected to shock waves. The experiments (JFM, to appear) cover particle volume fractions of 0.2-0.4 and flow Mach numbers of 0.3-1.2. The simulations are carried out with a compressible Navier-Stokes solver. The particles are allowed to move and collide. Cloud expansion are predicted quantitatively while effective-field and point-particle models fail severely. We presents ideas about causes and possible fixes.

MS-Th-D-48 13:30–15:30 212B

Regularization methods for biomedical image analysis on manifolds - Part II of II

For Part 1, see MS-Th-BC-48

Organizer: Chen, Chong — Chinese Acad. of Sci.

Organizer: Dong, Guozhi — Univ. of Vienna

Abstract: Inverse problems of functions defined on manifolds and Image analysis with data on surfaces are emerging topics, while the biomedical image and many other biological data analysis provide one the main sources of these problems. This minisymposium will be devoted to recent advances of regularization methods and the related topics, with respect to biomedical image analysis in the context of a manifold domain. The aim is to provide a platform to researchers and scientists for exchanging ideas and developing new research topics. It is supposed to contain two sections, and speakers consist of both leading experts and young researchers.

▶ MS-Th-D-48-1 13:30–14:00

A Extended Regularization for Recovering Vector Fields on Manifolds

Dong, Guozhi — Univ. of Vienna

Abstract: We will discuss what is the extended regularization, and what is the motivation behind and the convergence analysis of this method. More over, we will discuss the convergence rates based on the discretization of both manifolds and vector field spaces on manifolds, which lay the fundamental for an efficient numerical discretization of this type of problem. This is a joint work with Bert Juettler, Otmar Scherzer and Thomas Takacs.

▶ MS-Th-D-48-2 14:00–14:30

Landmark and Intensity-based Registration with Large Deformation via Quasiconformal Maps

LUI, Lok Ming Ronald — The Chinese Univ. of Hong Kong

Abstract: A new approach to obtain diffeomorphic registrations with large deformations using landmark and intensity information via quasi-conformal maps will be presented. The basic idea is to minimize an energy functional involving a Beltrami coefficient term, which measures the distortion of the quasiconformal map. The Beltrami coefficient effectively controls the bijectivity and smoothness of the registration. In this talk, both landmark-based and intensity-based registration between images or surfaces will be presented.

▶ MS-Th-D-48-3 14:30–15:00

Augmented Lagrangian Method for Total Variation Based Image Restoration and Segmentation over Triangulated Surfaces

Wu, Chunlin — Nankai Univ.

Tai, Xue-Cheng — Department of Mathematics, Univ. of Bergen

Abstract: Recently total variation (TV) regularization has been proven very successful in planar image restoration and segmentation. In this paper we extend TV regularization to image restoration and segmentation over triangulated surfaces. We also present augmented Lagrangian method for the related optimization problems, yielding fast solvers to our problems. Experiments on both gray and color images on surfaces demonstrate the efficiency of our algorithms.

▶ MS-Th-D-48-4 15:00–15:30

An Analysis-suitable Representation of 2-d Manifolds and Its Application

Wu, Meng — Hefei Univ. of Tech.

Abstract: In this talk, we will present a global representation of 2-d manifolds with splines defined recently. After that, we will present how to solving PDEs on a 2-d manifolds globally with this type of representation.

MS-Th-D-49 13:30–15:40 107

Modelling anomalous brain haemodynamics and its link to neurodegenerative diseases

Organizer: Toro, Eleuterio — Univ. of Trento

Abstract: There is medical evidence of the biologically plausible association of extracranial vein malformations to neurodegenerative diseases, e.g. Parkinson's disease. This minisymposium concerns mathematical modeling of the brain venous haemodynamics of subjects with extracranial venous malformations. Anatomical data and brain flow measurements are obtained from advanced magnetic resonance imaging. New model equations and advanced numerical methods for blood flow are described. These form the bases of a new global, closed-loop mathematical model for the human circulation. Our model predicts that extracranial venous strictures cause anomalous venous return from the brain and chronic intracranial venous hypertension. Potential implications are discussed.

▶ MS-Th-D-49-1 13:30–14:00

Modelling Brain Venous Haemodynamics: Challenges and Opportunities

Toro, Eleuterio — Univ. of Trento

Abstract: We addressed challenges and opportunities regarding mathematical modelling of venous haemodynamics of the Central Nervous System, including physiological, mathematical, algorithmic and pathological aspects. I addition we describe a recently proposed global mathematical model for the human circulation and show here some applications to neurological diseases thought to have a venous origin.

▶ MS-Th-D-49-2 14:00–14:30

Computational Models for Fluid Exchange between Microcirculation and Tissue Interstitium Applied to Cerebrospinal Flow.

Formaggia, Luca — Politecnico di Milano

Alessio, Fumagalli — Politecnico di Milano

Notaro, Domenico Politecnico di Milano
Scotti, Anna Politecnico di Milano, Department of Mathematics
Zunino, Paolo Politecnico di Milano

Abstract: This work aims at developing a numerical multiscale model for the interplay between microcirculation and interstitial flow. Such phenomena are at the basis of the exchange of nutrients, wastes and pharmacological agents between the cardiovascular system and the organs. In particular, we develop a model applicable at the microscopic scale, where the capillaries and the interstitial volume can be described as independent structures capable to propagate flow.

▶ MS-Th-D-49-3 14:30–15:00

IMAGING BLOOD VESSELS AND THEIR FLOW IN THE HEAD AND NECK USING MRI

Haacke, Mark Wayne State Univ.

Abstract: MRI is an in vivo imaging technique that provides both morphological and functional imaging of the human body. We will discuss its use in imaging blood flow and provide an overview of the methodology. Our primary interest will be measuring flow in the head and neck. We will show that blood flow can be measured as a function of the cardiac cycle and used to study the fluid dynamics of the cardiovascular system.

▶ CP-Th-D-49-4 15:00–15:20

FINITE VOLUME APPROXIMATIONS OF TRANSPORT EQUATION IN NEURONAL VARIABILITY

Kumar, Santosh Thapar Univ., Patiala

Abstract: A theoretical analysis of neuronal variability, in which we briefly discuss the distribution of time intervals between successive neuronal firings, the firing rate as a function of input frequency, the strength－duration curve and the role of inhibition. Then a first-order partial differential-difference equation for the distribution of neuronal firing intervals is derived and a godunov type finite volume scheme is constructed for solving such type of initial and boundary value problem.

▶ CP-Th-D-49-5 15:20–15:40

Numerical Solution of the Monge-Kantorovich Problem by Picard Iterations

Bouharguane, Afaf Univ. of Bordeaux

Abstract: We present an iterative method to numerically solve the L2 Monge-Kantorovich problem. The method is based on a Picard fixed point iteration of the linearized problem. Examples relative to the transport of two-dimensional densities show that the present method can significantly reduce the computational time. We finally apply this numerical method to quantitatively analyze the neuronal activity in the hippocampus.

MS-Th-D-50 13:30–15:30 207

Mathematical and Numerical Aspects of Electronic Structure Theory - Part II of V

For Part 1, see MS-Th-BC-50
For Part 3, see MS-Th-E-50
For Part 4, see MS-Fr-D-50
For Part 5, see MS-Fr-E-50

Organizer: Lin, Lin Univ. of California at Berkeley
Organizer: Lu, Jianfeng Duke Univ.

Abstract: Electronic structure theory and first principle calculations are among the most challenging and computationally demanding science and engineering problems. This minisymposium aims at presenting and discussing new developments of mathematical analysis, and numerical methods for achieving ever higher level of accuracy and efficiency in electronic structure theory. This includes ground state and excited state density functional theory calculations, wavefunction methods, together with some of their applications in computational materials science and quantum chemistry. We propose to bring together experts on electronic structure theory, which include not only mathematicians, but also physicists working actively in the field.

▶ MS-Th-D-50-1 13:30–14:00

Compressed Representation of Kohn-Sham Orbitals via Selected Columns of the Density Matrix

Damle, Anil Stanford Univ.
Lin, Lin Univ. of California at Berkeley
YING, LEXING Stanford Univ.

Abstract: Given a set of Kohn-Sham orbitals from an insulating system, it is often desirable to build a set of localized basis functions for the associated subspace. In this talk we present a simple, robust, efficient, and parallelizable method to construct a set of (optionally orthogonal) localized basis functions. The basis is constructed directly from a set of selected columns of the density matrix without the use of an optimization procedure.

▶ MS-Th-D-50-2 14:00–14:30

Error Estimates of Some Numerical Atomic Orbitals in Molecular Simulations

Chen, Huajie Univ. of Warwick

Abstract: Numerical atomic orbitals provide a nature, physical description of the electronic states and is suitable for $O(N)$ calculations based on the strictly localized property. We present a numerical analysis for some simplified atomic orbitals, with polynomial-type and confined Hydrogen-like radial basis functions respectively. We give some a priori error estimates to understand why numerical atomic orbitals are computationally efficient in electronic structure. This is a joint work with Reinhold Schneider (TU Berlin).

▶ MS-Th-D-50-3 14:30–15:00

Linear Scaling Discontinous Galerkin Methods for Density Functional Theory with Local Orbital Enriched Finite Element Basis

Lu, Tiao Peking Univ.
Cai, Wei Univ. of North Carolina at Charlotte

Abstract: In this talk, we will introduce a discontinuous Galerkin (DG) framework for many electron quantum systems. The salient feature of this framework is the flexibility of using hybrid physics-based local orbitals and accuracy-guaranteed piecewise polynomial basis in representing the Hamiltonian of the many body system. A linear-scaling algorithm and the advantage of using the local orbital enriched finite element basis in the DG approximations are verified by studying examples of one dimensional lattice model systems.

MS-Th-D-51 13:30–15:30 209A

Dynamics and information coding in neuronal systems - Part II of II

For Part 1, see MS-Th-BC-51

Organizer: Zhou, Douglas Shanghai Jiao Tong Univ.

Abstract: Computational neuroscience has experienced explosive growth over last two decades. It has helped to explain or even predict many neurophysiological phenomena in experiment over scales ranging from molecular, single cellular to neuronal circuits. As more realism is incorporated into these models, novel dynamical features often arise which further enrich our understanding of the brain. This minisymposium explores this theme by discussing recent work in the modeling of both individual neuron dynamics and network topology, focusing upon implications on network behavior and information coding. The speakers will draw particular attention to new mathematical approaches in explaining sensory processing and information propagation.

▶ MS-Th-D-51-1 13:30–14:00

Re-entrant Neural Circuits for Actively Controlled Computations

Tao, Louis Peking Univ.
Sornborger, Andrew UC Davis

Abstract: Abstract: We have shown that pulse-gated synfire chains can exactly (in the mean) propagate information in the form of graded current amplitudes. Furthermore, with appropriate pulse sequences, current amplitudes may be dynamically routed through neural subcircuits. A considerable literature shows that coherent pulse trains in neural circuits can improve feature recognition, mediate interactions between neurons and modulate learning and memory. We have proposed that pulse-gated synfire chains are the theoretical mechanism responsible for this observed coherent activity. In a framework based on our pulse-gating mechanism, we have described methods for constructing neural circuits capable of actively controlling sequences of linear maps. As an example, we demonstrate a neural circuit that combines split operator methods with re-entrant synaptic connectivity and pulse-gated control to create arbitrary rotations of vector coordinates on the sphere.

▶ MS-Th-D-51-2 14:00–14:30

Response Dynamics and Network Connection in Primary Visual Cortex

Xing, Dajun Beijing Normal Univ.

Abstract: Cortical areas in the brain have distinct intra- and inter- connection patterns with different inputs and output. Understanding the response dynamics is crucial for understanding network connectivity in the brain. We chose Macaque primary visual cortex to study network interactions. Our result reveals a variety of laminar response patterns including receptive field properties, nonlinear dynamic response, and gamma band (20-60 Hz) activity. The response dramatics implies the important role of recurrent and feedback connections.

▶ MS-Th-D-51-3 14:30–15:00

Dissecting the Neural Circuit Underlying Motor Control in C. Elegans

Wen, Quan Univ. of Sci. & Tech. of China

Abstract: Within only 300 hundred neurons and a known wiring diagram, C. elegans could be seen as the ”hydrogen model” in systems neuroscience.

Despite its simplicity, we still do not have a good understanding of the neural basis of its sensorimotor behaviors . By combining optical neurophysiology and modelling, we will discuss on-going endeavors aiming at developing a complete understanding of motor control in C. elegans from both algorithmic and mechanistic standpoint of view.

▶ MS-Th-D-51-4 15:00–15:30

Neural Dynamics of Animal Navigation

Si, Bailu Chinese Acad. of Sci.

Abstract: We propose a dynamical model based on attractor neural network to accounts for the responses of grid cells in medial entorhinal cortex, the neural substrate for mammalian navigation. In the model, grid cells collectively represent arbitrary conjunctions of positions and movements of the animal. A pattern formation process produces grid patterns in the population activity of the network, and achieves robust tracking of the position of the animal in the environment.

MS-Th-D-52 13:30–15:30 212A

Recent Development of Mathematical Models in Computational Biology - Part II of V

For Part 1, see MS-Th-BC-52
For Part 3, see MS-Th-E-52
For Part 4, see MS-Fr-D-52
For Part 5, see MS-Fr-E-52

Organizer: Zhang, Lei Peking Univ.
Organizer: Ge, Hao Peking Univ.
Organizer: Lei, Jinzhi Tsinghua Univ.

Abstract: One of the central problems in biology is to understand the design principles of complex biological systems. Mathematical and computational models of biological processes can be characterized both by their level of biological detail and by their mathematical complexity. In this minisymposium, we focus on recent findings of computational models and methods to gain insights of the complexity of cellular life and efficiently analyze the experimental observations. Topics of interests include stem cells, developmental patterning, gene regulatory networks, neuron networks, uncertainty quantification of biological data, etc.

▶ MS-Th-D-52-1 13:30–14:00

Mathematical Modeling, Optimization and Control for Networks of Complex Diseases Based on the High-throughput Data

Xiufen, Zou Wuhan Univ.

Abstract: We focus on developing quantitative tools and indexes to provide early diagnosis and drug targets of complex diseases and control of complex diseases. In this talk, I first introduce the work in identifying dynamical network biomarks of complex diseases. Then, I present the analysis of pathogenic mechanisms of influenza A virus (IAV) by combining mathematical model-based optimization and dynamical analysis. Finally, the control problems of complex diseases are discussed.

▶ MS-Th-D-52-2 14:00–14:30

Stochastic Phenotype Transition of A Single Cell in An Intermediate Region of Gene State Switching

Ge, Hao Peking Univ.

Abstract: Recent experiments have shown that at least in E. coli, the gene state switching can be neither extremely slow nor exceedingly rapid. Under this condition, from a full chemical-master-equation description we derive a simplified fluctuating-rate model. The simplified kinetics yields a nonequilibrium landscape function, which, similar to the energy function for equilibrium fluctuation, provides the leading orders of fluctuations around each phenotypic state, as well as the transition rates between the two phenotypic states.

▶ MS-Th-D-52-3 14:30–15:00

Robust and Precise Morphogen-mediated Patterning

Lo, Wing Cheong City Univ. of Hong Kong

Abstract: The perturbations of gene expression limit the accuracy of morphogen-mediated patterning. While it has been found that the robustness of patterning to the perturbation of morphogen synthesis can be enhanced by particular mechanisms, how such mechanisms affect robustness to other perturbations, such as to receptor synthesis, has been little explored. Here we elucidate how different mechanisms improve the robustness of patterning to receptor and morphogen syntheses and to the effects of cell-to-cell variability.

▶ MS-Th-D-52-4 15:00–15:30

Robust and Stochastic Dynamics in Signal Transduction, Stem Cells, and Development Patterning

Nie, Qing Univ. of California, Irvine

Abstract: Noise and stochastic effect exist in most biological systems due to many intrinsic and extrinsic factors. In this talk, I will discuss strategies and principles for noise attenuation and robustness to genetic and environmental perturbations in signal transduction, embryonic patterning, and regeneration driven by stem cells. In one case, I will introduce a critical quantity that dictates capability of attenuating temporal noise in feedback systems. In another case, I will show that noise in gene regulations actually enables reduction of stochastic effects in spatial patterns during embryonic development. Finally, novel experimental data that support our modeling and computational predictions will be presented and several multi-scale, stochastic, and computational modeling frameworks that are required for simulating such complex biological systems will be introduced.

MS-Th-D-53 13:30–15:30 311B

Stochastic modelling, control and optimization in finance I

Organizer: Ludkovski, Mike UC Santa Barbara
Organizer: Leung, Tim Columbia Univ.
Organizer: Li, Lingfei The Chinese Univ. of Hong Kong
Organizer: Chen, Nan The Chinese Univ. of Hong Kong

Abstract: This minisymposium will explore recent developments in applications of stochastic control to risk analysis and hedging of financial contracts.

▶ MS-Th-D-53-1 13:30–14:00

Time Dependency Modelling Using Time Change with Applications in Energy Markets

Li, Lingfei The Chinese Univ. of Hong Kong

Abstract: We study the theory of additive subordination, which is a technique for constructing time-dependent Markov processes by time changing time-independent Markov processes with additive subordinators. We show that this technique is useful for developing time-dependent financial models with tractability by considering two applications from the energy markets: consistent valuation of single commodity options and crack spread options as well as modelling seasonal spikes in electricity prices.

▶ MS-Th-D-53-2 14:00–14:30

Consistent Modeling of Smile Dynamics

Wu, Qi Chinese Univ. of Hong Kong

Abstract: Few existing models produce reasonable market dynamics of volatility smile. The challenge is that volatility processes are usually specified to generate smile effects, rather than to produce maturity consistencies. We propose a parsimonious and tractable multi-vol-factor model whose volatility structure is low-dimensional, structurally-intuitive and degenerates to various market standard models. Essential to the study is the general relationship between path moments and term structures of smile measures at vol level, skew slope and smile curvature.

▶ MS-Th-D-53-3 14:30–15:00

Convergence on Approximated Pricing of Basket CDS with Counterparty Risk

Song, Qingshuo City Univ. of Hong Kong

Abstract: In this paper we derive the sufficient conditions for the convergence of the approximation of the basket CDS price via the weak convergence method. We provide a new proof to show the induced probability measures from approximation converges to underlying probability measure in Wasserstein distance or order 1, which generalize the known weak convergence results in the literature to cover a class of path-dependent diffusions.

▶ MS-Th-D-53-4 15:00–15:30

Liquidity Risk and Network Risk

Chen, Nan The Chinese Univ. of Hong Kong

Abstract: This paper investigates how market liquidity and liability network propagate individual defaults to a system-wide catastrophe. We formulate the model as an optimization problem with equilibrium constraints and derive a partition algorithm to solve it. The obtained market-clearing equilibrium enables us to identify two factors, the network multiplier and the liquidity amplifier, to characterize the contributions of these two channels to financial systemic risk, whereby we can acquire a better understanding of effectiveness of several policy interventions.

MS-Th-D-54 13:30–15:30 VIP1-2
Modeling and Simulations of Complex Biological Systems - Part I of IV
For Part 2, see MS-Th-E-54
For Part 3, see MS-Fr-D-54
For Part 4, see MS-Fr-E-54

Organizer: Liu, Xinfeng — Univ. of South Carolina
Organizer: Ju, Lili — Univ. of South Carolina

Abstract: This mini-symposium aims to bring together researchers focusing on using modeling and numerical approach to study complex biological systems including (but not limited to) cell signaling pathways, complex bio-fluids, biofilms, cell polarization, developmental and cell biology, and stem cells, and etc. Such complex biological systems in general consist of multiple interacting components that exhibit complicated temporal and spatial dynamics. Furthermore, feedback, nonlinearities and multiple time and length scales often make such systems extremely difficult to describe, model or predict. The invited speakers will discuss the challenges of modeling such complex systems, introduce new computational techniques to simulate them and, where possible, present novel analytical techniques to extract meaningful information.

▶ MS-Th-D-54-1 13:30–14:00
Competing Interactions on Bilayer Membrane and Modeling of Lipid Rafts
Zhou, Yongcheng — Colorado State Univ.

Abstract: Competing interactions on bilayer membrane and modeling of lipid rafts

▶ MS-Th-D-54-2 14:00–14:30
Protein Function Discovery Using A New 3D Structure Comparison Algorithm
Gong, Xinqi — Renmin Univ. of China

Abstract: Proteins can interact with other partners or change their conformations to show different biological functions. But it's difficult and expensive for experiments to verify which functions may be observed for a protein. It is believed that protein functions relate closely with their 3D structures. So we propose a new protein 3D structure comparison method for discovering new functions for traditionally considered different functional proteins, whose better performances over other methods was verified on a dataset.

▶ MS-Th-D-54-3 14:30–15:00
Efficient and Stable Exponential Time Differencing Runge-Kutta Methods for Phase Field Elastic Bending Energy Models
Ju, Lili — Univ. of South Carolina
Wang, Xiaoqiang — Florida State Univ.
Du, Qiang — Columbia Univ.

Abstract: In this talk, we present efficient and stable high-order numerical methods for the Willmore flow formulated by phase field elastic bending energy models. Our methods combine explicit exponential time differencing Runge-Kutta approximations for time integration with spectral discretizations on regular meshes in space. In addition, linear operator splitting techniques and an augmented Lagrange multiplier approach are particularly used to circumvent numerical instabilities. Various experiments are presented to demonstrate stability and accuracy of the proposed methods.

▶ MS-Th-D-54-4 15:00–15:30
Computer Simulations of Cell-to-Cell Interactions
Chou, Ching-Shan — The Ohio State Univ.
Chen, Weitao — Univ. of California, Irvine

Abstract: Cell-to-cell communication is fundamental to biological processes which require cells to coordinate their functions. In this talk, we will present the first time computer simulations of the yeast mating process, which is a model system for investigating proper cell-to-cell communication. Computer simulations revealed important robustness strategies for mating in the presence of noise. These strategies included the polarized secretion of pheromone, the presence of the alpha-factor protease Bar1, and the regulation of sensing sensitivity.

MS-Th-D-55 13:30–15:30 106
Wavelet Methods for Inverse Problems Modelling Real World Systems - Part I of IV
For Part 2, see MS-Th-E-55
For Part 3, see MS-Fr-D-55
For Part 4, see MS-Fr-E-55

Organizer: Siddiqi,Prof., Abul — Sharda Univ.,NCR
Organizer: Al-Lawati, M.A. — Sultan Qaboos Univ.

Abstract: In a direct problem an effect is determined by a cause while in an inverse problem cause is determined from an effect. In an image processing the direct problem is to find out how a given sharp photograph would look like while camera is incorrectly focused.A related inverse problem is to find sharp photograph from a given blurry image.Inventors of CAT and MRI were awarded Nobel Prize of Medicine and Physiology respectively in 1979 and 2003.Inverse problems typically involve certain quantities based on indirect measurements of these quantities.Seismic exploration,CAT,MRI,X-ray are examples of inverse problems. Bio metric identifiers are measurements from human body;examples are ear,face,facial thermogram,hand thermogram,hand vein,hand geometry,finger print,iris,retina,signature and voice..The direct and indirect problems of biometrics correspond to the analysis and synthesis of biometric information,respectively.Recognition of face is a direct problem while face reconstruction is an an inverse problem.Refinement of Fourier methods,called wavelet methods including curve lets,shear lets play important role for study of inverse problems occurring in above themes. The symposium is devoted to updated research on applications of wavelets to the above problems.

▶ MS-Th-D-55-1 13:30–14:00
Singular Fourier Integral Operators Arising in Some Radar Imaging Problems
Krishnan, Venky — TIFR Centre for Applicable Mathematics

Abstract: We consider the microlocal properties of transforms arising in some radar imaging problems. We study the forward operators and image reconstruction operators associated to these transforms in a microlocal framework. The microlocal analysis of these operators help us understand whether artifacts arise in image reconstruction or not, and in the cases where artifacts do arise, we compare the strengths of the artifacts with that of the true images.

▶ MS-Th-D-55-2 14:00–14:30
NEW CONVEX INVERSION FRAMEWORK FOR THE ELASTICITY IMAGING INVERSE PROBLEM
Khan, Akhtar — Rochester Inst. of Tech.

Abstract: This talk will focus on the elasticity imaging inverse problem of tumor identification in the soft tissue of the human body. A general optimization framework for the identification of parameters in saddle point problems will be discussed along with a new modified output least-squares (MOLS) objective functional. Both continuous and discontinuous numerical examples will be shown.

▶ MS-Th-D-55-3 14:30–15:00
Wavelet Analyses of Water Cycling
ASLAN, ZAFER — ISTANBUL AYDIN Univ.

Abstract: The main aim of the paper is to understand spatial and temporal variation of water cycle, heat fluxes and thermo-dynamical structure of atmospheric boundary layer . By using wavelet techniques, role of micro-meso and large scale events on rainfall and evaporation variations will explain water deficit and role of climate changing.The results of the study will improve prediction of evaporation and precipitation by defining role of small, meso and large scale factors.

▶ MS-Th-D-55-4 15:00–15:30
Application of Wavelets to Biometrics
Manchanda, Pammy — Guru Nanak Dev Univ., Amritsar

Abstract: Feature extraction is fundamental preprocessing step for pattern recognition, and machine learning problems. Determination of ages with knowledge of fingerprints of a person is a challenging problem. DWT and SVD based fingerprint feature extraction along with determination of age will be discussed in this talk.

MS-Th-D-56 13:30–15:30 403
Mathematical trends, challenges and future applications for liquid crystal theories - Part I of IV
For Part 2, see MS-Th-E-56
For Part 3, see MS-Fr-D-56
For Part 4, see MS-Fr-E-56

Organizer: Majumdar, Apala — Univ. of Bath
Organizer: Wang, Changyou — Purdue Univ.
Organizer: Zhang, Pingwen — Peking Univ.

Abstract: Liquid crystals are mesogenic phases of matter intermediate between the solid and liquid phases of matter. Liquid crystals typically exhibit partial ordering and are consequently, highly sensitive to light, electric fields, mechanical and rheological effects. The proposed minisymposium focuses on key questions in liquid crystal research, based on defects, atomistic to continuum modelling, phase transitions, pattern formation and hydrodynamics. The minisymposum will comprise four themed sessions on (i) analysis, (ii) modelling, (iii) simulations and (iv) related areas, with invited talks from physicists, mathematicians and materials scientists, thus providing an ideal platform for the cross-fertilization of expertise from around the globe.

▶ MS-Th-D-56-1 13:30–14:00

Global Solution of A Simplified Ericksen-Leslie Equation with Non-zero Circulation Reynolds Number

YU, Yong The Chinese Univ. of Hong Kong

Abstract: In order to simplify and meanwhile preserve the dissipative property of the original Ericksen-Leslie equation, a simplified Ericksen-Leslie equation was proposed by Lin and later studied by Lin-Lin-Wang for the bounded domain case in dimension two. So far most of works are about finite-kinetic-energy solution, which has zero circulation Reynolds number. In this talk we are going to discuss global weak solution of the simplified Ericksen-Leslie equation with non-zero circulation Reynolds number in dimension two. This work is partially supported by RGC grant 409613 and 14306414.

▶MS-Th-D-56-2 14:00–14:30

Finite Time Singularity of Nematic Liquid Crystal Flows

Wang, Changyou Purdue Univ.
LIn, Fanghua Courant Inst./NYU
Liu, Chun Penn State Univ.

Abstract: In this talk, I will describe the example of finite time singularity of the simplified nematic liquid crystal flows in dimension three. This is a joint work with Tao Hang, Fanghua Lin, and Chun Liu.

▶MS-Th-D-56-3 14:30–15:00

Local Existence of Unique Strong Solution to Nonisothermal Model for Incompressible Nematic Liquid Crystals in 3D

Ding, Shijin South China Normal Univ.

Abstract: In this paper, we consider the non-isothermal model for incompressible flow of nematic liquid crystals in three dimensions and prove the local existence and uniqueness of the strong solution with periodic initial conditions on $\mathbb{T}^3$.

▶MS-Th-D-56-4 15:00–15:30

Defects of Liquid Crystals

Zhang, Pingwen Peking Univ.

Abstract: Defects in liquid crystals are of great practical importance and theoretical interest. Despite tremendous efforts, predicting the location and transition of defects under various topological constraint and external field remains to be a challenge. We investigate defect patterns of nematic liquid crystals confined in three-dimensional spherical droplet and two-dimensional disk under different boundary conditions, within the Landau-de Gennes model. A spectral method that numerically solves the Landau-de Gennes model with high accuracy is implemented, which allows us to study the detailed static structure of defects. We observe five types of defect structures. Among them the 1/2 disclination lines are the most stable structure at low temperature. Inspired by numerical results, we obtain the profile of disclination lines analytically. Moreover, the connection and difference between defect patterns under the Landau-de Gennes model and the Oseen-Frank model is discussed. Finally, four conjectures are made to summarize the common characteristics of defects in the Landau-de Gennes theory, in the hope of providing a deeper understanding of the defect pattern in nematic liquid crystals.

MS-Th-D-57 13:30–15:30 402A

Modeling, Applications, Numerical Methods, and Mathematical Analysis of Fractional Partial Differential Equations I - Part II of V

For Part 1, see MS-Th-BC-57
For Part 3, see MS-Th-E-57
For Part 4, see MS-Fr-D-57
For Part 5, see MS-Fr-E-57

Organizer: Wang, Hong Univ. of South Carolina
Organizer: Karniadakis, George Brown Univ.

Abstract: Fractional Partial Differential Equations (FPDEs) are emerging as a new powerful tool for modeling many difficult complex systems, i.e., systems with overlapping microscopic and macroscopic scales or systems with long-range time memory and long-range spatial interactions. They offer a new way of accessing the mesoscale using the continuum formulation and hence extending the continuum description for multiscale modeling of viscoelastic materials, control of autonomous vehicles, transitional and turbulent flows, wave propagation in porous media, electric transmission lines, and speech signals. FPDEs raise modeling, computational, mathematical, and numerical difficulties that have not been encountered in the context of integer-order partial differential equations. The aim of this minisymposium is to cover the recent development in mathematical and numerical analysis, computational algorithms, and applications in the context of FPDEs and related nonlocal problems.

▶MS-Th-D-57-1 13:30–14:00

Efficient Spectral Methods for Solving PDEs with Two-sided Fractional Derivatives

Shen, Jie Purdue Univ.

Abstract: For the PDEs with Riesz derivatives, we construct spectral methods using special basis functions based on generalized Jacobi functions which lead to diagonal systems, and we derive rigorous error estimates which show that the convergence rate is of spectral type in properly weighted Sobolev spaces despite the fact that the solutions have singularities at the endpoints. For PDEs with more general two-sided fractional derivatives, we construct efficient spectral-element methods to achieve spectral accuracy.

▶MS-Th-D-57-2 14:00–14:30

Tempered Fractional Sturm-Liouville Eigen-Problems

Zayernouri, Mohsen Brown Univ.
Karniadakis, George Brown Univ.

Abstract: We introduce two classes of regular and singular tempered fractional Sturm-Liouville problems (TFSLPs). We prove the well-posedness of the TFSLPs and show that the corresponding eigensolutions are real-valued. We also demonstrate that the explicitly obtained eigenfunctions of TFSLPs, called Tempered Jacobi Poly-fractonomials, possess several key properties such as orthogonality, recurrence formula, etc. Hence, we employ them as new basis/test functions in developing Petrov-Galerkin spectral methods for tempered problems, followed by stability and error analysis.

▶MS-Th-D-57-3 14:30–15:00

Fractional Diffusion Equations: Theoretical and Numerical Investigation

Chuanju, Xu Xiamen Univ.

Abstract: In this talk, we will present some preliminary results on the well-posedness of boundary value problems related to fractional differential equations, and efficient methods for their numerical solution. The main ingredients include: 1) Spectral methods for space fractional partial differential equations; 2) High order methods for time space diffusion equations. Particularly, We will talk about fast spectral methods for high dimensional fractional diffusion equations.

▶MS-Th-D-57-4 15:00–15:30

Finite Difference/finite Element Method for Two-dimensional Space and Time Fractional Bloch-Torrey Equations

Tang, Yifa Acad. of Mathematics & Sys. Sci., CAS

Abstract: In this paper, a class of two-dimensional space and time fractional Bloch-Torry equations (2D-STFBTEs) are considered. By finite difference method and Galerkin finite element method, a semi-discrete variational formulation for 2D-STFBTEs is obtained. The stability and convergence of the semi-discrete form are discussed. Then, a fully discrete scheme of 2D-STFBTEs is derived and the convergence is investigated. Finally, some numerical examples are given to prove the correctness of our theoretical analysis.

MS-Th-D-58 13:30–15:30 401

Theoretical and numerical studies of phase field model - Part I of IV

For Part 2, see MS-Th-E-58
For Part 3, see MS-Fr-D-58
For Part 4, see MS-Fr-E-58

Organizer: Wang, Cheng Univ. of Massachusetts Dartmouth
Organizer: Qiao, Zhonghua The Hong Kong Polytechnic Univ.
Organizer: Wang, Xiaoping Hong Kong Univ. of Sci. & Tech.

Abstract: Phase field equations, which treat the phase variable as a continuous function instead of a sharp interface, model a great number of physical and biological phenomena, such as phase transformations of materials at different scales, the process in biological growth and development, and the topological change involved in multi-phase flows. This mini symposium is focused on the developments of the phase field models. Both the theoretical analysis for these highly nonlinear PDEs and the numerical approximations are of great interests.

▶MS-Th-D-58-1 13:30–14:00

A Second-order Accurate Convex Splitting Finite Difference Scheme for the Cahn-Hilliard Equation and Its Improved Error Analysis

Wang, Cheng Univ. of Massachusetts Dartmouth
Yue, Xingye Soochow Univ.
Wise, Steven Univ. of Tennessee
Guo, Jing Soochow Univ.

Abstract: A second order accurate finite difference scheme is presented for the 2-D and 3-D Cahn-Hilliard equation, and an error analysis with an improved convergence constant is provided. The unique solvability and unconditional energy stability results from its convex splitting nature. Meanwhile, it is observed that a standard error estimate gives a convergence constant which depends on ε^{-1} in an exponential growth form, with the interface parameter very small. To overcome this well-known difficulty, we apply a spectrum estimate for the linearized Cahn-Hilliard operator and get an improved estimate, in which the convergence constant depends on ε^{-1} only in a polynomial order, other than the exponential growth one.

▶ MS-Th-D-58-2 14:00–14:30

Modified Wenzel's and Cassie's equations for Wetting on rough surfaces

Xu, Xianmin — Inst. of computational Mathematics, Chinese Acad. of Sci.

Abstract: Wetting is a common phenomenon in nature and industrial applications. The classic Wenzel's and Cassie's equations are used to characterize apparent contact angles of a liquid drop on rough or chemically patterned surfaces. However, the two equations cannot describe contact angle hysteresis phenomena, which are widely observed in reality. I will talk about our recent analysis for the problem by both phase-field and sharp-interface approaches. We derive some modified Wenzel's and Cassie's equations.

▶ MS-Th-D-58-3 14:30–15:00

Linear Iteration Algorithm for Epitaxial Thin Film Growth Model with Slope Selection

Conde, Sidafa — Univ. of Massachusetts Dartmouth
Wang, Cheng — Univ. of Massachusetts Dartmouth
Narayan, Akil — Univ. of Massachusetts Dartmouth

Abstract: A linear iteration algorithm is proposed and implemented for the convex splitting numerical scheme applied to epitaxial thin film growth model with slope selection. The convex splitting nature assures an unconditional energy stability and unique solvability. Meanwhile, the linear iteration approach greatly simplifies the computational efforts to implement these highly nonlinear numerical schemes. In addition, both the theoretical analysis and the numerical evidences have shown a contraction mapping property of the proposed linear iteration. Both the first and second order splitting schemes are considers in this work.

MS-Th-D-59 13:30–15:30 402B

Energy-Driven Pattern Formation - Part I of IV

For Part 2, see MS-Th-E-59
For Part 3, see MS-Fr-D-59
For Part 4, see MS-Fr-E-59

Organizer: Kohn, Robert — New York Univ.

Abstract: Energy-driven pattern formation examines how energy minimization leads to the formation of defects and microstructure in a variety of physical systems. Examples include the wrinkling of a stretched elastic membrane, the twinning produced by martensitic phase transformation, and the defects seen in liquid crystals. In these and many other examples, the physics is modelled by a nonconvex variational problem regularized by a higher-order term with a small coefficient, and energy-driven pattern formation can be studied by considering the limiting behavior of minimizers as the small parameter tends to zero. Another recurrent theme is the use of ansatz-free bounds to identify and explore the features of energy-minimizing configurations. A third recurrent theme is dynamics, since the patterns of interest are sometimes transient states of steepest-descent processes.

▶ MS-Th-D-59-1 13:30–14:00

Optimal Energy Scaling for Branched Transport Networks

Wirth, Benedikt — Univ. of Munster

Abstract: Several models for transport networks take into account that it is more efficient to transport material in bulk. Optimal networks then typically exhibit branching structures. The network complexity and ramification depends on a parameter epsilon describing the cost reduction due to bulk transport. We analyze the scaling of the network costs as epsilon approaches zero. In two dimensions we furthermore establish a close relation of network optimization to so-called Mumford-Shah image segmentation. (With Alessio Brancolini)

▶ MS-Th-D-59-2 14:00–14:30

On the Geometry of Dissipative Evolution Equations

Reina, Celia — Univ. of Pennsylvania

Abstract: The modeling of continuum dissipative evolution equations remains a challenge and is currently based on phenomenological constitutive relations such as Fourier's law for heat transfer. In this talk we present some connections between the geometry of dissipative gradient flows, the principle of maximum entropy production, large deviation principles for stochastically augmented evolution equations and fluctuation-dissipation relations. (Joint work with Johannes Zimmer)

▶ MS-Th-D-59-3 14:30–15:00

Rigidity, Non-rigidity and Scaling for the Cubic-to-Orthorhombic Phase Transition

Rueland, Angkana — Univ. of Oxford

Abstract: In this talk I will discuss a geometrically linearized model of the cubic-to-orthorhombic phase transition in an exactly stress-free setting. I will show that it is one of the simplest, physically relevant phase transitions in which already in the linearized theory pathological convex integration solutions exist. Complementary to that, I will show that under surface energy constraints only very specific patterns can arise. Finally, I will discuss stability under small energy perturbations.

▶ MS-Th-D-59-4 15:00–15:30

Quantum Dots and Dislocations: Dynamics of Materials Defects

Fonseca, Irene — Carnegie Mellon Univ.

Abstract: The formation and assembly patterns of quantum dots have a significant impact on the optoelectronic properties of semiconductors. We will discuss shapes of quantum dots and short time existence for a surface diffusion evolution equation with curvature regularization in the context of epitaxially strained three-dimensional films. Further, short time existence, uniqueness, and qualitative properties of solutions to an evolution law for systems of screw dislocations under the assumption of antiplane shear will be obtained.

IM-Th-D-60 13:30–15:30 310

Industrial Mathematics Around the World - Part VIII of VIII

Global Perspectives in Industrial Mathematics

Discussion Pannel

For Part 1, see IM-Mo-D-60
For Part 2, see IM-Mo-E-60
For Part 3, see IM-Tu-D-60
For Part 4, see IM-Tu-E-60
For Part 5, see IM-We-D-60
For Part 6, see IM-We-E-60
For Part 7, see IM-Th-BC-60

Organizer: Cai, Zhijie — Fudan Univ.
Organizer: Chen, Gui-Qiang G. — Univ. of Oxford
Organizer: Huang, Huaxiong — York Univ.
Organizer: LU, Liqiang — Fudan Univ.
Organizer: Ockendon, Hilary — Univ. of Oxford
Organizer: Ockendon, John — Univ. of Oxford
Organizer: Peng, Shige — Shandong Univ.
Organizer: Tan, Yongji — Fudan Univ.
Organizer: Wake, Graeme — Massey Univ.,
Organizer: Zhu, Yichao — The Hong Kong Univ. of Sci. & Tech.
Organizer: CHENG, JIN — Fudan Univ.

Abstract: The aim of this section is to boost the use of mathematics as an industrial resource in China and around the world. It will highlight (i) the global experience in industrial mathematics and (ii) the new mathematical ideas that these activities have created as well as the exploitation of existing technologies to new applications. Participants will come from both academia and industry and, for this purpose, the section is proposed to consist of eight minisymposia. Four of them will overview the identification and solution of industrially-driven mathematical problems and the mechanisms that have evolved to deal with them in different regions: China, other Asia-Pacific countries, Europe and North America. Three of the remaining minisymposia will focus on the problems coming from different industrial sectors: financial industry, petroleum industry and industrial areas in which wave propagation is important. The last minisymposium will involve an open discussion on how the global mathematics community can best respond to the increasing demand from industry for applied and computational mathematics; the agenda will include both the mechanisms for academic / industrial collaboration and the areas where it will be most fruitful.

CP-Th-D-61 13:30–15:30 101

Numerical Analysis

Chair: Sinha, Rajen — Indian Inst. of Tech. Guwahati

Abstract:

▶ CP-Th-D-61-1 13:30–13:50

A Posteriori Error Analysis for Lumped Mass Finite Element Method for Parabolic Problems

Sinha, Rajen — Indian Inst. of Tech. Guwahati
Sen Gupta, Jhuma — IIT Guwahati

Abstract: We study residual-based *a posteriori* error estimates for both the spatially discrete and fully discrete lumped mass finite element methods for linear parabolic problems in a bounded convex polygonal domain in $\mathbb{R}^2$. While the space discretization uses finite element spaces that are assumed to be

nested one, the time discretization is based on the backward Euler method. Optimal order *a posteriori* error estimates in $L^\infty(L^2)$ and $L^2(H^1)$-norms are established using energy method. Our analysis relies on the appropriate adaptation of the elliptic reconstruction technique introduced by Makridakis and Nochetto [SIAM J. Numer. Anal., 41(4):1585-1594, 2003] and the stability of L^2 projection in $H^1(\Omega)$.

▶CP-Th-D-61-2 13:50–14:10

Mixed Finite Element Methods for Time Fractional Parabolic Optimal Control Problems - A Priori Error Estimates

Kandasamy, Manickam Periyar Univ., Salem 636011, Tamil Nadu, INDIA

Abstract: In this paper, a numerical theory based on mixed finite element methods for time fractional parabolic optimal control problems is presented and analyzed. The space discretization of the state variable is done using usual mixed finite elements, whereas the time discretization is based on difference methods. We derive, a priori error estimates for both the control variable and the state variables. We illustrate with a numerical example to confirm our theoretical results.

▶CP-Th-D-61-3 14:10–14:30

Finite Element Approximation for Parabolic Integro-Differential Equations with Discontinuous Coefficients

Deka, Bhupen Indian Inst. of Tech. Guwahati

Abstract: Finite element treatment for parabolic integro-differential equations with discontinuous coefficients are analyzed in this work. Convergence for the backward difference scheme in time direction are discussed. Optimal error estimates are derived in $L^\infty(L^2)$ and $L^\infty(H^1)$ norms when initial data $u_0 \in H^3 \cap H^1_0(\Omega)$.

▶CP-Th-D-61-4 14:30–14:50

NONCONFORMING FINITE ELEMENT APPROXIMATIONS OF THE VON KARMAN EQUATIONS

Mallik, Gouranga Indian Inst. of Tech. Bombay
Nataraj, Neela Indian Inst. of Tech. Bombay

Abstract: In this talk, we consider the von Karman equations which describe bending of thin elastic plates governed by two non-linear fourth order partial differential equations defined on polygonal domain. The main contributions include (i) derivation of an approximation for an isolated solution using the nonconforming Morley elements for discretization; (ii) development of optimal order energy norm and H1 norm error estimates; (iii) numerical realization of the theoretical results.

▶CP-Th-D-61-5 14:50–15:10

A Constrained Finite Element Method Based on Domain Decomposition Satisfying the Discrete Maximum Principle for Diffusion Problems

Chen, Xingding Beijing Tech. & Business Univ.

Abstract: In this paper, we are concerned with the constrained finite element method based on domain decomposition satisfying the discrete maximum principle for diffusion problems with discontinuous coefficients on distorted meshes. The basic idea of domain decomposition methods is used to deal with the discontinuous coefficients. To get the information on the interface, we generalize the traditional Neumann- Neumann method to the discontinuous diffusion tensors case. Then, the constrained finite element method is used in each subdomain. Comparing with the method of using the constrained finite element method on the global domain, the numerical experiments show that not only the convergence order is improved, but also the nonlinear iteration time is reduced remarkably in our method.

▶CP-Th-D-61-6 15:10–15:30

Convergence of Adaptive Mixed Finite Element Method for Second Order Elliptic Problems

Dond, Asha Indian Inst. of Tech. Bombay
Nataraj, Neela Indian Inst. of Tech. Bombay
Pani, Amiya Indian Inst. of Tech. Bombay

Abstract: The talk addresses the convergence of an adaptive mixed finite element method (AMFEM) for nonsymmetric, indefinite second order elliptic problems. First we analyze a nonconforming finite element discretization which converges owing to some a priori L^2 -error estimates under reduced regularity assumptions. An equivalence result of nonconforming FE scheme to the mixed finite element method (MFEM) leads to the well-posedness of the discrete solution and to a priori error estimates for the MFEM. The explicit residual-based aposteriori error analysis allows some reliable and efficient error control. The main difficulties in the analysis of convergence of AMFEM are posed by the non-symmetric and indefinite form of the problem along with the lack of the orthogonality property in MFEM. The important tools in the analysis are *a posteriori* error estimators, quasi-orthogonality property and quasi-discrete reliability established using representation formula for the lowest-order Raviart-Thomas solution in terms of the Crouzeix-Raviart solution.

CP-Th-D-62	13:30–15:30	102
Linear Algebra, Discrete Mathematics, Physics and Statistical Mechanics, Other Mathematical Topics and Their Applications		

Chair: Bu, Changjiang Harbin Engineering Univ.,

Abstract:

▶CP-Th-D-62-1 13:30–13:50

Some Results on the Generalized Inverse of Tensors and Idempotent Tensors

Bu, Changjiang Harbin Engineering Univ.,

Abstract: Let $\mathcal{A}$ be an order t dimension $m \times n \times \cdots \times n$ tensor over complex field. In this paper, we study some generalized inverses of $\mathcal{A}$, the k-T-idempotent tensors and the idempotent tensors based on the general tensor product. Using the tensor generalized inverse, some solutions of the equation $\mathcal{A} \cdot x^{t-1} = b$ are given, where x and b are dimension n and m vectors, respectively. The generalized inverses of some block tensors, the eigenvalues of k-T-idempotent tensors and idempotent tensors are given. And the relation between the generalized inverses of tensors and the k-T-idempotent tensors is also showed.

▶CP-Th-D-62-2 13:50–14:10

Finding Distance Magic and Antimagic Graphs

Simanjuntak, Rinovia Institut Teknologi Bandung

Abstract: For an arbitrary set of distances $D \subseteq \{0, 1, \ldots, d\}$, a graph G is said to be D-distance magic if there exists a bijection $f : V \to \{1, 2, \ldots, v\}$ and a constant k such that for any vertex x, $\sum_{y \in N_D(x)} f(y) =$ k, where $N_D(x) = \{y \in V | d(x, y) \in D\}$. Additionally, a graph G is said to be D-distance antimagic if the $\sum_{y \in N_D(x)} f(y) =$ k is unique for each vertex v..

A D-distance graph of a graph G, denoted by $X_D(G)$, is the graph with vertex set $V(G)$ and edge set $\{(x, y) : d(x, y) \in D\}$.

In this talk we shall study the relationships between D-distance magic and antimagic graphs for various D by using the notion of D-distance graph.

▶CP-Th-D-62-3 14:10–14:30

Phase Transitions in Three-channel Totally Asymmetric Simple Exclusion Process with Langmuir Kinetics

Gupta, Arvind Indian Inst. of Tech. Ropar

Abstract: In the past few years, due to its important role in understanding the nonequlibirium phenomena, totally asymmetric simple exclusion processes (TASEP) a paradigmatic model for self-driven many particle systems has attracted much attention. This simple model can describe some of the complex phenomenon such as boundary induced phase transitions, phase separation, spontaneous symmetry breaking and shock formation etc. The present study deals with the three-lane TASEPs with particles attachment and detachment in the bulk under open boundary conditions. The particles can hop along the lanes as well as to the adjacent lanes. The phase diagrams are obtained using singular perturbation technique on mean field equations. Several interesting dynamic phenomena are observed. The theoretical results are validated with extensive Monte-Carlo simulations.

▶CP-Th-D-62-4 14:30–14:50

Results on Mixed Anisotropic L2-BV Regularization of Ill-posed Problems and Applications to Image Restoration.

Spies, Ruben Inst. for Applied Mathematics of Litoral , IMAL, CONICET-UNL
Temperini, Karina IMAL-FICH, CONICET-UNL
Mazzieri, Gisela IMAL-FBCB

Abstract: Several generalizations of the traditional Tikhonov-Phillips regularization method for inverse ill-posed problems have been proposed during the last decades. Many of these variants consists essentially in modifications of the penalizing term, which forces certain features in the obtained regularized solution. If it is known that the regularity of the exact solution is inhomogeneous it is often desirable the use of mixed, spatially adaptive methods. These methods are also highly suitable when the preservation of borders and edges is also an important issue, since they allow for the inclusion of penalizers appropriate for border detection. In this work, we propose the use of a convex spatially-adaptive combination of classic L2 penalizers and anisotropic bounded variation semi-norm. Results on existence and uniqueness of minimizers of the corresponding Tikhonov- Phillips functional are presented. Stability results of those minimizers with respect to different perturbations are presented and applications to image restoration problems are shown.

CP-Th-D-63 13:30–15:50 103
Discrete Mathematics
Chair: Yue, Jing-yan Inst. of Applied Physics & Computational Mathematics, Beijing, China

Abstract:

▶ CP-Th-D-63-1 13:30–13:50

New Monotone Finite Volume Schemes for Diffusion Equations on Distorted Meshes

Yue, Jing-yan Inst. of Applied Physics & Computational Mathematics, Beijing, China
Yuan, Guang-wei Inst. of Applied Physics & Computational Mathematics, Beijing, China

Abstract: We construct a new monotone finite volume method for diffusion equations on star-shaped polygonal meshes. A distinct feature of the new scheme is that the discrete stencil of normal flux on a cell-edge can contain the cell-edge, which is different from the existing monotone schemes based on a nonlinear two-point flux approximation. The new scheme is proved to be monotone, i.e. it preserves positivity of analytical solutions for diffusion equations with strongly anisotropic and heterogeneous full tensor coefficients. Numerical results are presented to demonstrate the numerical performance of our new monotone scheme such as solution positivitypreserving, conservation, accuracy and efficiency on distorted meshes.

▶ CP-Th-D-63-2 13:50–14:10

On Connected Ramsey (3K2,K3)-minimal Graphs with Small Order

Wijaya, Kristiana Univ. of Jember
Baskoro, Edy Tri Institut Teknologi Bandung
Assiyatun, Hilda Institut Teknologi Bandung
Suprijanto, Djoko Institut Teknologi Bandung

Abstract: Ramsey graphs theory deals with regularity and coloring of graphs. There are many interesting applications of Ramsey graphs theory, such as in the fields of communications, information retrieval, and decision making. Let F, G and H be simple graphs. We write F →(G,H) to mean that any red-blue coloring of all edges of F contains either a red copy of G or a blue copy of H. The graph F (without isolated vertices) satisfying F →(G,H) and (F-e) ↛ (G,H) for every e in E(F) is called a Ramsey (G,H)-minimal graph. The set of all Ramsey (G,H)-minimal graphs is denoted by R(G,H). In this paper, we characterize all connected Ramsey (3K2,K3)-minimal graphs of order 9.

▶ CP-Th-D-63-3 14:10–14:30

Some Bounds on Restricted Size Ramsey Number for P3 Versus Pn

Silaban, Denny Riama Univ. of Indonesia/ Institut Teknologi Bandung
Baskoro, Edy Tri Institut Teknologi Bandung
Uttunggadewa, Saladin Institut Teknologi Bandung

Abstract: Let F, G, and H are simple graphs. We say F→(G,H) if for every 2-coloring of the edges of F there exist a monochromatic G or H in F. The Ramsey number r(G,H) is defined as min V(F) — F→(G,H) and the restricted size Ramsey number r*(G,H) is defined as min E(F) — F→(G,H), V(F)=r(G,H). In this paper we give lower and upper bounds for restricted size Ramsey number for path P_3 versus P_n. In particular, we give the exact size Ramsey number for some small values of n.

▶ CP-Th-D-63-4 14:30–14:50

Prime Cordial Labeling for Some Operations on Graphs

Sudarsana, I Wayan Tadulako Univ.

Abstract: All graphs in this paper are connected, finite, simple and undirected with p vertices and q edges. The greatest common divisor of two positive integers a and b is denoted by $gcd(a,b)$. A *prime cordial labeling (P-CL)* of a graph G with the vertex set V and the edge set E is a bijection $f: V \to \{1,2,3,...,p\}$ and the induced function $f^*: E \to \{0,1\}$ is defined by

$$f^*(uv) = \begin{cases} 1, \&if\ gcd(f(u),f(v)) = 1; \\ 0, \&otherwise. \end{cases}$$

satisfies the condition $|e_{f^*}(0) - e_{f^*}(1)| \leq 1$, where $e_{f^*}(i)$ is the number of edges of G having label i under f^* with $i = 0$ and 1. A graph which admits PCL is called *prime cordial (PC)* graph. In this note, we proved that fan and friendship corona path order two admit PCL. We also give a technique to construct for PCL on union of paths.

▶ CP-Th-D-63-5 14:50–15:10

On the Separation of Linear Constant-weight Codes

Li, Xin Beijing Inst. of Tech.
Liu, Zihui Beijing Institution of Tech.

Abstract: By using the finite projective geometry method, the separating properties of linear constant-weight codes are presented. An algorithm is given for computing the cardinality of separating coordinate positions of certain disjoint codeword sets of linear constant-weight codes.

▶ CP-Th-D-63-6 15:10–15:30

Construction of A Modular Homogeneous Two-weight Code over Finite Chain Rings

Liu, Zihui Beijing Institution of Tech.

Abstract: Modular homogeneous two-weight codes are useful in graph and combination theory, and the graph of a modular homogeneous two-weight code is strongly regular. We will construct several classes of modular homogeneous two-weight code over finite chain rings in this paper.

▶ CP-Th-D-63-7 15:30–15:50

Hamming Distance between the Strings Generated by Adjacency Matrix of A Graph

Ramane, Harishchandra Karnatak Univ., Dharwad-580 003

Abstract: Let A(G) be the adjacency matrix of a graph G. Denote by s(v) the row of the adjacency matrix corresponding to the vertex v of G. It is a string n-tuples over the field of order two. The Hamming distance between the strings s(u) and s(v) is the number of positions in which s(u) and s(v) differ. In this paper the Hamming distance between the strings generated by the adjacency matrix is obtained. Also HA(G), the sum of the Hamming distances between all pairs of strings generated by the adjacency matrix is obtained for some graphs.

CP-Th-D-64 13:30–15:30 104
Other Mathematical Topics and their Applications
Chair: Arshad, Misbah Abdus Salam School of Mathematical Sci., GCU, Lahore, Pakistan

Abstract:

▶ CP-Th-D-64-1 13:30–13:50

On the General Sum-connectivity Index of Connected Unicyclic Graphs with K Pendant Vertices.

Arshad, Misbah Abdus Salam School of Mathematical Sci., GCU, Lahore, Pakistan

Abstract: In this paper, we show that in the class of connected unicyclic graphs G of order n ⩾3 having 0 ⩽k ⩽n − 3 pendant vertices, the unique graph G having minimum general sum-connectivity index χ α (G) consists of Cn−k and k pendant vertices adjacent to a unique vertex of Cn−k, if −1 ⩽ α ¡ 0. This property does not hold for zeroth-order general Randić index 0R α (G).

▶ CP-Th-D-64-2 13:50–14:10

BINOMIAL EDGE IDEALS AND RATIONAL NORMAL SCROLLS.

Chaudhry, Faryal G.C.U, Lahore, Pakistan

Abstract: ABSTRACT. Let X be the Hankel matrix of size 2 ×n and let G be a closed graph on the vertex set [n]. We study the binomial ideal IG ⊂K[x1, . . . ,xn+1] which is generated by all the 2-minors of X which correspond to the edges of G. We show that IG is Cohen-Macaulay. We find the minimal primes of IG and show that IG is a set theoretical complete intersection. Moreover, a sharp upper bound for the regularity of IG is given.

▶ CP-Th-D-64-3 14:10–14:30

Fractional Power Series Solutions and Convergence Accelerations for Nonlinear Fractional Differential Equations

Duan, Jun-Sheng Shanghai Inst. of Tech.

Abstract: Fractional power series solutions for nonlinear fractional ordinary differential equations are considered by using a fast and efficient algorithm for the Adomian polynomials. Furthermore, the series solutions are combined with convergence acceleration techniques, such as the diagonal Pade approximants and the iterated Shanks transforms, to expand the effective region of convergence. Numeric examples demonstrate the effectiveness of the proposed methods

▶ CP-Th-D-64-4 14:30–14:50

Hierarchical Matrix ($\mathscr{H}$-matrix) Adaptation on Iterative Solvers

Syafiq, Nik Amir Universiti Putra Malaysia
Othman, Mohamed Universiti Putra Malaysia
Senu, Norazak Universiti Putra Malaysia

Abstract: In this paper we proposed an adaption of hierarchical matrix ($\mathscr{H}$-matrix) iterative based solution to solve two-dimensional partial differential equation, specifically for two-dimensional Poisson problem with Dirichlet boundary condition. The finite difference approximation is used to discretize the problem, which leads to a system of linear equation. The adaption of $\mathscr{H}$-matrix and by adding accelerated factor to a linear system lead to save space

utilization and speed up the iterative solver, respectively. An experiments were conducted and the results were compared with the standard iterative method. The results shown good in space utilization and relatively good in execution time.

▶ CP-Th-D-64-5 14:50–15:10

Least Absolute Deviation Criteria and Method

Gu, Lemin Tongji Univ.

Abstract: Least Absolute Deviation （LAD）criteria, proposed by mathematician Boscovitch in 1755 and Laplace in 1795,source in classical research on the 18th century astronomical meridian problem, is about the sum of the absolute value of error minimization criteria. The solution of LAD, a pending problem for more than 200 years in mathematics, is not easy to calculate because of the absolute value function.LAD solution problem has a big breakthrough in recent years, the breakthrough point is based on the "Zero-error principle" and "Representative manner" solution way. The paper carries out the following research:（1）Zero-error principle is presented. Error in the condition of zero, the absolute value is loss its meaning, thus overcome the two iron chain of blocking calculations, and makes LAD method become one as simple as Least Squares method. It is pointed out that LAD method is the best method to find the implicit function who is hidden behind the data and control data changes.（2）" Representative manner" solution way is put forward. This is an ideal and the best way to prevent and isolate the unusual data negative effect. It is completely different from LS method's "bundling manner" solving way. Both Zero-error principle and "Representative manner "solution way make some good characteristics of LAD method appear gradually, such as intuitive, robustness, zero-error, generalized, predictable and so on, the paper introduces these characteristics. Finally an application example that 2000-2013 China's total crude oil production and consumption change rule as well as future tendency is given.

▶ CP-Th-D-64-6 15:10–15:30

A Family of Accelerated Four-Point- Explicit Group Iterative Solvers

Shaharuddin, Shafiqah Universiti Putra Malaysia
Othman, Mohamed Universiti Putra Malaysia
Senu, Norazak Universiti Putra Malaysia

Abstract: In this paper, we investigated a family of four-points- explicit group iterative based solution for solving two-dimensional Poisson problem with Dirichlet boundary condition. The family consists of four-points- Explicit Group (EG), Explicit Decoupled Group (EDG), Modiﬁed Explicit Group (MEG), Modiﬁed Explicit Decoupled Group (MEDG) and Octo Modiﬁed Explicit Group (OMEG) iterative methods. The high order ﬁnite difference approximation is used to derive the methods, thus ended with a huge system of linear equation. By introducing an optimal accelerated factor to the linear equation, several experiments were conducted and the results will be compared with the computed theoretical complexity of all the methods. An evaluation of both results have shown some degree of agreements between them.

CP-Th-D-65 13:30–15:30 105
Dynamical Systems and Nonlinear Analysis
Chair: Benzekri, Tounsia Univ. of Sci. & Tech. Houari Boumedien
Abstract:

▶ CP-Th-D-65-1 13:30–13:50

Control of Hindmarsh-Rose Neuron Model

Benzekri, Tounsia Univ. of Sci. & Tech. Houari Boumedien

Abstract: In this work, we use the Nonlinear-Open-Plus-Closed-Loop (NOPCL) method to control a nonlinear model: the Hindmarsh-Rose model in which we can exhibit regular and chaotic dynamics. The aim of the NOPCL method is to entrain complex dynamics to arbitrary given goal dynamics, by adding a suitable control term to the system. We use this method to suppress chaos, by entraining chaotic dynamics to a periodic one for the Hindmarsh-Rose model.

▶ CP-Th-D-65-2 13:50–14:10

Effect of Data Transformation on Long Term Memory of Chaotic Time Series

Ogunjo, Samuel Federal Univ. of Tech., Akure

Abstract: There are many situations in which data set has to be subjected to mathematical manipulations such as differencing, logarithmic scaling, logarithmic differencing etc. In this paper, the effect of mathematical transformation onlong term memory of chaotic data set was investigated using Hurst exponent. Using four chaotic systems, two common approaches to the computation of Hurst exponent was studied. From the results obtained, the effects ranged from small changes to large differences. . Further more, data transformation highlights difference between the two methods of obtaining the Hurst exponents.

▶ CP-Th-D-65-3 14:10–14:30

Filippov Unplugged

Hogan, John Univ. of Bristol

Abstract: Almost every paper on piecewise smooth systems references the book by A.F. Filippov Differential equations with discontinuous righthand sides (Kluwer 1988). Yet it is a almost impossible read. It is tempting to ask how many people have read it all, or know of the results that it contains. Recently, a group at the University of Bristol has been systematically going through the text. Meeting every week, we have endeavoured to understand all the material, and to extract those results that are relevant to the modern audience. To do so, we need to revise our notions of 1) the solution to an equation, 2) trajectories, 3) singularities, 4) separatrices, 5) structural stability and 6) topological equivalence. This talk will not dwell on the fine detail. Instead we direct attention toward key, forgotten, results, to encourage others to delve into the book for themselves.

▶ CP-Th-D-65-4 14:30–14:50

Global Dynamics of A Tri-trophic Food Chain Model

Pahari, Ujjwal Kumar Netaji Nagar Day College

Abstract: In this paper we study the dynamical behavior of a tri-trophic food chain model in the presence of harvesting. In this model there is one predator feeding on the prey and a second predator called super predator feeding on the first predator. A time delay is introduced to the functional response term involved with the growth equation of the first predator. The effect of super predator and delay on the stability of the system is investigated and the time delay is regarded as bifurcation parameter. Local stability, global stability and bifurcation analysis under different conditions are also investigated. By using the normal form method and center manifold theorem, we give the formula for determining the direction of the Hopf bifurcation and the stability of bifurcating periodic solutions. Numerical simulations are carried out to support the analytical findings.

▶ CP-Th-D-65-5 14:50–15:10

Covariance Inflation by Shadowing Methods for Ensemble Data Assimilation

Bellsky, Thomas Univ. of Maine

Abstract: Covariance (ensemble) inflation is a process typically required in ensemble data assimilation, where an algorithm is used to periodically increase the ensemble variance in order to prevent ensemble collapse (a significant and permanent deviation of the ensemble from the truth). We will discuss ensemble shadowing techniques and our implementation of shadowing methods to inflate ensembles. We will also present forecasting results that support using shadowing inflation.

▶ CP-Th-D-65-6 15:10–15:30

Periodic and Chaotic Behavior in A Two-dimensional Monopoly Model.

Govaerts, Willy Ghent Univ.

Abstract: We study the discrete monopoly model of T. Puu with cubic price and quadratic marginal cost functions. A numerical continuation method is used to compute branches of solutions of period 5, 10, 13 and 17 and to determine the stability regions of these solutions. General formulas for solutions of period 4 are derived analytically. We show that the solutions of period 4 are never linearly asymptotically stable. A nonlinear stability criterion is combined with basin of attraction analysis and simulation to determine the stability region of the 4-cycles. This corrects the erroneous linear stability analysis in previous studies of the model. The chaotic and periodic behavior of the monopoly model is further analyzed by computing the largest Lyapunov exponents, and this confirms the above mentioned results (joint work with B. Al-Hdaibat and N. Neirynck).

MS-Th-D-66 13:30–15:30 VIP4-3
Theory and applications of Painleve type equations - Part I of II
For Part 2, see MS-Th-E-66

Organizer: Takenawa, Tomoyuki Tokyo Univ. of Marine Sci. & Tech.
Organizer: Dzhamay, Anton Univ. of Northern Colorado

Abstract: Last few decades have seen major developments in the theory of differential Painlevé equations. Their solutions, called Painlevé transcendents, are nonlinear special function that are playing an increasingly important role in many nonlinear problems in Mathematical Physics in areas such as Integrable Systems, Random Matrices, and others. Recently a lot of progress has been made in understanding the discrete analogues of Painlevé equations and their connections to Algebraic Geometry and Representation Theory. The purpose of this minisumposium is to bring together researchers working in this active area to discuss recent advances in the theory and their applications to other fields.

▶ MS-Th-D-66-1 13:30–14:00

Painlevé Equations and the Isomonodromy
Dzhamay, Anton — Univ. of Northern Colorado

Abstract: This talk is a brief introduction into the theory of Painlevé equations with the emphasis on the isomonodromic framework. We review definitions of continuous and discrete Painlevé equations, providing some historical context. Next, we give some examples of the appearance of the Painlevé equations and their solutions, the Painlevé transcendents, in various nonlinear problems in mathematics and physics. We also explain the connection between Painlevé equations and isomonodromic deformations of linear equations on the Riemann

▶ MS-Th-D-66-2 — 14:00–14:30
Painlevé Equations from A Geometric View Point
Takenawa, Tomoyuki — Tokyo Univ. of Marine Sci. & Tech.

Abstract: This talk is a brief introduction to continuous and discrete Painlevé equations from a geometric view point. While Painlevé equations are defined by the Painlevé property, i.e. the branch points of solutions are independent to the initial conditions, discrete Painleé equations are characterized by so called the singularity confinement criterion. We will show that these two properties are closely related to each other through the space of initial conditions in the sense of Okamoto.

▶ MS-Th-D-66-3 — 14:30–15:00
Autonomous Limit of 4-dimensional Painlevé-type Equations
Nakamura, Akane — the Univ. of Tokyo

Abstract: According to recent studies in the classification of 4-dimensional Painlevé-type equations, there are 40 types of them. In this talk, we consider their autonomous limit, which are integrable systems. By studying the spectral curves fibrations, we are able to grasp the characteristics of these systems.

▶ MS-Th-D-66-4 — 15:00–15:30
Distributions of Poles to the Painleve' Transcendents: Theory and Experiment
Novokshenov, Victor — Inst. of Mathematics, Russian Acad. of Sci., Ufa

Abstract: All solutions to the Painleve' equations are meromorphic functions. The method of isomonodromic deformations provides an exhaustive description of their asymptotic behavior at infinity. In contrast, it is little known about distribution of poles in bounded domains of the complex plane. A method based on Pade' approximations is discussed which provides non-trivial facts about dynamics of the movable poles, emergence of rational and truncated solutions and various patterns formed by the poles.

MS-Th-E-01 — 16:00–18:00 — 311A
Funding for Research in Mathematics: the European Research Council
Organizer: Macias, Angeles — ERCEA

Abstract: The aim of this workshop is to disseminate the research funding programmes of the European Research Council (ERC), a branch of the European Commission. They are individual-oriented, bottom up in the subject, for up to 5 years, and very substantial in size. Overall, the PIs are required to work in Europe for at least half of their time. The workshop will combine: a) a presentation of the ERC policies, b) a description of the schemes (Starting, Consolidator, and Advanced Grants), c) a sample of some of the projects that are currently being developed (by PIs), and d) an explanation of the evaluation procedures (by panel members). All in all, the workshop intends to encourage potentially competitive candidates to apply by making them aware of this opportunity. In addition to the expected participants proposed by the ERC, the contribution of high-level representatives of the Chinese mathematical community and of the national research funding body would be very desirable.

16:00–16:35
European Research Council (ERC) mission–7'
Jean-Pierre Bourguignon, ERC President (chair)
Welcome to ICIAM 2015 – Mathematics Research in China - CAS – 7'
ZhiMing Ma, Chinese Academy of Sciences
Mathematics Research in China - Universities – 7'
Shige Peng, Shandong University
Mathematics Research – General Trends of funding agencies – 7'
Tony F. Chan, Hong Kong University
NSF – ERC agreement – 7'
Zhao Guilin, Department of Mathematical and Physical Sciences, National Natural Science Foundation of China

16:35–17:05
Step by step to ERC grants (video) – 5'
Grant schemes, opportunities, ERC-China agreement, opportunities – 5'
Angeles Macias, ERC programme officer
Tics for a good proposal: a success B1part (Project Synopsys) – 5'
Enrique Zuazua, AdG panel chair
Interdisciplinary aspects in mathematics research – 5'
Volker Mehrmann, AdG panel member
Evaluation keys – Remote Reviewers – 5'
Maria Esteban, AdG panel chair
The Interviews (Evaluation Step 2) – 5'
José Antonio Carrillo, CoG panel member

17:05–17:35
My project, opportunities for young researchers, personal experience – 10'
Annalisa Buffa, StG 2007 grantee
My project, opportunities for middle career researchers, personal experience – 10'
Martin Hairer, CoG 2013 grantee
My project, opportunities for high prestige researchers, personal experience – 10'
Jean-Michel Coron, AdG 2010 grantee

17:35–18:00
Questions and Answer session – 20'
Wrap-up/ close Session – 5'

MS-Th-E-02 — 16:00–18:00 — 309A
Special session 3 of Chinese Conferece of Complex Networks (CCCN) 2015
Organizer: Wang, Xiaofan — Shanghai Jiao Tong Univ.

Abstract: This mini-symposium is organized for invited young scholars,and is recommended to be held at 16:00-18:00, Aug.13, 2015.

MS-Th-E-03 — 16:00–18:00 — 306A
Propagation Phenomena of Reaction-Diffusion Models in Biology - Part II of IV
For Part 1, see MS-Th-D-03
For Part 3, see MS-Fr-D-03
For Part 4, see MS-Fr-E-03
Organizer: Li, Wan-Tong — Lanzhou Univ.
Organizer: Ruan, Shigui — Univ. of Miami

Abstract: With the tide of globalization, biological invasions and pathogen transmission, which in turn can affect ecosystem or threaten public health, become focal spots in literature. In mathematical biology, there are many reaction-diffusion models arising from various applications such as animal dispersal, geographic spread of epidemics. To model/illustrate these problems/phenomena and investigate/evaluate the corresponding control strategy, it has been proved that the corresponding propagation modes are very important and useful. This minisymposium focus on the recent advances of propagation phenomena of different reaction-diffusion models in biology. In particular, the traveling wave solutions, asymptotic spreading, entire solutions, generalized transmission and threshold dynamics with their applications of reaction-diffusion models will be discussed.

▶ MS-Th-E-03-1 — 16:00–16:30
Spatial Dynamics of A Delayed Nonlocal Reaction-diffusion System
Wu, Shiliang — Xidian Univertisty

Abstract: This talk is concerned with the spatial dynamics of a delayed nonlocal reaction-diffusion system. We first investigate the global attractivity of equilibria of the system. Then we establish the exisence of the minimal wave speed of traveling wave solutions and show that it coincides with the spreading speed. Finally, some front-like entire solutions are constructed by combing any finite numbers of traveling wave solutions with different speeds and a spatially independent solution.

▶ MS-Th-E-03-2 — 16:30–17:00
Traveling Wave Solutions and Entire Solutions for Nonlocal Dispersl Equations with Delay
Guobao, Zhang — Northwest Normal Univ.

Abstract: In this talk, we study traveling wave solutions and entire solutions for a nonlocal dispersal equation with convolution-type crossing-monostable nonlinearity. Firstly, by means of the (technical) weighted energy method, we show that the traveling wave with large speed is exponentially stable. Secondly, we apply Ikehara's Tauberian theorem to show that all noncritical traveling waves are unique up to translation. Finally, we combine the traveling wavefronts and spatially independent solutions to construct entire solutions.

▶ MS-Th-E-03-3 — 17:00–17:30
On A Free Boundary Problem for A Competition System: Two Invasive Species Case
Wu, Chang-Hong — Department of Applied Mathematics, National Univ. of Tainan

Abstract: We focus on a two-species competition-diffusion model with two free

boundaries. Here, two free boundaries which may intersect each other are used to describe the spreading fronts of two competing species, respectively. The spreading mechanism for species is determined by a Stefan condition, which is proposed by Du and Lin (2010). We mainly study the dynamics and offer some biological insight.

▶ MS-Th-E-03-4 17:30–18:00

Persistence and Spread of A Species with A Shifting Habitat Edge

Li, Bingtuan Univ. of Louisville

Abstract: We discuss a reaction-diffusion model that describes the growth and spread of a species along a shifting habitat gradient. We assume that the linearized species growth rate is positive near positive infinity and is negative near negative infinity. We provide the conditions under which the species goes extinct, and determine the spreading speed at which the species spreads along the shifting habitat gradient. Joint work with Sharon Bewick, Jin Shang, and William F. Fagan.

MS-Th-E-04 16:00–18:00 308

Curves and Surfaces in Computer Aided Geometric Design - Part III of III

For Part 1, see MS-Th-BC-04
For Part 2, see MS-Th-D-04

Organizer: Jia, Xiaohong Chinese Acad. of Sci.
Organizer: Cheng, Jin-San Chinese Acad. of Sci.

Abstract: The symposium is aimed at bridging between people who are working theoretically on curves and surfaces in algebraic geometry and those who are endeavoring to seek for suitable modeling forms of curves and surfaces in Computer Aided Geometric Design. Therefore, the symposium includes wide-ranging topics on curves and surfaces from classic theory aspects to their applications in modern industry. The forms of curves and surfaces consist of but are not limited to: algebraic curves and surfaces, parametric curves and surfaces including NURBS as well as triangular surface patches.

▶ MS-Th-E-04-1 16:00–16:30

How Many Regions Does A Real Algebraic Curve Divide the Plane?

Cheng, Jin-San Chinese Acad. of Sci.

Abstract: In this talk, we investigate the number of regions of a real algebraic plane curve C defined by f(x,y) = 0 dividing the real plane R^2. We obtain a relationship between the zero-th Betti number of $R^2 \setminus C$ and the number of bounded connected components of C, from which we derive a formula only involved with f(x,y) for the zero-th Betti number. It is a joint work with Mingbo Zhang.

▶ MS-Th-E-04-2 16:30–17:00

An Algebraic Approach of Computing the Variations of the Intersection Curve of Two Moving Quadrics

Jia, Xiaohong Chinese Acad. of Sci.

Abstract: We propose a symbolic algorithm for detecting the variations in the topological and algebraic properties of the intersection curve of two quadratic surfaces (QSIC) that are moving or deforming in PR3PR3 (real projective 3-space). The core of our algorithm computes all the critical instants when the QSIC changes type using resultants and Jordan forms. These critical instants partition the time axis into intervals within which the QSIC is invariant. The QSIC at the computed critical instants and within the time intervals can both be exactly determined using symbolic technique. Examples are provided to illustrate our algorithm.

▶ MS-Th-E-04-3 17:00–17:30

Quaternion Rational Surfaces: Rational Surfaces Generated from the Quaternion Product of Two Rational Space Curves

Wang, Xuhui Hefei Univ. of Tech.

Abstract: A quaternion rational surface is a surface generated from two rational space curves by quaternion multiplication. The goal of this talk is to demonstrate how to apply syzygies to analyze quaternion rational surfaces. We show that we can easily construct three special syzygies for a quaternion rational surface from a μ-basis for one of the generating rational space curves. The implicit equation of any quaternion rational surface can be computed from these three special syzygies and inversion formulas for the nonsingular points on quaternion rational surfaces can be constructed. Quaternion rational ruled surfaces are generated from the quaternion product of a straight line and a rational space curve. We investigate special mu-bases for quaternion rational ruled surfaces and use these special mu-bases to provide implicitization and inversion formulas for quaternion rational ruled surfaces. Finally, we show how to determine if a real rational surface is also a quaternion rational surface.

▶ MS-Th-E-04-4 17:30–18:00

Geometric Iteration Method and Its Applications in Geometric Design

Hongwei, Lin Zhejiang Univ.

Abstract: Geometric iteration method, also called progressive-iterative approximation, is an iterative method with clear geometric meaning. By adjusting the control points of curves or surfaces iteratively, the limit curve or surface interpolates (approximates) the given data point set. In this report, we present the iterative formats of the interpolatory and approximating geometric iteration methods, show their convergence and local property, and develop the accelerating techniques. Moreover, some successful applications of the geometric iteration method are demonstrated.

MS-Th-E-05 16:00–18:00 215

Geometric Understanding of Data in 3D and Higher - Part I of III

For Part 2, see MS-Fr-D-05
For Part 3, see MS-Fr-E-05

Organizer: Lai, Rongjie Rensselaer Polytechnic Inst.
Organizer: Zhao, Hongkai UC Irvine

Abstract: Rapid development of data acquisition technology stimulates research on developing new computational tools for analyzing and processing data to make more effective decisions. In many problems, coherent structures of data allows us to model data as a low dimension manifold in a high dimension space. More recently, there has been increasing interests in using geometric based method to analyze and infer underlying structures from the given data. This minisymposium aims to bring together people from different research groups with common interest. We hope that this symposium can propel further collaborations and developments in this field.

▶ MS-Th-E-05-1 16:00–16:30

Multi-scale Non-Rigid Point Cloud Registration Using Robust Sliced-Wasserstein Distance via Laplace-Beltrami Eigenmap

Zhao, Hongkai UC Irvine
Lai, Rongjie Rensselaer Polytechnic Inst.

Abstract: Point clouds sampled from manifolds are transformed to new point clouds by Laplace-Beltrami(LB) eigenmap defined intrinsically on the manifolds which is invariant under isometric transformation of the original manifolds. We design computational models and algorithms for registration of the transformed point clouds in distribution/probability form based on optimal transport theory and incorporate a rigid transformation to handle ambiguities. Our method provides an efficient, robust and accurate multi-scale approach for non-rigid point cloud registration.

▶ MS-Th-E-05-2 16:30–17:00

Graph Cut Methods for Semi-supervised and Unsupervised Data Classification

Bertozzi, Andrea UCLA

Abstract: We present variational methods for semi-supervised and unsupervised data classification involving graph cuts, which are equivalent to minimizing the graph total variation of an assignment function. We discuss performance and efficiency of various algorithms for such problems including max flow, augmented Lagrangian, and geometric methods such as the MBO scheme and Allen-Cahn flow.

▶ MS-Th-E-05-3 17:00–17:30

Convergence of the Laplace-Beltrami Operator from Point Clouds

Sun, Jian tsinghua Univ.

Abstract: The spectral convergence of the weighted graph Laplacian is a theoretical foundation of the Laplacian based algorithms such as spectral clustering, and dimensionality reduction using diffusion maps and Laplacian eigenmaps. In this talk, I will present our recent results showing the eigenvalues and eigenvectors of the weighted graph Laplacian converges to the eigenvalues and eigenfunctions of the Laplace-Beltrami operator of the manifold with the Neumann boundary in the limit of infinitely many sample points. We consider the convergence problem from the point of view of solving the Poisson equations on submanifolds. This new perspective also leads to the methods for computing the eigensystem of the Laplace-Beltrami operator with Dirichlet boundaries and for solving the harmonic extension problem from point clouds. I will also present some numerical results.

▶ MS-Th-E-05-4 17:30–18:00

New Old Methods for Manifold Correspondence

Bronstein, Michael Univ. of Lugano (USI) / Intel

Abstract: In recent years, geometric data is gaining increasing interest both in the academia and industry. In this talk, I will use the problem of manifold correspondence (a fundamental problem with a wide range of applications in geometric processing, graphics, vision, and learning) as a showcase for signal processing (sparse coding, joint diagonalization, matrix completion) applied to geometric problems. I will show applications to 3D shape correspondence, multi-view clustering, and image labeling.

MS-Th-E-06 16:00–18:30 201
Data-driven methods for quantifying uncertainty of multiscale dynamical systems - Part II of IV

For Part 1, see MS-Th-D-06
For Part 3, see MS-Fr-D-06
For Part 4, see MS-Fr-E-06

Organizer: Harlim, John The Pennsylvania State Univ.
Organizer: Sapsis, Themistoklis MIT
Organizer: Giannakis, Dimitrios New York Univ.

Abstract: A major challenge in contemporary applied science is to design efficient models for predicting dynamical behavior resulting from complex interaction of multiple scale processes. This task, implicitly, requires one to account for uncertainties of the models due to initial conditions, boundary conditions, model errors, and observation errors. A promising interdisciplinary approach to address such issue is with a data-driven statistical methods that combine ideas from dynamical systems theory, stochastic processes, statistics, and data analysis. This special session aims to bring together researchers from across the spectrum of disciplines related to data-driven methods to discuss the development and application of emerging ideas and techniques for these important and difficult practical issues.

▶ MS-Th-E-06-1 16:00–16:30
Modeling of Unresolved Scales with Data-inferred Stochastic Processes
Crommelin, Daniel CWI Amsterdam

Abstract: I will discuss a data-driven stochastic approach to modeling unresolved scales in multiscale systems, in which feedback from micro-scales is represented by a network of Markov processes. The Markov processes are conditioned on macro-scale model variables, and their properties are inferred from pre-computed high-resolution (micro-scale resolving) simulations. These processes are designed to emulate, in a statistical sense, the feedback observed in the high-resolution simulations, thereby providing a statistical-dynamical coupling between micro- and macro-scale models.

▶ MS-Th-E-06-2 16:30–17:00
Improving Prediction Skill of Imperfect Turbulent Models Through Statistical Response and Information Theory
Qi, Di Courant Inst. of Mathematical Sci.

Abstract: Simplified imperfect models are useful in areas like climate science where the true climate system is vastly more complicated than any conceivable approximation. Simple statistical closure models using additional damping and enhanced noise in replacement of the higher order moments are constructed for resolving turbulent systems with quadratic nonlinearities. An information consistent strategy to improve imperfect model performance ensuring statistical equilibrium fidelity and optimal model responses to different perturbations is developed in a low-order subspace.

▶ MS-Th-E-06-3 17:00–17:30
Perspectives on Nonlinear Filtering
Law, Kody ORNL

Abstract: This talk will survey some recent theoretical results involving accurate signal tracking with noise-free (degenerate) dynamics in high-dimensions (infinite, in principle, but say d between 10^3 and 10^8, depending on the size of your application and your computer), and high-fidelity approximations of the filtering distribution in low dimensions (say d between 1 and several 10s).

▶ MS-Th-E-06-4 17:30–18:00
Analog Forecasting with Dynamics-Adapted Kernels
Zhao, Zhizhen Courant Inst. of Mathematical Sci., NYU
Giannakis, Dimitrios New York Univ.

Abstract: We introduce a suite of forecasting methods which improve traditional analog forecasting by combining ideas from state-space reconstruction in dynamical systems and kernel methods developed in harmonic analysis and machine learning. The first improvement is to use Takens' delay-coordinate maps to recover information lost through partial observations. Then, weighted ensembles of analogs are chosen according to similarity kernels featuring an explicit dependence on the dynamical vector field generating the data.

▶ MS-Th-E-06-5 18:00–18:30
A Continuum Perspective on Eigenmaps and Diffusion Maps
Portegies, Jacobus Max Planck Inst. for Mathematics in the Sci.

Abstract: We present a continuum perspective on several nonlinear data analysis methods, with a special focus on Eigenmaps and Diffusion Maps. We derive bounds on the complexity of the continuous versions of these algorithms, in terms of the geometry of the manifold they are trying to learn. In particular, we bound the number of eigenfunctions needed to accurately represent the manifold in a (low-dimensional) Euclidean space.

MS-Th-E-07 16:00–18:00 202A
Computational Methods in Ice Sheet Modeling for Next Generation Climate Simulations - Part II of II

For Part 1, see MS-Th-D-07

Organizer: Tezaur, Irina Sandia national Laboratories
Organizer: Wei, Leng LSEC
Organizer: Martin, Daniel Lawrence Berkeley National Laboratory
Organizer: Ng, Esmond Lawrence Berkeley National Laboratory
Organizer: Perego, Mauro Sandia National Laboratories

Abstract: Changes in glaciers and ice sheets are expected to have a tremendous influence on sea-level rise and global climate change. Many mathematical challenges in simulating ice sheet dynamics arise: ill-conditioned systems; a wide range of scales; complex evolving geometries; ill-posed inverse problems; sparse observational data; large-scale forward and inverse UQ problems in high-dimensions ("curse of dimensionality"). Speakers in this MS will present recent developments aimed at overcoming these and other difficulties arising in ice sheet modeling. A broad range of topics will be covered, including forward and inverse problems, UQ, solvers/preconditioners, and coupling to global climate models.

▶ MS-Th-E-07-1 16:00–16:30
A Model for Temperature Ice Formation
Hewitt, Ian Univ. of Oxford

Abstract: Many ice-sheets contain ice that is at the melting temperature and contains pore water. We examine a model to determine the heat/water content of such ice, and to locate the boundaries between cold and temperate ice. In some circumstances, the model reduces to common treatments of temperate ice employed in ice-sheet models, but in some cases it does not. We examine different boundary-layer behaviour that can occur using a combination of asymptotic and numerical

▶ MS-Th-E-07-2 16:30–17:00
Improving Discretization of Grounding Lines Using An Embedded-Boundary Approach in BISICLES
Martin, Daniel Lawrence Berkeley National Laboratory
Ng, Esmond Lawrence Berkeley National Laboratory
Schwartz, Peter Lawrence Berkeley National Laboratory

Abstract: Correctly representing grounding line dynamics is of fundamental importance in modeling marine ice sheets. We have developed a grounding-line discretization based on the Chombo embedded-boundary cut-cell framework. This promises better representation of grounding lines vs. a traditional stair-step discretization on Cartesian meshes like those used in the block-structured AMR BISICLES code. Also, the fundamental discontinuous nature of flow across the grounding line is respected by treating it as a material phase change.

▶ MS-Th-E-07-3 17:00–17:30
Coupling of Momentum Balance and Thickness Evolution Equations for Ice Sheet Modeling
Perego, Mauro Sandia National Laboratories

Abstract: The main components of an ice sheet model are the equations for: (1) the momentum balance (typically Stokes equations or their approximations) and (2) the ice thickness evolution. These two components are strongly coupled, and a straightforward sequential solution of them leads to prohibitively small time steps. In this talk we analyze the coupled problem and we propose a method to solve it effectively. We show numerical results on idealized and realistic geometries.

▶ MS-Th-E-07-4 17:30–18:00
Development of the Adjoint of A Higher-order Ice Sheet Model
Goldberg, Daniel Univ. of Edinburgh

Abstract: Development of the efficient adjoint generation of a higher-order ice sheet model using Algorithmic Differentiation (AD) methods is presented. Recent innovations are adjoint generation with open-source AD software and the implementation of a specialized treatment of the fixed-point problem for ice velocities which decreases computation time and lowers memory overhead, which are important considerations for large scale simulation. Recent assimilation results using time-dependent remote sensing data is also presented.

MS-Th-E-08 16:00–18:30 202B
Minisymposium on Inverse Problems in Wave Propagation - Part I of II
For Part 2, see MS-Fr-D-08

Organizer: Bao, Gang Zhejiang Univ.
Organizer: Li, Peijun Purdue Univ.
Organizer: Triki, Faouzi Joseph Fourier Univ.

Abstract: Inverse problems in wave propagation have played a fundamental role in diverse scientific areas such as radar and sonar, geophysical exploration, medical imaging, near-field optical microscopy, and nano-optics. Due to the complexity of material properties and uncertainty in physical models and parameters, precise modeling and accurate computing present challenging and significant mathematical and computational questions, and remain the subject matter of much ongoing research.
The minisymposium aims to recent mathematical and computational studies of inverse problems in various wave propagation models, including acoustic, electromagnetic, optical, elasticity, and quantum wave propagation. It seeks to bring together leading researchers in these fields to present recent developments, promote exchange of ideas, and discuss new directions including treatment of multi-frequency and near-field data, and multi-wave imaging. The talks will cover all the aspects of inverse scattering problems like asymptotic techniques, sensitivity analysis, numerical computation, and wave propagation in complex and random media.

▶MS-Th-E-08-1 16:00–16:30
Relaxation Methods for Inverse Wave Scattering
Demanet, Laurent MIT

Abstract: Inversion of kinematic parameters from scattered waves can lead to hard optimization problems, e.g., when the measurements are interferometric, or when a background velocity needs to be estimated. I will explain how and when the semidefinite relaxation framework can be used to mitigate some of the nonconvexity inherent in these problems. Joint work with Augustin Cosse and Laurent Seppecher.

▶MS-Th-E-08-2 16:30–17:00
Unique Determination of Polyhedral Perfect Conductors by An Electric Dipole
Liu, Xiaodong Inst. of Applied Mathematics, Chinese Acad. of Sci.

Abstract: We prove a uniqueness result in inverse electromagnetic scattering by polyhedral-type scatterers with perfectly conducting boundary conditions. The incident field is an electric dipole with a fixed dipole point and a fixed polarization. The boundary of the underlying object can be not only bounded and closed surface but also unbounded locally rough surface.

▶MS-Th-E-08-3 17:00–17:30
Neutral Inclusions and Cloaking
Kang, Hyeonbae Inha Univ.

Abstract: It was discovered by Hashin that by coating inclusions we can make structures which does not perturbed the field outside the structure. Such structures are called neutral inclusions. Recently they have been applied to dramatically enhance near cloaking. In this talk I will discuss about this development. I will also discuss about an over-determined problem arising from study of neutral inclusions.

▶MS-Th-E-08-4 17:30–18:00
Stability of Recovering Wave Speed from Boundary Measurements
Zhang, Hai ENS, Paris

Abstract: We report recent progress on the stability of recovering wave speed from boundary measurements. Two cases are considered: the hyperbolic Dirichlet to Neumann map and the scattering relation. We showed that hyperbolic D-t-N map is not good for the reconstruction, while the scattering relation can be used to reconstruct wave speed in a stable way.

▶MS-Th-E-08-5 18:00–18:30
Adjoint State Methods for Identification Problems in Single Photon Emission Computerized Tomography (SPECT)
Qian, Jianliang Michigan State Univ.

Abstract: Based on some recent theoretical understanding of the identification problem of single photon emission computerized tomography (SPECT), we propose an adjoint state method to solve the identification problem numerically so that we can verify the theory and demonstrate uniqueness and non-uniqueness, stability and instability of the inverse problem.

MS-Th-E-09 16:00–18:00 203A
Recent advances on computational wave propagation - Part II of II
For Part 1, see MS-Th-D-09

Organizer: Li, Jichun Univ. of Nevada Las Vegas
Organizer: Huang, Yunqing Xiangtan Univ.
Organizer: Shu, Shi Xiangtan Univ.

Abstract: This mini-symposium is organized to provide a forum for fellow researchers working on numerical methods for wave propagation problems to present and discuss their recent advances and achievements. Topics to be covered include but not limited to: hybrid FDTD methods, time-domain finite element methods, spectral methods, high-performance computing, high frequency waves, multiscale methods, novel techniques for metamaterials and cloaking simulations).
Note: All invited speakers are confirmed.

▶MS-Th-E-09-1 16:00–16:30
Efficient Evaluation of Green's Function for 2D Scattering in Layered Medium
Lai, Jun New York Univ.

Abstract: Conventional Green's function evaluation for layered medium through Sommerfeld integral suffers from slow convergence when the point source is near the interface. In this talk, we propose a novel method to efficiently evaluate the layered Green's function via the combination of Sommerfeld integral and physical density along the interface. Numerical experiments for scattering problem with object imbedded in the layered medium are provided to show the efficiency.

▶MS-Th-E-09-2 16:30–17:00
Fast Huygens Sweeping Methods for Helmholtz Equations in the High Frequency Regime
Qian, Jianliang Michigan State Univ.

Abstract: We propose the fast Huygens sweeping methods for Helmholtz equations in inhomogeneous media in the high frequency regime. With four to six points per wave length, the new method is of nearly optimal complexity independent of the frequency. 2-D and 3-D numerical examples demonstrate the performance of the new method.

▶MS-Th-E-09-3 17:00–17:30
Transformation Optics Based Finite Difference Time Domain Method for Solving Maxwell's Equations
Liu, Jinjie Delaware State Univ.

Abstract: Transformation optics (TO) is an elegant coordinate transformation technique to design the metamaterial invisibility cloak. Recently, we have developed a TO based FDTD method to numerically solve the Maxwell's equations. This method can achieve subgridding effect, by using TO to enlarge certain small regions so that they look much larger in the transformed space. In this talk, we will discuss the recent progress of TO-FDTD, its extension to space-time domain and some applications.

▶MS-Th-E-09-4 17:30–18:00
Finite Element Time Domain Methods for Wave Propagation in Metamaterials
Yang, Wei Xiangtan unversity

Abstract: In this talk, we propose the time domain finite element methods for modeling of electromagnetic cloaks, backward wave propagations and the optical black holes. The permit tivity and permeability of the cloak model are described by the drude dispersion model. Stability analysis and optimal error estimate are carried out for the proposed scheme.Numerical simulations using edge elements demonstrate that our algorithms are quite effective for simulating in time-domain.

MS-Th-E-10 16:00–18:00 206B
Stochastic Dynamics with Applications - Part I of III
For Part 2, see MS-Fr-D-10
For Part 3, see MS-Fr-E-10

Organizer: Duan, Jinqiao Illinois Inst. of Tech

Abstract: Nonlinear systems are often under random influences. The uncertainties may be due to external fluctuations or unresolved scales. These random influences may affect system evolution at various spatial and temporal scales, subtly or profoundly. Taking uncertainty into account is essential in modeling various complex phenomena in biological, physical and chemical systems.
The objective of this special session is to bring together experts from multiple disciplines with complementary views and approaches to stochastic dynamics in the context of applications.
The topics to be discussed include: Overview of stochastic dynamics, stochastic approaches for multi-scale modeling, impact of noise, non-Gaussian dynamics, statistical physics near or out of equilibrium, adaptive dynamics, bi-

ological modeling, stochastic modeling in systems biology

▶MS-Th-E-10-1 16:00–16:30

On Connections between Stochastic Differential Equations and Information Theory

Liu, Xianming Huazhong Univ. of Sci. & Tech.
Han, Guangyue The Univ. of Hong Kong

Abstract: In this talk, making use of interesting connections between stochastic differential equations and information theory, we derive the capacity regions of several classes of continuous-time Gaussian channels. The "complete" results obtained in this work stand in stark contrast to the status quo of network information theory in discrete-time, where the capacity regions of the all the above-mentioned channels are known only for a handful of special scenarios.

▶MS-Th-E-10-2 16:30–17:00

Random Periodic Processes, Periodic Measures and Strong Law of Large Numbers

Zhao, Huaizhong Loughbrough Univ.

Abstract: We first prove that a random periodic path of a random dynamical system gives a periodic measure (p.m.), and conversely construct random periodic process on an enlarged probability space. The law of the random periodic process is the p.m. We further prove the strong law of large numbers (SLLN) of the random periodic processes. Joint work with Chunrong Feng.

▶MS-Th-E-10-3 17:00–17:30

Stability in Distribution of Stochastic Delay Recurrent Neural Networks with Markovian Switching

Enwen, Zhu Changsha Univ. of Sci. & Tech.

Abstract: This paper investigates the stability in distribution of stochastic delay recurrent neural networks with Markovian switching. Using Lyapunov function and stochastic analysis techniques, sufficient conditions on the stability in distribution are given. For such recurrent neural networks, it reveals that the limit distribution of transition probability for segment process associated with solution process is indeed a unique ergodic invariant probability measure. Moreover, a numerical example is also provided to demonstrate the effectiveness and applicability of the theoretical results.

▶MS-Th-E-10-4 17:30–18:00

On the Complete Dynamical Behavior for Three-Dimensional Stochastic Competitive Lotka-Volterra Systems

Jiang, Jifa Shanghai Normal Univ.

Abstract: We exploit the long-run behavior for 3-dimensional competitive Lotka-Volterra systems with the equal growth rate perturbed by the same multiplicative noise. Firstly, it is proved that the solutions of considered systems can be expressed in terms of the solutions of the noise-free system multiplied by appropriate solutions of the scalar logistic equation driven by the same kind noise. This decomposition helps us to classify the long-run behavior for considered systems. There are exactly 37 classes.

MS-Th-E-11 16:00–18:00 203B

Matrix computations using structures and other innovative techniques - Part II of III

For Part 1, see MS-Th-D-11
For Part 3, see MS-Fr-D-11

Organizer: Xia, Jianlin Purdue Univ.
Organizer: Chen, Jie IBM Thomas J. Watson Research Center

Abstract: This minisymposium is concerned with a wide range of innovative matrix computation techniques, including structures, randomization, splitting preconditioning, etc. The techniques make it feasible to develop new fast and reliable direct or iterative solutions. In particular, certain block or hierarchical structures can be used to obtain effective preconditioners or nearly linear complexity direct solvers for challenging numerical problems. Interesting applications to imaging, PDE/integral equation solutions, optimization, parallel computing, and engineering simulations will also be shown.

▶MS-Th-E-11-1 16:00–16:30

Superfast Divide-and-Conquer Eigensolvers and Structured Perturbation Analysis

Xia, Jianlin Purdue Univ.

Abstract: We present nearly O(n) complexity divide-and-conquer methods for finding all the eigenvalues and eigenvectors of a class of symmetric matrices, as well the perturbation analysis. The matrices have certain rank structures, as often encountered in practical applications such as Toeplitz matrices and some discretized problems. We show how to quickly and stably perform the major operations. Eigenvalue approximation accuracies, clustered eigenvalues, and generalizations to SVDs are studied. This is joint work with James Vogel.

▶MS-Th-E-11-2 16:30–17:00

High Performance Parallel Implementation of A Novel HSS-structured Sparse Solver Using Randomized Sampling

Ghysels, Pieter Lawrence Berkeley National Lab
Rouet, Francois-Henry Lawrence Berkeley National Laboratory
Li, Xiaoye Lawrence Berkeley National Laboratory

Abstract: We present an efficient code for solving large sparse linear systems using the multifrontal method with hierarchically semi-separable (HSS) matrices. The low rank compression in HSS limits fill-in and reduces complexity of the solver. The HSS matrices are constructed using randomized sampling and rank-revealing QR. ULV decomposition replaces the traditional dense LU. The factorization acts as solver or preconditioner. Shared and distributed memory parallel results are presented for a range of applications.

▶MS-Th-E-11-3 17:00–17:30

A New Integral Formulation and Fast Direct Solver for Periodic Stokes' Flow

Gillman, Adrianna Rice Univ.

Abstract: Many solution techniques have recently been developed to accurately and efficiently numerically model vesicle flow. The introduction of a periodic confining geometry adds further complications to such simulations. This talk presents a new integral formulation which avoids the use of the periodic Green's function. Additionally, a fast direct solver for the discretized confining geometry is presented. This solver allows for efficient time stepping by decoupling the static geometry from the moving vesicles.

▶MS-Th-E-11-4 17:30–18:00

Some Accelerated Solvers for the Eigenvalue and SVD Problems

Li, Shengguo National Univ. of Defense Technologt

Abstract: In this report, we present some accelerated eigenvalue and SVD solvers by using the hierarchically semiseparable (HSS) matrix techniques. We mainly exploit the off-diagonal low-rank property of some intermediate matrices. By comparing with some highly optimized packages such as Intel MKL, our proposed algorithms can be faster in both serial and parallel cases. We will present some numerical results to show that.

MS-Th-E-12 16:00–18:00 208B

Orthogonal Polynomials, Special Functions, and their Applications - Part I of III

For Part 2, see MS-Fr-D-12
For Part 3, see MS-Fr-E-12

Organizer: Qiu, Weiyuan Fudan Univ.
Organizer: Wong, Roderick City Univ. of Hong Kong
Organizer: Zhang, Lun Fudan Univ.
Organizer: Zhao, Yuqiu Sun Yat-sen Univ.

Abstract: Special functions and orthogonal polynomials is a very classical subject with numerous applications in both pure and applied mathematics. Tremendous progresses in this area have been achieved recently and new connections with other research areas such as random matrices, Riemann-Hilbert problems, etc. have been found. It is the aim of this minisymposim to provide a forum for researchers with diverse backgrounds whose research interests overlap with special functions and orthogonal polynomials. The speakers will report the latest developments in these areas, exchange their expertise, experience and insights. We hope this minisymposium will strengthen the connections among people in the relevant areas and stimulate future research.

▶MS-Th-E-12-1 16:00–16:30

Complex Singularities of Ordinary Differential Equations

Huang, Min City Univ. of Hong Kong
Zhang, Lun Fudan Univ.

Abstract: Global singular behavior of solutions to ODEs in the complex plane is an important and challenging topic in both theory and applications. We introduce a new constructive method of studying global behavior and singularities of complex ODEs, based on generalized asymptotic formulas with rigorous error estimates. We prove special cases of a conjecture concerning pole distributions of Painleve transcedents proposed by Novokshenov, namely tritronquees to PI and the Hastings-McLeod solution to PII.

▶MS-Th-E-12-2 16:30–17:00

Asymptotic Analysis of Associated Orthogonal Polynomials via Three-term Recurrence Relations

Wang, Xiang-Sheng Southeast Missouri State Univ.

Abstract: We study a group of orthogonal polynomials satisfying certain three-

term recurrence relations with coefficients being linear or quadratic in the polynomial degree. Plancherel-Rotach type asymptotic formulas of the orthogonal polynomials as the polynomial degree tends to infinity are obtained by successive approximation and matching principle. Applications are given to asymptotic analysis of associated orthogonal polynomials.

▶ MS-Th-E-12-3 17:00–17:30

Semi-classical Orthogonal Polynomials and the Painleve Equations

Clarkson, Peter — Univ. of Kent

Abstract: In this talk I shall discuss semi-classical orthogonal polynomials arising from perturbations of classical weights. It is shown that the coefficients of the three-term recurrence relation satisfied by the polynomials can be expressed in terms of Wronskians which involve special functions. These Wronskians are related to special function solutions of the Painleve equations. Using this relationship recurrence relation coefficients can be explicitly written in terms of exact solutions of Painleve equations.

MS-Th-E-13 16:00–18:30 VIP3-2

Progress in hyperbolic problems and applications - Part IV of VI

For Part 1, see MS-We-E-13
For Part 2, see MS-Th-BC-13
For Part 3, see MS-Th-D-13
For Part 5, see MS-Fr-D-13
For Part 6, see MS-Fr-E-13

Organizer: Wang, Ying — Univ. of Oklahoma
Organizer: Tesdall, Allen — City Univ. of New York, College of Staten Island

Abstract: Hyperbolic conservation laws form the basis for the mathematical modeling of many physical systems, and describe a wide range of wave propagation and fluid flow phenomena, including shock waves in nonlinear situations. For one dimensional systems with small data, a well-posedness theory of entropy weak solutions is well known. Analysis in several space dimensions, however, remains an enormous challenge. In this minisymposium, recent results in the theory and numerical analysis of hyperbolic problems will be presented. A variety of computational techniques, including finite volume, finite element, spectral, WENO, and discontinuous Galerkin methods, will be represented.

▶ MS-Th-E-13-1 16:00–16:30

A Fully Conservative Discontinuous Galerkin Method for Third-order Linear Equations in One Dimension

Dong, Bo — Univ. of Massachusetts Dartmouth

Abstract: We introduce a Bassi-Rebay type discontinuous Galerkin (DG) method for both stationary and time-dependent third-order linear equations. This method is the first DG method which conserves the mass and the L^2-, H^1-, and H^2- norms of the solution. We prove that projections of the errors are superconvergent when the polynomial degree k is even, and converge sub-optimally, but sharply, with order k when it is odd. (Joint work with Yanlai Chen and Bernardo Cockburn.)

▶ MS-Th-E-13-2 16:30–17:00

Lax-Friedrichs Multigrid Fast Sweeping Methods for Steady State Problems for Hyperbolic Conservation Laws

Chen, Weitao — Univ. of California, Irvine
Kao, Chiu-Yen — Clarmeont McKenna College
Chou, Ching-Shan — The Ohio State Univ.

Abstract: We propose Lax-Friedrichs fast sweeping multigrid methods which allow efficient calculations of viscosity solutions of stationary hyperbolic problems. Due to the choice of Lax-Friedrichs numerical fluxes, general problems can be solved without difficult inversion. High order discretization can be incorporated to achieve high order accuracy. In addition, we use multigrid methods coupled with biased WENO interpolation to speed up the computation by smoothing errors of low frequencies on coarse meshes.

▶ MS-Th-E-13-3 17:00–17:30

Linear and Nonlinear Waves in Multidimensional Gas Dynamics Equations

Keyfitz, Barbara — The Ohio State Univ.

Abstract: As the community of analysts studying hyperbolic conservation laws continues to make progress on multidimensional problems, largely through the study of self-similar solutions to shock reflection phenomena, one difficulty that emerges is the interaction of nonlinear waves (such as acoustic waves in compressible flow) and linear waves (shear or entropy waves, for example). In recent work with Katarina Jegdic, Suncica Canic and Hao Ying, we have developed an approach that solves a small, local problem.

▶ MS-Th-E-13-4 17:30–18:00

Low Order Polynomial Method Versus Multi-resoution Analysis for Detecting Shocks for WNEO Methods

Guo, Jingyang — SUNY at Buffalo
Jung, Jae-Hun — SUNY at Buffalo

Abstract: We present the RBF WENO finite difference methods, which is based on our adaptive RBF-WENO finite volume methods. The polynomial basis is replaced with the radial basis functions. For the nonsmoothness region, the low order monotone polynomial method is used. For the hybrid method, we will explain how the low order method is enough to be used for WENO calculation and compare the results by the multi-resolution analysis popularly used for the hybrid method.

▶ MS-Th-E-13-5 18:00–18:30

Optimal Energy Conserving Local Discontinuous Galerkin Methods for Second-order Wave Equation in Heterogeneous Media

Chou, Ching-Shan — The Ohio State Univ.
Shu, Chi-Wang — Brown Univ.
Xing, Yulong — Oak Ridge National Laboratory & Univ. of Tennessee

Abstract: Solving wave propagation problems within heterogeneous media has been of great interest and has a wide range of applications in physics and engineering. The design of numerical methods for such general wave propagation problems is challenging because the energy conserving property has to be incorporated to minimize the phase or shape errors after long time integration. In this talk, we will present an LDG method for multi-dimensional wave problems in heterogeneous media.

MS-Th-E-14 16:00–18:00 111

Effective dynamics of stochastic partial differential equations - Part I of III

For Part 2, see MS-Fr-D-14
For Part 3, see MS-Fr-E-14

Organizer: Wang, Wei — Nanjing Univ.
Organizer: Gao, Hongjun — Nanjing Normal Univ.

Abstract: Stochastic partial differential equations (SPDEs) are appropriate mathematical models for many multiscale systems with uncertain and fluctuating influences. A complex system often contains different scales both in time and space, which make numerical simialtion difficult, so effective and simplifed system, governing the evolution of the system over long time scale, is desirable. The simplified system provide an effective model to be applied to simulate the complex system. This minisymposium aim to present new methods and results on the effective description complex system and application in science and engineering.

▶ MS-Th-E-14-1 16:00–16:30

Impacts of Noise on A Class of Partial Differential Equations

Lu, Guangying — Henan Univ.

Abstract: This paper is concerned with effects of noise on the solutions of partial differential equations. We first provide a sufficient condition to ensure the existence of a unique positive solution for a class of stochastic partial differential equations. Then, we prove that noise could induce singularities (finite time blow up of solutions). Finally, we show that a stochastic Allen-Cahn equation does not have finite time singularities and the unique solution exists globally.

▶ MS-Th-E-14-2 16:30–17:00

Large Deviations for An Stochastic Integrable Equation Governing Short-waves in A Long-wave Model

Chen, Yong — Zhejiang Sci-Tech Univ.
Gao, Hongjun — Nanjing Normal Univ.

Abstract: This paper is concerned with an stochastic integrable equation governing short-waves in a long-wave model. Firstly, the local well-posedness for this system is established by fixed point argument and (bilinear) trilinear estimates. Then the small noise large deviation principle is proved by the weak convergence approach. Some analogous results are also obtained for the small time asymptotics of the system.

▶ MS-Th-E-14-3 17:00–17:30

Random Perturbations of Reaction-diffusion Waves in Biology

Tang, Yanbin — Huazhong Univ. of Sci. & Tech.

Abstract: This talk considers the statistical properties of the traveling wave fronts of the scalar Fitzhugh-Nagumo equation with random perturbations by two-parameter white noise on the whole real line, where the traveling wave front connects two stable equilibria. As well as the method of Green's function, we get the asymptotic fluctuations behavior of two stable states which are two boundaries of the traveling wave front to the Nagumo equation by the fundamental solution.

▶ MS-Th-E-14-4 17:30–18:00

Dynamics for A Stochastic Reaction-diffusion Equation with Additive Noise

Yang, Meihua Huazhong Univ. of Sci. & Tech.

Abstract: In this talk I will present a new scheme of investigating some interested problems about the dynamics of SPDE. In order to present our idea clearly, we consider a stochastic reaction-diffusion equation with the nonlinearity which satisfies a dissipative condition with polynomial growth of arbitrary order $p \geqslant 2$. This model is one of the basic models for rising and developing the notation, theory and method about dynamics. Joint work with Daomin Cao and Chunyou Sun

MS-Th-E-15 16:00–18:00 213B

PDEs and applications: theory and computation - Part II of IV

For Part 1, see MS-Th-D-15
For Part 3, see MS-Fr-D-15
For Part 4, see MS-Fr-E-15

Organizer: Wang, Ying Univ. of Oklahoma
Organizer: Nie, Hua Shaanxi Normal Univ.

Abstract: Partial differential equations (PDEs) have been widely used in the mathematical modeling of physical and biological phenomena, including mixed type equations. Many problems of an applied nature reduce to finding specific solutions and properties of PDEs of elliptic, parabolic, or of mixed type; in particular, problems of plane transonic flow of a compressible medium, and problems in the theory of envelopes. In this mini-symposium, recent results in the theory and computation of PDEs and their applications will be presented. The goal of this mini-symposium is to provide a platform for the world experts in the area of PDEs, both theory and computation, to report the recent progresses, exchange ideas and build up collaborative works. We anticipate that our speakers will have expertise in a wide-ranging array of topics, possibly including: (i) qualitative and quantitative properties enjoyed by solutions to nonlinear partial differential equations of elliptic, parabolic, or of mixed type. (ii) numerical schemes derived for various types of PDEs. (iii) physical and biology modeling involving nonlinear partial differential equations of elliptic, parabolic, or of mixed type.

▶ MS-Th-E-15-1 16:00–16:30

Longtime Dynamics of the Quasi-linear Strongly Damped Wave Equation

Yang, Zhijian Zhengzhou Univ.

Abstract: In this talk, we are concerned with the longtime dynamics of the quasilinear strongly damped wave equations. We present a new method to establish the global attractor and exponential attractor in natural phase space endowed with strong topology (rather than the weaker one as is done before) in the case of the supercritical nonlinearities.

▶ MS-Th-E-15-2 16:30–17:00

Approximate Solutions to the Korteweg-de Vries-Burgers Equation

Feng, Zhaosheng Univ. of Texas-Pan American

Abstract: In this talk, we provide a connection between the Abel equation of the first kind, an ordinary differential equation that is cubic in the unknown function, and the Korteweg-de Vries-Burgers equation, a partial differential equation that describes the propagation of waves on liquid-filled elastic tubes. We present an integral form of the Abel equation with the initial condition. By virtue of the integral form and the Banach Contraction Mapping Principle we derive the asymptotic expansion of bounded solutions in the Banach space, and use the asymptotic formula to construct approximate solutions to the Korteweg-de Vries-Burgers equation.

▶ MS-Th-E-15-3 17:00–17:30

The Spline Finite Element Method for Solving the Thin Plate Bending Problem

Chen, Juan Dongbei Univ. of Finance & Economics
Li, Chong-Jun Dalian Univ. of Tech.

Abstract: The FEM is a important method for solving PDEs. There are some difficulties involved in obtaining conforming displacement models for the thin plate bending problem. In this paper, we reconstruct two conforming quadrilateral thin plate elements by using the cubic spline Hermite interpolation bases defined on the quadrilateral elements. They both have good accuracy for the numerical examples and are less insensitive to mesh distortions than the well-known DKQ element.

▶ MS-Th-E-15-4 17:30–18:00

Quasilinear Elliptic Equations on Convex Domains

JIA, HUILIAN Xi'an Jiaotong Univ.

Abstract: In this talk, we want to discuss the global regularity for p-Laplacian type elliptic equations on convex domains with very rough boundary data. The maximal function, Vitali covering lemma and approximation (or compactness method) are the main techniques. To derive the approximation lemma, we need Lipschitz estimates for the corresponding homogeneous equations, where the convexity of the domain plays an important role. This is a joint work with prof. Lihe Wang.

MS-Th-E-16 16:00–18:00 205A

System of Conservation Laws and Related Models - Part II of IV

For Part 1, see MS-Th-D-16
For Part 3, see MS-Fr-D-16
For Part 4, see MS-Fr-E-16

Organizer: Li, Yachun Shanghai Jiao Tong Univ.
Organizer: Wang, Weike Shanghai Jiao Tong Univ.
Organizer: Wang, Yaguang Shanghai Jiaotong Univ.
Organizer: Xie, Chunjing Shanghai Jiao Tong Universit

Abstract: This minisymposium focuses on the analysis for system of conservation laws and related models. It covers the following topics: 1. Multidimensional conservation laws and transonic flows; 2. Compressible Navier-Stokes system and singular limits for fluid dynamics; 3. Free boundary problems arising in fluid mechanics and related models.

▶ MS-Th-E-16-1 16:00–16:30

Global Behavior of Large Solutions of Compressible Viscous and Heat Conductive Fluids

Pan, Ronghua Georgia Inst. of Tech.

Abstract: In this talk we report some recent progress on the global existence and large time behavior for compressible Navier-Stokes-Fourier system with temperature-dependent viscosity and/or heat conductivity coefficients with large initial data. The talk is based on joint works with W. Zhang, X. Qin, and Z. Yao.

▶ MS-Th-E-16-2 16:30–17:00

Transonic Problems for the Euler System of Equations in Two Space Dimensions

Zheng, Yuxi The Pennsylvania State Univ.

Abstract: We build smooth solutions at a given smooth sonic curve for the compressible Euler system of equations in two space dimensions for both time-dependent and steady cases. We try to reduce the regularity requirements on the solutions so as to match the general sense of weak solutions for hyperbolic conservation laws. For self-similar solutions, our efforts illustrate various structures of solutions to the two-dimensional Riemann problems. Talk is based on recent work with Tianyou Zhang.

▶ MS-Th-E-16-3 17:00–17:30

Global Weak Solutions to A Cahn-Hilliard-Stokes-Darcy System for Two Phase Incompressible Flows in Karstic Geometry

Wu, Hao Fudan Univ.

Abstract: We will present our recent results on a Cahn-Hilliard-Stokes-Darcy system which is a diffuse-interface model for immiscible two phase incompressible flows with matched density in a karstic geometry. Existence of finite energy weak solution that is global in time is established in both 2D and 3D. Weak-strong uniqueness property of the weak solutions is provided as well. This is a joint work with Prof. Xiaoming Wang and Dr. Daozhi Han.

▶ MS-Th-E-16-4 17:30–18:00

Rigorous Compressible to Incompressible Limit in 1D

Colombo, Rinaldo M. Univ. of Brescia

Abstract: Consider 2 inviscid, immiscible, compressible and isentropic fluids in 1 space dimension. We consider the limit in which one of the fluid becomes incompressible. For data with small total variation, we prove the rigorous convergence of compressible equations and solutions to their incompressible counterpart.

MS-Th-E-17 16:00–18:00 205B

Singular limits in mathematical physics - Part IV of V

For Part 1, see MS-We-E-17
For Part 2, see MS-Th-BC-17
For Part 3, see MS-Th-D-17
For Part 5, see MS-Fr-D-17

Organizer: Cheng, Bin Univ. of Surrey
Organizer: Secchi, Paolo Univ. of Brescia
Organizer: Ju, Qiangchang Inst. of Applied Physics & Computational Mathematics (IAPCM)
Organizer: Jiang, Ning Tsinghua Univ., Beijing

Abstract: This minisymposium will address recent advances in analytical and numerical studies of singular limits of multiscale physical models as certain parameters approach zero or infinity. It shall cover such areas as incompressible and fast rotating limits in fluid dynamics, hydrodynamical limits of complex fluid and kinetic models, and relaxations. The singular nature of these models makes it challenging to rigorously justify and quantify their limits and to

numerically simulate them in a way consistent with theory. Novel techniques and results in partial differential equations, stochastic differential equations and numerical analysis will be discussed.

▶ MS-Th-E-17-1 16:00–16:30

Stochastic 3D Rotating Navier-Stokes Equations: Averaging, Convergence and Regularity

Mahalov, Alex — Arizona State Univ.

Abstract: Regularity results are established by bootstrapping from global regularity of the limit stochastic equations and convergence theorems. The energy injected in the system by the noise is large, the initial condition has large energy, and the regularization time horizon is long. Regularization is the consequence of a precise mechanism of relevant three-dimensional nonlinear interactions and the averaged covariance operator for the stochastic dynamics. Arch. Rat. Mech. Anal, 205, 195-237, 2012 (with F. Flandoli).

▶ MS-Th-E-17-2 16:30–17:00

Meso-scale Weakly Compressible Atmospheric Flow: A Three Time Scale Asymptotic Problem

Klein, Rupert — Freie Universität Berlin

Abstract: "Sound-proof models" are the atmospheric analogue of the classical incompressible flow equations. Their mathematical justification is non-trivial because they result from the full compressible flow equations by elimination of only one of three asymptotically separated scales. As a consequence, the sound-proof equations still constitute an asymptotic two-scale system rather than a limit system that is free of the singular parameter. I will report on recent efforts towards a rigorous justification that circumvents these issues.

▶ MS-Th-E-17-3 17:00–17:30

Time-averaging and Error Estimates for Reduced Fluid Models

Cheng, Bin — Univ. of Surrey

Abstract: I will discuss the application of time-averaging in getting rigorous error estimates of some reduced fluid models, including the incompressible approximation and quasi-geostrophic approximation. The spatial boundary can be present as a non-penetrable solid wall. I will show a very recent (and somewhat surprising) result on the ϵ^2 accuracy of incompressible approximation of Euler equations, thanks to several decoupling properties.

▶ MS-Th-E-17-4 17:30–18:00

BACKWARD BEHAVIOR OF DISSIPATIVE EVOLUTION EQUATIONS

Guo, Yanqiu — Weizmann Inst. of Sci.

Abstract: In this talk, I will discuss the backward-in-time behaviors of several dissipative evolution equations. This study is motivated by investigating the Bardos-Tartar conjecture on the 2D Navier-Stokes equations. Besides the rigorous mathematical treatment, we provide physical interpretation of the mechanism of singularity formulation, backward in time, for perturbations of the KdV equation. Finally, I present the connection between the backward behavior and the energy spectra of the solutions. This is a joint work with E.S.Titi.

MS-Th-E-18 16:00–18:00 209B

Mathematics and Optics - Part II of IV

For Part 1, see MS-Th-D-18
For Part 3, see MS-Fr-D-18
For Part 4, see MS-Fr-E-18

Organizer: Santosa, Fadil — Inst. for Mathematics & its Applications
Organizer: Bao, Gang — Zhejiang Univ.
Organizer: Weinstein, Michael — Columbia Univ.

Abstract: The importance of optics and is summarized in the 2013 US National Academy of Sciences report "Optics and Photonics: Essential Technology for Our Nation". Envisioned technologies which rely on optics include communications, imaging, sensing, and computing. What is clear from the report is that the Mathematical Sciences is poised to make significant contributions to the progress in technology. Indeed there is a growing research activity at the nexus of the Mathematical Sciences and the Optical Sciences. Together with advances in materials science and nano-structure fabrication, there is a growing role for mathematical tools, both computational and analytical.
The goal of this minisymposium is to highlight research in the mathematical sciences that deal with problems arising in optics and photonics. Topics that will be discussed in the sessions include optics in meta-materials, cloaking, photonic bandgap structures, design and control of optical devices, plasmonics, and nonlinear phenomena in optics. These topics will be emphasized during the Institute for Mathematics and its Applications (IMA) annual thematic program "Mathematics and Optics", 2016-17. The minisymposium is an invitation to mathematical scientists to participate in the IMA program.

▶ MS-Th-E-18-1 16:00–16:30

Spectral Theory of Neumann-Poincaré Operator and Analysis of Plasmon Resonance

Kang, Hyeonbae — Inha Univ.

Abstract: The Neumann-Poincaré (NP) operator is a boundary integral operator which arises naturally when solving boundary value problems using layer potentials. It is not self-adjoint with the usual inner product. But it can symmetrized by introducing a new inner product using Plemelj's symmetrization principle. Recently many interesting properties of the NP operator have been discovered. I will discuss about this development and applications to plasmon resonance.

▶ MS-Th-E-18-2 16:30–17:00

Approximate Cloaking via Change of Variables

Nguyen, Hoai-Minh — Ecole Polytechnique Federale de Lausanne EPFL

Abstract: Cloaking using transformation optics was suggested by Pendry et al. and Leonhardt. A similar scheme was previously used by Greenleaf et al. for electrical impedance tomography. In this talk, I discuss approximate cloaking using transformation optics. Emphasis is on the occurence of the resonance and the cloaking on the time domain. The approximate schemed considered is due to Kohn et al.

▶ MS-Th-E-18-3 17:00–17:30

Vertical Mode Expansion Method for Electromagnetic Scattering Problems

Lu, Ya Yan — City Univ. of Hong Kong

Abstract: In many applications, it is necessary to solve the 3D Maxwell's equations for scattering problems where the scatter is a layered cylindrical object in a layered background. The vertical mode expansion method (VMEM) is a recently developed method that expands the field in 1D modes with "coefficients" satisfying 2D Helmholtz equations, and finds the solution by matching field components along the boundaries of different layered regions. We present the VMEM with applications in plasmonics.

▶ MS-Th-E-18-4 17:30–18:00

Spectral Theory in the Absence of Ellipticity for High Contrast Photonic Crystals

Lipton, Robert — LSU
Viator, Robert — Louisiana State Univ.

Abstract: Photonic crystals employ high contrast media for controlling light. Here we identify an underlying quasiperiodic resonance spectra and use it to represent solution operators associated with the Maxwell system for high contrast photonic crystals. We develop representation formulas for the resolvent for selfadjoint holomorphic families of operators. This technique is applied to compute and to design dispersion characteristics for photonic crystals. Computational examples of this approach are provided to illustrate the ideas.

MS-Th-E-19 16:00–18:00 307B

Women in Applied Mathematics: Recent Advances in Modeling, Numerical Algorithms, and Applications - Part IV of IV

Career Panel Session

For Part 1, see MS-We-E-19
For Part 2, see MS-Th-BC-19
For Part 3, see MS-Th-D-19

Organizer: Li, Fengyan — Rensselaer Polytechnic Inst.
Organizer: Cheng, Juan — Inst. of Applied Physics & Computational Mathematics

Abstract: This mini-symposium aims at bringing women mathematicians to share recent progress and to inspire new ideas in applied mathematics. Talks may address modeling, theoretical and computational aspects of numerical methods, as well as various applications arising from biomedical problems, fluid dynamics, electromagnetism, rarefied gas dynamics, and constrained optimal control problems etc. Besides the scientific aspects, the fourth part of this mini-symposium is a career panel session, which is to create a platform for women mathematicians at different stages with different career paths to network, to exchange experiences and advices in career advancement, and to discuss challenges and strategies for a successful career.

▶ MS-Th-E-19-1

Discovering Partial Differential Equations

Keyfitz, Barbara — The Ohio State Univ.

Abstract: I don't see how one can become a mathematician without being motivated by the excitement of a problem, or of an entire field. In my case, the field was PDE, and the problem was the nature of wave propagation in nonlinear media. The obstacles to having a career fade when one has a goal. Contributing through service repays, for me, the ability to work, throughout my career, on the problems that I still find exciting.

▶ MS-Th-E-19-2
Build International Cooperation Networks
Xu, Yan — Univ. of Sci. & Tech. of China

Abstract: In this talk, I will talk about my experience on building international cooperation networks with many mathematicians from different countries.

▶ MS-Th-E-19-3
Applying in the UK and Surroundings
Ryan, Jennifer — Univ. of East Anglia

Abstract: This portion of the panel will present information regarding the differences in the application and interview process for jobs in the US and the UK.

▶ MS-Th-E-19-4
Recent Advances on Imaging Sciences
Zhang, Xiaoqun — Shanghai Jiao Tong Univ.

Abstract: In this short talk, I will discuss some recent advances on imaging sciences from my prospective. I will also share my personal experience of development of an academic career in China and discuss challenges and s-trategies.

▶ MS-Th-E-19-5
Communication and Supporting Networks
Li, Fengyan — Rensselaer Polytechnic Inst.

Abstract: I would like to share some aspects from my own academic experiences, such as holding positive attitudes, the importance of communication and building supporting networks.

MS-Th-E-20 16:00–18:00 210B
Computational Inverse Problems - Part II of IV

For Part 1, see MS-Th-D-20
For Part 3, see MS-Fr-D-20
For Part 4, see MS-Fr-E-20

Organizer: Jin, Bangti — Univ. College London
Organizer: Lu, Xiliang — Wuhan Univ.

Abstract: Inverse problems arise in a wide variety of applications, e.g., medical imaging, tomography, anomalous diffusion and compressed sensing. Their efficient and stable numerical solution is however very challenging due to the ill-posed nature of inverse problems. There have been significant progress in recent years, in novel application, new mathematical techniques and efficient optimization algorithms. In this mini-symposium, we aim to present and discuss recent advances in the area.

▶ MS-Th-E-20-1 16:00–16:30
Inverse Transport Problems with Internal Data and Applications
Ren, Kui — Univ. of Texas at Austin

Abstract: We consider here some inverse coefficient problems for the transport equation with multiple internal data sets. Such problems find applications in recent hybrid imaging modalities such as (fluorescence) photoacoustic tomography. We will discuss some theoretical results on the uniqueness and stability of the inverse problems and propose some efficient reconstruction strategies which we demonstrate with numerical simulations.

▶ MS-Th-E-20-2 16:30–17:00
Recovery by A Single Far-field Measurements
Liu, Hongyu — Hong Kong Baptist Unversity

Abstract: In this talk, the speaker will present several inverse scattering schemes of recovering inhomogeneous scatterers by a single acoustic or electromagnetic far-field measurement. The proposed schemes work for very general and practical scenarios. They are classified according to whether the frequency of the detecting plane wave is from the low-frequency, resonant-frequency, or high-frequency regimes.

▶ MS-Th-E-20-3 17:00–17:30
Case Studies for Two Classical Inverse Problems for Fractional Derivatives.
Rundell, William — Texas A&M Univ.
Jin, Bangti — Univ. College London

Abstract: Two classical inverse problems that exhibit extreme ill-conditioning are the backwards heat problem and the sideways heat problem. This talk looks at these when the heat operator is changed to one involving fractional derivatives. In both cases one obtains results quite counter to the classical situation.

▶ MS-Th-E-20-4 17:30–18:00
Cine Cone Beam CT Reconstruction Using Low-rank Matrix Factorization
Zhao, Hongkai — UC Irvine

Abstract: Respiration-correlated CBCT, commonly called 4DCBCT, provide respiratory phase-resolved CBCT images. In many clinical applications, it is more preferable to reconstruct true 4DCBCT with the 4th dimension being time, i.e., each CBCT image is reconstructed based on the corresponding instantaneous projection. We propose in this work a novel algorithm for the reconstruction of this truly time-resolved CBCT, called cine-CBCT, by effectively utilizing the underlying temporal coherence, such as periodicity or repetition, in those cine-CBCT images.

MS-Th-E-21 16:00–18:00 309B
Minisymposium on discontinuous Galerkin method: recent development and applications - Part VII of VIII

For Part 1, see MS-Tu-D-21
For Part 2, see MS-Tu-E-21
For Part 3, see MS-We-D-21
For Part 4, see MS-We-E-21
For Part 5, see MS-Th-BC-21
For Part 6, see MS-Th-D-21
For Part 8, see MS-Fr-D-21

Organizer: Xu, Yan — Univ. of Sci. & Tech. of China
Organizer: Shu, Chi-Wang — Brown Univ.

Abstract: Over the last few years, discontinuous Galerkin (DG) methods have found their way into the main stream of computational sciences and are now being successfully applied in almost all areas of natural sciences and engineering. The aim of this minisymposium is to present the most recent developments in the design and theoretical analysis of DG methods, and to discuss relevant issues related to the practical implementation and applications of these methods. Topics include: theoretical aspects and numerical analysis of discontinuous Galerkin methods, non-linear problems, and applications. Particular emphasis will be given to applications coming from fluid dynamics, solid mechanics and kinetic theory.

▶ MS-Th-E-21-1 16:00–16:30
A Simple High Order Accurate DG Scheme for Curved Boundaries
Zhang, Xiangxiong — Purdue Univ.

Abstract: When curved boundaries are present, in general schemes defined on a conforming mesh should be used towards high order accuracy. For a 2D problem, given a straight-sided triangular geometry-fitting mesh, DG scheme using polynomials of high degrees will be only second order accurate. We discuss a simple modification to DG schemes defined on straight-sided triangles to recover the high order accuracy, as an alternative to the full curvilinear DG method.

▶ MS-Th-E-21-2 16:30–17:00
High Order Finite Element Method for Scalar Conservation Laws: the Impact of Boundary Approximation.
Tokareva, Svetlana — Univ. of Zurich

Abstract: We generalize the technique for boundary treatment for finite-difference SBP-SAT schemes to finite element approximations of the scalar conservation laws on two-dimensional unstructured triangular meshes. In the generalized FEM-SBP-SAT approach the boundary and/or interface conditions are imposed weakly using the high order finite element representation of the solution. We show that the FEM-SBP-SAT boundary conditions ensure the stability of high order Galerkin FEM approximations even without additional artificial dissipation terms.

▶ MS-Th-E-21-3 17:00–17:30
A Fully Discrete Stable Discontinuous Galerkin Method for the Thin Film Epitaxy Problem without Slope Selection
Xia, Yinhua — Univ. of Sci. & Tech. of China

Abstract: We present an energy stable fully discrete discontinuous Galekin (DG) finite element method for the thin film epitaxy problem. Based on the method of lines, we construct and prove the energy stability of the spatial semi-discrete DG scheme firstly. The energy stability of the fully discrete convex splitting DG scheme is also proved. To improve the temporal accuracy, spectral deferred correction (SDC) method is adapted to achieve the high order accuracy in space and time.

▶ MS-Th-E-21-4 17:30–18:00
Efficient High Order Semi-implicit Time Discretization and Local Discontinuous Galerkin Methods for Highly Nonlinear PDEs
Guo, Ruihan — Institut Camille Jordan, Universite Claude Bernard, Lyon I
Xu, Yan — Univ. of Sci. & Tech. of China

Abstract: In this paper, we devote to develop a high order semi-implicit time discretization method for highly nonlinear PDEs. These PDEs are highly nonlinear, fully implicit method will incredibly increase the difficulty of implementa-

tion. In particular, we can not well separate the stiff and non-stiff components for these problems, which makes the traditional implicit-explicit methods nearly meaningless. We couple the semi-implicit method with LDG method to obtain high order accuracy both in space and time.

MS-Th-E-22 16:00–18:00 206A
Recent development and applications of weighted essential non-oscillatory methods - Part III of V

For Part 1, see MS-Th-BC-22
For Part 2, see MS-Th-D-22
For Part 4, see MS-Fr-D-22
For Part 5, see MS-Fr-E-22

Organizer: Qiu, Jianxian Xiamen Univ.
Organizer: Shu, Chi-Wang Brown Univ.

Abstract: The spectrum covered by the minisymposium ranges from recent development, analysis, implementation and applications, for the weighted essential non-oscillatory (WENO) methods. The WENO methods provide a practical effective framework to solve out many nonlinear wave-dominated problems with discontinuities or sharp gradient regions, which play an important role arising in many applications of computational fluid dynamics, computational astrophysics, computational plasma physics, semiconductor device simulations, among others. Devising robust, accurate and efficient WENO methods for solving these problems is of considerable importance and, as expected, has attracted the interest of many researchers and practitioners. This minisymposium serves as a good forum for researchers to exchange ideas and to promote this active and important research direction.

▶ MS-Th-E-22-1 16:00–16:30
Multidimensional, Self-similar, strongly-Interacting, Consistent (MuSIC) Riemann Solvers – Applications to Divergence-Free MHD and ALE Schemes
Balsara, Dinshaw Univ. of Notre Dame

Abstract: The majority of Riemann solvers are still one-dimensional. The present talk describes the design of multidimensional Riemann solvers and their applicability to higher order schemes. Such multidimensional Riemann solvers act at the vertices of the mesh, where the multidimensional flow structure becomes visible to the Riemann solver. At any vertex, all the adjacent one-dimensional Riemann problems interact to form a strongly interacting state. The strongly interacting state evolves self-similarly and we find its structure.

▶ MS-Th-E-22-2 16:30–17:00
An Eulerian-Lagrangian WENO Scheme for Nonlinear Conservation Laws
Huang, Chieh-Sen National Sun Yat-sen Univ.

Abstract: We develop a formally high order Eulerian-Lagrangian WENO finite volume scheme for nonlinear scalar conservation laws that combines ideas of Lagrangian traceline methods with WENO reconstructions. The particles within a grid element are transported in the manner of a standard Eulerian-Lagrangian (or semi-Lagrangian) scheme using a fixed velocity v. A flux correction computation accounts for particles that cross the v-traceline during the time step. If v=0, the scheme reduces to an almost standard WENO5 scheme.

▶ MS-Th-E-22-3 17:00–17:30
High Order Multi-dimensional Semi-Lagrangian Finite Difference WENO Approaches for Incompressible Euler Equations
Xiong, Tao Univ. of Houston

Abstract: Many existing grid-based semi-Lagrangian approach are based on one-dimensional splitting, which is subject to splitting errors. We will propose a multi-dimensional strategy of tracing characteristics without splitting. It is high order in time via a prediction-correction approach. WENO interpolation is then used to recover function values with accurately located foot of characteristics between grid points. The algorithm does not have time step restrictions. The application to incompressible Euler equations will demonstrate its good performance.

▶ MS-Th-E-22-4 17:30–18:00
A Direct Arbitrary-Lagrangian-Eulerian ADER-WENO Finite Volume Scheme on Unstructured Tetrahedral Meshes for Conservative and Nonconservative Hyperbolic Systems in 3D
Boscheri, Walter Univ. of Trento

Abstract: We present a new family of high order accurate Arbitrary-Lagrangian-Eulerian (ALE) one-step ADER-WENO finite volume schemes for the solution of nonlinear systems of conservative and non-conservative hyperbolic partial differential equations with stiff source terms on moving tetrahedral meshes in three space dimensions. We consider the 3D Euler equations of compressible gas dynamics, the equations of classical ideal magnetohydrodynamics (MHD) as well as the non-conservative seven-equation Baer-Nunziato model with stiff relaxation source terms.

MS-Th-E-23 16:00–18:00 208A
Computational Methods of PDE-based Eigenvalue Problems and Applications in Nanostructure Simulations - Part II of IV

For Part 1, see MS-Th-D-23
For Part 3, see MS-Fr-D-23
For Part 4, see MS-Fr-E-23

Organizer: Bai, Zhaojun Univ. of California, Davis
Organizer: Yang, Chao Lawrence Berkeley National Laboratory
Organizer: Zhou, Aihui Acad. of Mathematics & Sys. Sci., Chinese Acad. of Sci.

Abstract: PDE based eigenvalue problems arise from electronic structure calculations, band structure calculations in photonic crystals and dynamics of electromagnetic fields. This minisymposium brings together researchers working on PDE-based eigenvalue problems from areas of mathematical modeling and analysis, numerical analysis, high-performance computing and applications. This minisymposium features the latest progress on developing adaptive discretizations, stable nonlinear iterations and fast algebraic solvers, code designing and high performance computing on modern computer systems.

▶ MS-Th-E-23-1 16:00–16:30
A Tucker-tensor Approach for Kohn-Sham Density Functional Theory Calculations.
Motamarri, Phani Univ. of Michigan Ann Arbor
Gavini, Vikram Univ. of Michigan

Abstract: In this talk, we describe a systematic way of computing a globally-adapted Tucker-type basis for solving the Kohn-Sham DFT eigenvalue problem, by using a separable approximation of the Kohn-Sham Hamiltonian. The rank of the Tucker representation and the computational complexity of the resulting self-consistent DFT calculations using these Tucker basis are examined on representative benchmark examples involving metallic and insulating systems.

▶ MS-Th-E-23-2 16:30–17:00
A Mixed FEM for the Quad-curl Eigenvalue Problem
Sun, Jiguang Michigan Technological Univ.

Abstract: The quad-curl problem arises in the study of the electromagnetic interior transmission problem and magnetohydrodynamics (MHD). In this paper, we study the quad-curl eigenvalue problem and propose a mixed method using edge elements. Assuming stringent regularity of the solution of the quad-curl source problem, we prove the convergence and show that the divergence-free condition can be bypassed.

▶ MS-Th-E-23-3 17:00–17:30
A Posteriori Error Estimates for Discontinuous Galerkin Methods Using Non-polynomial Basis Functions
Lin, Lin Univ. of California at Berkeley

Abstract: We present the first systematic work for deriving a posteriori error estimates for general non-polynomial basis functions in an interior penalty discontinuous Galerkin (DG) formulation. The main merit of our residual type upper and lower bound error estimates is that the method is almost parameter-free, in the sense that all but one solution-dependent constants are explicitly computable. We develop an efficient numerical procedure to compute the error estimators. (Joint work with Benjamin Stamm)

▶ MS-Th-E-23-4 17:30–18:00
Linear Response Eigenvalue Problem Solved by Extended Locally Optimal Preconditioned Conjugate Gradient Methods
Li, Ren-Cang Univ. of Texas at Arlington

Abstract: A deflation technique is a way to remove already known eigenvalues/eigenpairs from possibly being computed again. It is critical for any efficient eigensolver. In this talk, we will investigate a couple of deflation techniques for the linear response eigenvalue problem. We will also discuss an extended locally optimal preconditioned conjugate gradient method and present numerical examples to demonstrate the efficiency of both the deflation techniques and the conjugate gradient type methods.

MS-Th-E-24 16:00–18:00 211
Computational Electromagnetism and Its Engineering Applications - Part II of IV
For Part 1, see MS-Th-D-24
For Part 3, see MS-Fr-D-24
For Part 4, see MS-Fr-E-24

Organizer: Duan, Huoyuan Collaborative Innovation Centre of Mathematics, School of Mathematics & Statistics, Wuhan Univ., Wuhan 430072, China
Organizer: Zheng, Weiying Chinese Acad. of Sci.

Abstract: In recent years, there arises a surge of numerical studies for electromagnetic problems in complex engineering systems, such as large power transformers, electrical machinery, magnetic fusion, etc. The mathematical models turn out to be nonlinear, multiscale, strongly singular, and coupled with multiple physical fields. It brings new challenges to researchers from both mathematical and engineering communities in developing practical mathematical models and effective and efficient numerical methods and solvers. This mini-symposium seeks to bring together researchers in both computational mathematics and electromagnetic engineering that involve the mathematical modeling, analysis, computation, and experimental validation for electromagnetic problems. The main theme will be focused on new efficient numerical methods and fast solvers for Maxwell's equations and magnetohydrodynamic equations and will address their extensive applications to engineering problems. It will promote exchange of ideas and recent developments on mathematical modeling, numerical discretization, solvers and engineering practices of computational electromagnetism.

▶MS-Th-E-24-1 16:00–16:30
Gyrokinetic Simulation of Microturbulence in Tokamaks
Xiao, Yong IFTS, Zhejiang Univ.

Abstract: The newly-developed capabilities enable the gyrokinetic code GTC to simulate the turbulent transport for real tokamak plasma shape and profiles. Linear and nonlinear simulations are carried out with the new capabilities in GTC for recent EAST and HL-2A tokamak experiments. We found that in the pedestal region with strong electron temperature gradient, the unstable waves propagate in the electron diamagnetic direction, showing a trapped electron mode (TEM) feature.

▶MS-Th-E-24-2 16:30–17:00
Parallel PIC Simulation Based on Fast Electromagnetic Field Solver
Cui, Tao ICMSEC, AMSS, CAS
Zheng, Weiying Chinese Acad. of Sci.
Lin, Deng The Inst. of Computational Mathematics & Scientific/Engineering Computing

Abstract: In this talk, a parallel symplectic PIC program for solving non-relativistic Vlasov-Maxwell system on unstructured grids for realistic applications will be introduced. The implicit scheme is used in our code. We solve Maxwell equations on tetrahedral mesh by finite element method. An efficient and scalable parallel algebraic solver is used for solving the discrete system. Numerical results will be given to show that our method and parallel program is robust and scalable.

▶MS-Th-E-24-3 17:00–17:30
Seamless Integration of Global DtN Nonreflecting Boundary Conditions in Spectral Elements for Invisibility Cloak Simulations
Wang, Li-Lian Nanyang Technological Univ.
Yang, Zhiguo Nanyang Technological Univ.

Abstract: In this talk, we shall present efficient and accurate semi-analytic techniques for seamless integration of global Dirichlet-to-Neumann (DtN) boundary conditions with local spectral elements, and discuss the applications in invisibility cloak simulations. We introduce special transformation between curved elements and the reference element, which lead to seamless coupling of local elements with DtN boundary conditions only on spectral-element grids.

▶MS-Th-E-24-4 17:30–18:00
Adaptive Finite Element Method for Incompressible Magnetohydrodynamics
Mao, Shipeng LSEC, Inst. of Computational Mathematics, AMSS, Chinese Acad. of Sci.

Abstract: We consider a mixed finite element method for the numerical discretization of a stationary incompressible magnetohydrodynamics problem in three dimensions with its velocity field is discretized using H^1 conforming elements and the magnetic field is approximated by curl-conforming Nédélec elements. Under the assumption that the original model has a unique solution pair, we derive a posteriori error estimates of the incompressible magnetohydrodynamic (MHD) equations with a sharp upper bound. Using these a posteriori error estimates, we construct an adaptive algorithm for computing the solution of 3D magnetohydrodynamics. Numerical experiments are carried out to show the performance of the adaptive finite element method.

MS-Th-E-25 16:00–18:00 210A
Emerging PDEs: Analysis and Computation - Part II of IV
For Part 1, see MS-Th-D-25
For Part 3, see MS-Fr-D-25
For Part 4, see MS-Fr-E-25

Organizer: Chen, Zhiming AMSS, Chinese Acad. of Sci.
Organizer: Nochetto, Ricardo Univ. of Maryland
Organizer: Zhang, Chensong Acad. of mathematics & Sys. Sci.

Abstract: Novel models in science and engineering are governed by nonlinear integro-differential equations with increasing complexity which demand innovative techniques in both analysis and computation, such as adaptivity, fast methods and preconditioning, and structure preserving algorithms. Areas of special interest include complex fluids and new materials, electromagnetism and wave propagation, uncertainty quantification, and fractional PDEs, among others.
This minisymposium intends to gather about 16 world experts and young researchers in analysis and computation of PDE to discuss the most recent progress in this exciting field as well as future directions for research.

▶MS-Th-E-25-1 16:00–16:30
Analysis of Upwinded De Rham Sequences
Christiansen, Snorre Univ. of Oslo

Abstract: The author has recently introduced a method to modify the shape functions in mixed finite element methods, to treat vanishing viscosity problems such as those that appear in fluid mechanics, in a Petrov Galerkin setting. The method retains some of the good properties of Raviart-Thomas-Nedelec elements, such as the existence of commuting projections and is related to exponential fitting. The talk will present our latest results on the stability of the method.

▶MS-Th-E-25-2 16:30–17:00
Blowup of 1D Models for 3D Incompressible Axisymmetric Euler Equations
Hou, Thomas Caltech

Abstract: Inspired by the recent computation of 3D Euler singularity, we investigate the self-similar singularity for a 1D model of the 3D axisymmetric Euler equations. This work is motivated by a particular singularity formation scenario observed in numerical computation. We prove the existence of a discrete family of self-similar profiles for this model and analyze their far-field properties. The self-similar profiles we find agree with direct simulation of the model and seem to have some stability.

▶MS-Th-E-25-3 17:00–17:30
Non-adaptive Quasi-optimal Points Selection for Least Squares Linear Regression
Shin, Yeonjong Univ. of Utah
Xiu, Dongbin Univ. of Utah

Abstract: We present a quasi-optimal sample set for ordinary least squares regression. The quasi-optimal set is designed in such a way that, for a given number of samples, it delivers the near optimal regression model. The quasi-optimal set is defined by maximization of a quantity measuring the mutual orthogonality and determinant of the model matrix. We present its theoretical justification, efficient implementation and demonstrate its efficiency via several numerical examples.

▶MS-Th-E-25-4 17:30–18:00
Space-time Adaptive Wavelet Methods for Evolutionary Problems
Stevenson, Rob Korteweg-de Vries (KdV) Inst. for Mathematics, Univ. of Amsterdam, P.O. Box 94248, 1090 GE Amsterdam, The Netherlands

Abstract: Adaptive wavelet methods solve (semi-) linear operator equations at optimal rates. With time evolutionary problems, the spaces can be equipped with products of temporal and spatial wavelet bases. Consequently, the evolutionary problem can be solved at a complexity of solving the stationary problem. In an adaptive wavelet scheme, the residual is used as an a posteriori error estimator. A reformulation as a system of first order enables a much more efficient approximate residual evaluation.

MS-Th-E-26 16:00–18:00 110
Disturbance rejection control: novel designs and performance analysis
Organizer: Xue, Wenchao Key Lab. of Sys. & control, Acad. of Mathematics & Sys. Sci., Chinese Acad. of Sci.

Abstract: This session concerns with the novel design methods and theoreti-

cal analysis on the disturbance rejection control. We will present the promising modifications and novel designs to achieve better performance despite the uncertainties in system. On the other hand, the rigorous justification of the approaches featured with disturbance estimating and compensating will be shown via performance analysis on both time-domain and frequency-domain. We will also discuss the open problems which will have huge impacts in developing the control theory of disturbance rejection.

▶MS-Th-E-26-1 16:00–16:30

Predictive Disturbance Rejection Control Solution for Engine Waste Heat Recovery System

Xie, Hui — Tianjin Univ.

Abstract: The energy management of engine waste heat recovery system is a complex problem characterized by great coupling, large inertia and uncertain delay. A commander-tracker energy management framework was proposed as the solution, in which a predictive disturbance rejection method was designed as a tracking controller to follow the power splitter's command gotten online from the top level. The system performance was achieved by the combination of the dynamic system model and a predictive controller.

▶MS-Th-E-26-2 16:30–17:00

Decentralized PID Controller Tuning Based on Desired Dynamic Equations

Li, Donghai — Tsinghua Univ.

Abstract: We show the ability of the desired-dynamic-equations (DDE) based decentralized PID controller tuning method with its application to the ALSTOM gasifier benchmark control problem. The DDE-based PID controller tuning method was deduced from a kind of nonlinear adaptive controller, which behaves good tracking performance and robustness by using an extended state observer and DDE to estimate and compensate the uncertainty and disturbance. Moreover, the tunable parameters of DDE-based PID controller have explicit physical meanings.

▶CP-Th-E-26-3 17:00–17:20

Extended State Observer Based Controller and Filter Designs for Nonlinear Uncertain Systems

Xue, Wenchao — Key Lab. of Sys. & control, Acad. of Mathematics & Sys. Sci., Chinese Acad. of Sci.
Bai, Wenyan — Chinese Acad. of Sci.
Huang, Yi — Acad. of Mathematics & Sys. Sci., Chinese Acad. of Sci.
Fang, Haitao — Acad. of Mathematics & Sys. Sci., Chinese Acad. of Sci.

Abstract: The Extended State Observer (ESO), which is featured with timely estimating the "total disturbance" of system, has been proven to be powerful dealing with nonlinear uncertain systems. With the idea of ESO, we proposed the augmented Luenberger Observer which ensures the resulting control feedback design has better disturbance rejection. Also, we constructed the Extended State Filter and proven its stability for a general class of systems with nonlinear unknown dynamics, stochastic process and measurement noises.

▶CP-Th-E-26-4 17:20–17:40

On Tuning of Linear Active Disturbance Rejection Control

Sun, Mingwei — Nankai Univ.
Zengqiang, Chen — Nankai Univ.

Abstract: Several tuning guidelines are provided for Linear Active Disturbance Rejection Control (LADRC). At first, the tuning rules are obtained to avoid overshoot for typical industrial processes. Secondly, the difficulty or impossibility of a general stability analysis is revealed. Finally the effects of the observer bandwidth on the closed-loop sensitivity to the input time-delay perturbation are thoroughly investigated from three aspects respectively to illustrate the inherent tradeoff between robust stability and dynamic performance when using LADRC.

MS-Th-E-27 16:00–18:00 407

Decoupling methods for multi-physics and multi-scale problems - Part VI of VIII

For Part 1, see MS-Tu-E-27
For Part 2, see MS-We-D-27
For Part 3, see MS-We-E-27
For Part 4, see MS-Th-BC-27
For Part 5, see MS-Th-D-27
For Part 7, see MS-Fr-D-27
For Part 8, see MS-Fr-E-27

Organizer: He, Xiaoming — Missouri Univ. of Sci. & Tech.
Organizer: Xu, Xuejun — Inst. of Computational Mathematics, AMSS, CAS

Abstract: The inherent multi-physics and multi-scale features of many real world problems accentuate the importance to develop efficient and stable numerical methods for the relevant PDEs, especially the decoupling methods. Although great efforts have been made for solving these problems, many practical and analytical challenges remain to be solved. This mini-symposium intends to create a forum for junior and senior researchers from different fields to discuss recent advances on the decoupling methods for multi-physics and multi-scale problems with their applications.

▶MS-Th-E-27-1 16:00–16:30

Mixed Finite Element Method for the Stefan Problem with Surface Tension

Walker, Shawn — Louisiana State Univ.
Davis, Christopher — Tennessee Technological Univ.

Abstract: A mixed formulation is proposed for the Stefan problem with surface tension (Gibbs-Thomson law). The method uses a mixed form of the heat equation in the solid and liquid domains, and imposes the interface motion law (on the solid-liquid interface) as a constraint. Well-posedness of the time semi-discrete and fully discrete (finite element) formulations is proved in 3-D, and an a priori bound, conservation law, and error estimates. Simulations are presented in 2-D.

▶MS-Th-E-27-2 16:30–17:00

A CVOD Based Low-dimensional Approximation to Nonlinear Stochastic Partial Differential Equations

Ming, Ju — Beijing Computational Sci. Research Centre

Abstract: Over past decade, reduced-order models have been found increased use to greatly reduce the computational cost in the areas such as flow control and optimization. In this lecture, we will present an effective stochastic reduced-order modeling method that combines the advantages of proper orthogonal decomposition and centroidal Voronoi tessellations. The optimality of such hybrid method for model reduction is discussed and numerical tests are performed to validate our results.

▶MS-Th-E-27-3 17:00–17:30

Recent Progress in Hybrid Discontinuous Galerkin Methods

Park, Eun-Jae — Yonsei Univ.
Shin, Dong-wook — Yonsei Univ.
Jeon, Youngmok — Ajou Univ.

Abstract: Hybrid discontinuous Galerkin methods are studied for second-order elliptic equations. Our approach is composed of generating PDE-adapted local basis and solving a global matrix system arising from a flux continuity equation. Our method can be viewed as a hybridizable discontinuous Galerkin method using a Bauman-Oden type local solver. A priori and a posteriori error estimates are derived and applications to the Stokes equations and Convection-Diffusion equations are discussed. Several numerical results are presented.

▶MS-Th-E-27-4 17:30–18:00

Some Recent Advances on the Theory of High Order Finite Volume Methods

Zou, Qingsong — Sun Yat-sen Univ.

Abstract: In this talk, we will present some of our recent results on the theory of high order finite volume methods. We will first explain how to construct these schemes. Then we will prove that these schemes have the stability (inf-sup condition) and optimal convergence rates under H1 norm. The superconvergence and L2 norm error estimate will also be discuused in the talk.

MS-Th-E-28 16:00–18:00 109

Mathematical Theory of System and Control II: analysis and control of stochastic systems

Organizer: Tang, Shanjian — Fudan Univ.
Organizer: Zhang, Xu — Sichuan Univ.

Abstract: The minisymposium concerns analysis and control of stochastic systems.

▶MS-Th-E-28-1 16:00–16:30

Weak Solutions of Mean-field Stochastic Differential Equations and Application to Zero-sum Stochastic Differential Games
Li, Juan — Shandong Univ., Weihai

Abstract: In this paper we discuss the concept of weak solution for a new type of mean-field stochastic differential equations, which drift coefficient depends on the full past of the state but also on the law of the solution. With the help of the Girsanov Theorem we prove the existence and the uniqueness in law of the weak solution, when the drift coefficient is a bounded and only measurable function of the solution process and a continuous one of the law of the solution process. In the second part of the work we apply this concept of weak solution to zero-sum stochastic differential games of mean-field type. We obtain for them the existence of generalized saddle point controls under Isaacs' condition and we discuss conditions under which we have saddle point controls.

▶MS-Th-E-28-2 16:30–17:00
Short Selling and Equilibrium Price Uncertainty
Ma, Chenghu — Fuda Univ.

Abstract: This paper studies the price and trading impact of margin rules for short selling within the context of Markowitz (1952). It is shown that heterogeneity in margins may have price effect and lead to price indeterminacy, particularly in the presence of derivative trading. Existence of equilibrium, along with a characterization theorem on the equilibrium outcome, is proved when investors have heterogeneous beliefs and when margins for short selling may vary among agents and securities.

▶MS-Th-E-28-3 17:00–17:30
Learning How to Consume Effectively
Koo, Hyeng Keun — Ajou Univ.

Abstract: This paper proposes a utility model in which agents require effort to learn how to consume effectively. In this model, there is an ideal utility function of consumption that requires skill to achieve. At each time, there is a range of consumption levels for which the agent can consume at the full potential described by this ideal utility function, and consuming outside this range generates less than the potential utility. We derive an optimal policy.

▶MS-Th-E-28-4 17:30–18:00
Dual Representation of Value Function and Applications
Zheng, Harry — imperial college

Abstract: We discuss a standard utility maximisation problem in Black-Scholes world with general utility functions. We show there is a classical solution to HJB equation with dual control method and give a representations of value function, optimal wealth process, optimal control in terms of those of dual problem. We apply results to solve wealth maximisation, turnpike property, and efficient frontier of utility and CVaR problems. (based on papers with Bian, Baojun and Bernard, Carole.)

MS-Th-E-29 16:00–18:00 305
Numerical Homogenization and Multiscale Model Reduction Methods - Part III of V

For Part 1, see MS-Th-BC-29
For Part 2, see MS-Th-D-29
For Part 4, see MS-Fr-D-29
For Part 5, see MS-Fr-E-29

Organizer: Zhang, Lei — Shanghai Jiao Tong Univ.
Organizer: Peterseim, Daniel — Universität Bonn
Organizer: Jiang, Lijian — Hunan Univ.
Organizer: Chung, Eric — The Chinese Univ. of Hong Kong

Abstract: Problems that transcend a variety of strongly coupled time and length scales are ubiquitous in modern science and engineering such as physics, biology, and materials. Those multiscale problems pose major mathematical challenges in terms of analysis, modeling and simulation. At the same time, advances in the development of multiscale mathematical methods coupled with continually increasing computing power have provided scientists with the unprecedented opportunity to study complex behavior and model systems over a wide range of scales.
This minisymposium is aimed at presenting the state-of-the-art in multiscale modeling, simulation and analysis for the applications in science and engineering. It will focus on the developments and challenges in numerical multiscale methods and multiscale model reduction methods. The lectures will cover the following subjects: - Numerical homogenization methods, e.g. Generalized FEM, MsFEM, FEM-HMM, DG methods, Partition of Unity methods, multiscale domain decomposition etc. - Multiscale model reduction methods for stochastic systems, such as stochastic PDEs and random materials. - Multiscale methods for problems arising in composite materials and heterogeneous porous media. - Multiscale methods for eigenvalue problems, high frequency waves, and multiscale hyperbolic PDEs. - Multiscale modeling in various applications such as reservoir performance prediction, bio-motility, chemical vapor infiltration, etc.

▶MS-Th-E-29-1 16:00–16:30
Discontinuous Galerkin Methods for Elliptic Multiscale Problems
Georgoulis, Emmanuil — Univ. of Leicester, UK / National Technical Univ. of Athens, Greece

Abstract: We shall review some recent results on the use of discontinuous Galerkin methods for elliptic multiscale problems. The first part of the talk will be concerned with a-priori error analysis for a multiscale discontinuous Galerkin method for elliptic problems with multiscale diffusion coefficients, while the second part of the talk will be concerned with a stochastic collocation discontinuous Galerkin method for elliptic multiscale problems involving randomness.

▶MS-Th-E-29-2 16:30–17:00
High Dimensional Finite Elements for Multiscale Wave Equations
Hoang, Viet Ha — Nanyang Technological Univ.

Abstract: For locally periodic multiscale wave equations, we solve the high dimensional multiscale homogenized problem obtained from multiscale convergence that contains all the microscopic and macroscopic information. We consider the sparse tensor product finite element method which achieves an accuracy essentially equal to that for the full tensor product, but only requires an essentially equal number of degrees of freedom as for solving a one macrosocopic scale wave equation. (Joint work with Bingxing Xia, NTU, Singapore).

▶MS-Th-E-29-3 17:00–17:30
Intrinsic Sparse Mode Decomposition of High Dimensional Random Fields with Application to Stochastic Elliptic PDEs
Li, Qin — Caltech

Abstract: Inspired by the recent developments in data sciences, we introduce an intrinsic sparse mode decomposition method for high dimensional random fields. This sparse representation of the random field allows us to break a high dimensional stochastic field into many spatially localized modes with low stochastic dimension. Such decomposition enables us to break the curse of dimensionality in our local solvers. We apply this technique to solve stochastic elliptic PDEs with high dimensional stochastic coefficients.

▶MS-Th-E-29-4 17:30–18:00
Generalized Multiscale Finite Element Methods for Interface Problems
Chu, Chia-Chieh — National Tsing Hua Univ.

Abstract: In this talk, I will introduce generalized multiscale finite element methods. The method uses local solutions to generate an efficient and accurate approximation. Reduction of the basis functions is done by spectral decomposition. This method can be generalized to interface problems that often occur in two-phase flow simulation. Convergence analysis is presented and several numerical examples confirm the theoretical results.

MS-Th-E-30 16:00–18:00 VIP2-2
Numerical approaches in optimization with PDE constraints: recent progress and future challenges - Part V of VII

For Part 1, see MS-We-D-30
For Part 2, see MS-We-E-30
For Part 3, see MS-Th-BC-30
For Part 4, see MS-Th-D-30
For Part 6, see MS-Fr-D-30
For Part 7, see MS-Fr-E-30

Organizer: Yan, Ningning — Chinese Acad. of Sci.
Organizer: Hinze, Michael — Universität Hamburg

Abstract: The numerical treatment of optimization problems with PDE constraints is a very active field of mathematical research with great importance for many practical applications. To achieve further progress in this field of research, the development of tailored discretization techniques, adaptive approaches, and model order reduction methods has to be intertwined with the design of structure exploiting optimization algorithms in function space.
This minisymposium covers mathematical research in PDE constrained optimization ranging from numerical analysis and adaptive concepts over algorithm design to the tailored treatment of optimization applications with PDE constraints. It thereby forms a platform and fair for the exchange of ideas among young researchers and leading experts in the field, and for fostering and extending international collaborations between research groups in the field.

▶MS-Th-E-30-1 16:00–16:30
Optimal Control of Elastic Contact Problems

Meyer, Christian TU Dortmund

Abstract: This talk is concerned with an optimal control problem governed by a small-strain model for elastic contact problems without friction. The model involves an elliptic variational inequality (VI) of the first kind. We show that the control-to-state map is directionally differentiable and derive strong stationarity conditions cased on this result. Moreover, the directional derivative is used for the design of an efficient trust-region method.

▶MS-Th-E-30-2 16:30–17:00

Optimal Control in the Coefficients for Nonlinear Elliptic Partial Differential Equations

Leugering, Guenter Univ. Erlangen-Nuremberg

Abstract: We consider nonlinear partial differential equations of unisotropic p-Laplace type, where the unisotropy, represented by a weight funtion in front of the leading differential opertar, is considered as a contrlol. We prove existence of optimal controls and provide optimality conditions, first for a family of regularized problems and then for the original problem by passing to the limit in the regularization parameters. This work is joint work with P. Kogut and E. Casas.

▶MS-Th-E-30-3 17:00–17:30

A LEAST-SQUARES MIXED ELEMENT APPROXIMATION OF ELLIPTIC OPTIMAL CONTROL PROBLEMS

Rui, Hongxing Department of Mathematics, Shandong Univ.
Fu, Hongfei China Univ. of Petroleum

Abstract: A constrained distributed optimal control problem governed by a first-order elliptic system is considered. Least-squares mixed element methods, which are not subject to the LBB consistency condition, are used for the elliptic system. Continuous and discrete optimality systems are derived with. Both the discrete state equation and adjoint state equation yield symmetric and positive definite systems. Optimal a priori error estimates are obtained and a numerical example is carried out.

▶MS-Th-E-30-4 17:30–18:00

On the Optimal Control of Wave-type Solutions in Some Reaction-diffusion Equations

Ryll, Christopher TU Berlin

Abstract: We investigate optimal control problems for some reaction diffusion equations, where patterns of traveling wave fronts, impulses, spiral waves, and other phenomena appear. In particular, we discuss the consideration of pointwise state constraints. We derive first-order necessary optimality conditions for the associated control problem and present various numerical examples.

MS-Th-E-31 16:00–18:00 405

Advances on Mixed Finite Element Methods for Linear Elasticity - Part II of IV

For Part 1, see MS-Th-D-31
For Part 3, see MS-Fr-D-31
For Part 4, see MS-Fr-E-31

Organizer: Hu, Jun Peking Univ.
Organizer: Zhang, Shangyou Univ. of Delaware

Abstract: The elasticity equations are solved in many scientific and engineering problems where the stress is often more important than the displacement. In this sense, the classical Hellinger–Reissner mixed formulation of the elasticity equations, where the stress tensor is sought in a symmetric H-div space and the displacement in an L2 space, is a natural and important variational formulation for this problem. The approximation of displacement can be taken in the space of discontinuous piecewise polynomials of some degree－but the approximation of the symmetric stress tensor is a long-standing, challenging, and surprisingly hard problem. As a matter of fact, “four decades of searching for mixed finite elements for elasticity beginning in the 1960s did not yield any stable elements with polynomial shape functions” [D. N. Arnold, Proceedings of the International Congress of Mathematicians, Vol. I: Plenary Lectures and Ceremonies (2002), 137-157].
This minisymposium will gather about 16 world experts and young researchers to discuss the most recent advances in this challenging field as well as future directions for research.

▶MS-Th-E-31-1 16:00–16:30

A Survey of Mixed Simplicial Finite Elements for Elasticity with Weak Symmetry

Falk, Richard Rutgers Univ.

Abstract: Because of the difficulty of constructing mixed finite elements for linear elasticity based on the Hellinger-Reissner mixed variational principle, modifications of this principle were introduced in which the symmetry of the stress tensor was enforced only weakly by means of a Lagrange multiplier. We survey the development of mixed simplicial finite elements based on this idea, highlighting the new ideas which led to advances in this approach.

▶MS-Th-E-31-2 16:30–17:00

Robust Preconditioners for Poroelasticity

Winther, Ragnar Univ. of Oslo

Abstract: We will discuss the construction of robust preconditioners for finite element discretizations of Biot’s consolidation model in poroelasticity. This model describes the coupling of the deformation of an elastic porous medium and the viscous flow inside. We will discuss several possible finite element discretizations of the Biot model, and how to design preconditioners for the discrete systems which are robust with respect to the discretization paramenters and various physical parameters.

▶MS-Th-E-31-3 17:00–17:30

Mixed Finite Elements for Elasticity on Quadrilateral Meshes

Awanou, Gerard Univ. of Illinois at Chicago

Abstract: We present stable mixed finite elements for planar linear elasticity on general quadrilateral meshes. The symmetry of the stress tensor is imposed weakly and so there are three primary variables, the stress tensor, the displacement vector field, and the scalar rotation. We develop and analyze a stable family of methods as well a simple first order element. Joint work with D. Arnold and W. Qiu.

▶MS-Th-E-31-4 17:30–18:00

Remarks on the Hypercircle Method

Stenberg, Rolf Aalto Univ.

Abstract: The classical hypercircle theorem states: Suppose that we have a statically and kinematically admissible stress fields. Then the distance in energy norm from the exact stress to the average of the statically and kinematically fields equals half the distance between these fields. We will discuss the case when the fields are not exactly admissible. We show that the errors introduced can be estimated with computable error constants and hence one obtains an asymptotically exact estimator.

MS-Th-E-32 16:00–18:00 307A

Structured-mesh methods for interface problems. - Part VI of VIII

For Part 1, see MS-Tu-E-32
For Part 2, see MS-We-D-32
For Part 3, see MS-We-E-32
For Part 4, see MS-Th-BC-32
For Part 5, see MS-Th-D-32
For Part 7, see MS-Fr-D-32
For Part 8, see MS-Fr-E-32

Organizer: Chen, Huanzhen College of Mathematical Sci. Shandong Normal Univ.
Organizer: He, Xiaoming Missouri Univ. of Sci. & Tech.
Organizer: KWAK, Do Young Korea Advanced Inst. of Sci. & Tech.
Organizer: Zhang, Xu Purdue Univ.

Abstract: In many real world applications it is more convenient or efficient to utilize structured meshes for solving different types of interface problems. Since the structured meshes may not fit the non-trivial interfaces, special methods need to be developed to deal with the difficulties arising from the interface problems in order to solve them on these meshes. Therefore, great efforts have been made for solving interface problems and tracing the moving interfaces based on structured meshes in the past decades. This mini-symposium intends to create a forum for researchers from different fields to discuss recent advances on the structured-mesh numerical methods for interface problems and their applications.

▶MS-Th-E-32-1 16:00–16:30

Level-set Variational Implicit Solvation Model of Biomolecules Interfaces

Wang, Zhongming Florida International Univ.

Abstract: The variational implicit-solvent model uses free-energy functional that couples both the nonpolar and polar contributions. Such a functional can be numerically relaxed by the level-set method to determine the stable equilibrium solute-solvent interfaces and the free energies. In nonpolar systems, the model and its simulation leads to often quantitatively correct results, such as capillary evaporation. With Coulomb-field approximation of electrostatics, the model reveals the coupling of polar and nonpolar interactions and dehydration of the interface.

▶MS-Th-E-32-2 16:30–17:00

Multilevel Monte Carlo Method for PDEs with Random Input under Hierarchical Meshes

Kim, Myoungnyoun National Inst. for Mathematical Sci.

Sim, Imbo National Inst. for Mathematical Sci.

Abstract: The order of convergence of the Monte Carlo method is 1/2 which means that we need quadruple samples to decrease the error in half in the numerical simulation. Multilevel Monte Carlo methods reach the same order of error by spending less computational time than the Monte Carlo method. To reduce the computational complexity further, we introduce a projected multilevel Monte Carlo method using hierarchical meshes. Numerical experiments validate our theoretical results.

▶ MS-Th-E-32-3 17:00–17:30

A Dynamic Interface Immersed-Finite-Element Particle-in-Cell Method for Modeling Plasma-Wall Interactions

Cao, Yong harbin Inst. of Tech.

Abstract: The evolution of wall surface is an unavoidable problem in all related engineering plasma applications. An improved immersed-finite-element PIC algorithm with dynamic interface for modeling plasma-wall interactions is proposed. The Huygens wavelet method, which shows the superiority to handle interface evolution problems in the literature, is incorporated into the IFE-PIC method to simulate the dynamic changes of interfaces. A numerical example is provided to demonstrate the features of this dynamic interface method.

▶ MS-Th-E-32-4 17:30–18:00

A Fast Numerical Method for Tempered Space-fractional Diffusion Equations of Variable Order

Wang, Hong Univ. of South Carolina

Abstract: Tempered, variable-order fractional partial differential equations provide very powerful alternatives to integer-order PDEs for modeling anomalous transport and long-range interactions. They model these heavy-tail behavior accurately while retaining finite high-order moments. Furthermore, they provide greater flexibility modeling challenging phenomenon instead of the current practice of tweaking free parameters that multiply pre-set integer-order operators. However, FPDEs involve complex and singular integral operators. Consequently, corresponding numerical methods generate dense stiffness matrices, for which direct solvers require $O(N^2)$ memory and $O(N^3)$ complexity for a problem of size N. We present a fast numerical method for tempered, variable-order space-fractional diffusion equations with optimal memory requirement and almost linear computational complexity.

MS-Th-E-33 16:00–18:00 406

Mathematical and computational methods for coupling local and nonlocal models - Part II of IV

For Part 1, see MS-Th-D-33
For Part 3, see MS-Fr-D-33
For Part 4, see MS-Fr-E-33

Organizer: D'Elia, Marta Sandia National Laboratories
Organizer: Seleson, Pablo Oak Ridge National Laboratory
Organizer: Bochev, Pavel Sandia Labs

Abstract: Nonlocal continuum and atomistic models are used in many scientific and engineering applications, where material dynamics depends on microstructure. The numerical solution of nonlocal models might be prohibitively expensive; therefore, concurrent multiscale methods have been proposed for efficient and accurate solutions of such systems. These methods employ nonlocal models in parts of the domain and use local, macroscopic, models elsewhere. A major challenge is to couple these models at interfaces or in overlapping regions. This minisymposium invites contributions on coupling local and nonlocal continuum models and concurrent multiscale methods for atomistic-to-continuum coupling. Related domain decomposition methods are also considered.

▶ MS-Th-E-33-1 16:00–16:30

Blended Atomistic-to-continuum Hybrid Methods for Modelling Crystalline Materials

Li, Xingjie Helen Brown Univ.

Abstract: The development of consistent and stable atomistic-to-continuum coupling models for multi-dimensional crystalline solids remains a challenge. In this talk, we consider two prototypical atomistic-to-continuum coupling methods of blending type: the energy-based and the force-based quasicontinuum methods, with a comprehensive error analysis that is valid in two and three dimensions, for finite many-body interactions (e.g., Embedded-Atom Method potential type), and in the presence of lattice defects (point defects and dislocations). Based on a precise choice of blending mechanism, the error estimates are considered in terms of degrees of freedom. The numerical experiments confirm the theoretical predictions, and demonstrate a superior accuracy of the force-based blending over energy-based blending schemes.

▶ MS-Th-E-33-2 16:30–17:00

Seamless Coupling of Local and Nonlocal Models

Tian, Xiaochuan Columbia Univ.
Tao, Yunzhe Pennsylvania State Univ.
Du, Qiang Columbia Univ.

Abstract: We present some analytical and computational studies of a nonlocal model with saptially varying horizon. We demonstrate how such a model can be combined with asymptotically compatible schemes to simulate coupled local and nonlocal models.

▶ MS-Th-E-33-3 17:00–17:30

How Does One Determine the Kernel Function in A Nonlocal Model? A Heat Conduction Example.

Li, Xiantao The Pennsylvania State Univ.

Abstract: How to determine the kernel function in a nonlocal model is a central issue from a modeling perspective. This talk demonstrates a first-principle approach, in the context of heat conduction, in which the traditional Fourier's Law is known to fail in nano-mechanical systems. Our derivation starts from a molecular-level models, incorporating the detailed interactions of the atoms. In additional to the statistical-mechanics derivation, we discuss numerical implementations of the nonlocal model.

▶ MS-Th-E-33-4 17:30–18:00

A Consistent Blending Scheme to Concurrently Couple Peridynamics and Classical Continuum Mechanics

Seleson, Pablo Oak Ridge National Laboratory

Abstract: Peridynamics is a nonlocal reformulation of classical continuum mechanics, suitable for material failure and damage simulation. Being nonlocal, peridynamic models are computationally more expensive than classical (local) models. This motivates the development of concurrent multiscale methods, for which peridynamics is applied in regions where discontinuities appear, whereas classical models are used elsewhere. We derive blending schemes to concurrently couple peridynamics and classical continuum mechanics, avoiding common artifacts present in this type of methods.

MS-Th-E-34 16:00–18:00 112

Modeling and Simulation of Complex Fluids and Biological Systems - Part II of IV

For Part 1, see MS-Th-D-34
For Part 3, see MS-Fr-D-34
For Part 4, see MS-Fr-E-34

Organizer: Zhang, Hui Beijing Normal Unversity
Organizer: Forest, M. Gregory Univ. of North Carolina at Chapel Hill
Organizer: Wang, Qi Univ. of South Carolina & Beijing Computational Sci. Research Center

Abstract: This mini symposium will bring together researchers in complex fluids and biological systems to exchange ideas and perspectives as well as to share their most recent findings. The goal is to integrate advances in mathematics (theory, modeling, data analytics, algorithms, simulations, high performance computing techniques) with new experimental data from complex fluids and biological systems, and targeted applications. The specific systems represented include single living cells, biofilms, active molecular fluids, and transport properties of biological fluids such as lung mucus.
We would like to invite you to give a talk on your current research at the proposed mini-symposium. The talks are scheduled to be 25 minutes each + 5 minutes for discussion.

▶ MS-Th-E-34-1 16:00–16:30

Hydrodynamic Modeling of Active Liquid Crystals

Cui, Zhenlu Fayetteville State Univ.

Abstract: Active liquid crystals are complex fluids composed of active units. Examples include bacterial suspensions, the cell cytoskeleton and even nonliving analogues such as vibrated granular rods. They are interesting from a more fundamental perspective as their dynamic phenomenons are both physically fascinating and potentially of great biological significance. In this talk, I will present a model for flowing active liquid crystals. Hydrodynamics, instabilities and rheology as well as effects of boundary conditions will be discussed.

▶ MS-Th-E-34-2 16:30–17:00

Compact Implicit Integration Factor Method for A Class of High Order Differential Equations

Liu, Xinfeng Univ. of South Carolina
Ju, Lili Univ. of South Carolina

Abstract: In this talk, we will present an efficient integration factor method for solving a family of semilinear fourth-order parabolic equations, in which the bi-Laplace operator is explicitly handled and the computational cost and stor-

age remain the same as to the classic integration factor methods for second-order problems. In particular, the proposed method can deal with not only stiff nonlinear reaction terms but also various types of homogeneous or inhomogeneous boundary conditions.

▶MS-Th-E-34-3 17:00–17:30

A General Continuum Model for Active Liquid Crystals.

Yang, Xiaogang Beijing Computational Sci. Research Center

Abstract: The characteristics of active liquid crystals is that they are composed of self-driven units, known as the active particles, and each particle is capable of converting the internal or external free energy, thus they can form self-assembled ordered states with respect to the orientation and self-motion. In this talk, I systemically derive a general continuum model for active liquid crystals using the general hydrodynamic theories, depending on the Onsager principle.

▶MS-Th-E-34-4 17:30–18:00

Some Energy Stable Schemes for Phase Field Model with Moving Contact Lines.

Yang, Xiaofeng Univ. of South Carolina

Abstract: we present some efficient energy stable schemes to solve a phase field model incorporating moving contact line. The model is a coupled system that consists of incompressible Navier – Stokes equations with a generalized Navier boundary condition and Cahn – Hilliard equation in conserved form. By some subtle explicit-implicit treatments, we obtain a linear coupled energy stable scheme for systems with dynamic contact line conditions and a linear decoupled energy stable scheme for systems with static contact

MS-Th-E-35 16:00–18:00 408

Analysis, Modeling, and Numerical Methods for High Frequency Waves - Part II of IV

For Part 1, see MS-Th-D-35
For Part 3, see MS-Fr-D-35
For Part 4, see MS-Fr-E-35

Organizer: YANG, XU Univ. of California, Santa Barbara
Organizer: YING, LEXING Stanford Univ.
Organizer: HUANG, ZHONGYI Tsinghua Univ.
Organizer: RUNBORG, OLOF Department of Mathematics, KTH

Abstract: The development of modern techniques has been able to provide accurate studies on the micro- and nano-scale physics. Under this small scale, the objects often appear as a form of waves, and present quantum properties. On the other hand, the observation is often made at macroscopic scale which is closely related to small-scale details, therefore it is necessary to consider problems at multiple scales. Propagation of high frequency waves is one such topic. The major challenge is that one usually needs to handle the disparity between the two length scales: the large domain size and the small wavelength. This means one has to work on a large computational domain that contains thousands to millions of wavelengths, and each of them needs to be resolved if direct numerical methods are applied. Therefore the total number of grid points is huge, which usually leads to unaffordable computational cost. This minisymposium will focus on high-frequency waves and their applications in quantum mechanics and seismology. Topics on analysis, modeling and numerical methods will be discussed.

▶MS-Th-E-35-1 16:00–16:30

A Two-grid Accelerated Sweeping Preconditioner for the Helmholtz Equation

Stolk, Chris Univ. of Amsterdam

Abstract: Helmholtz solvers based on sweeping preconditioners have relatively high per-iteration cost. We reduce this cost by using the sweeping preconditioner at the coarse level of a two-grid method, so that it is applied to an eight times smaller problem. A new two-grid method is developed for this purpose. The effectiveness of the method is shown using large 3-D examples.

▶MS-Th-E-35-2 16:30–17:00

Boundary Integral Equation Method for Wave Scattering from Large Number of Layers

Min Hyung, Cho Dartmouth College

Abstract: Modern electronic/optical devices rely on wave such as solar cells, antennae, and radar. For optimizing/characterizing these devices, we developed a robust and fast computational method based on boundary integral equations for Helmholtz equation in periodically patterned multilayered media. The new method uses near- and far-field decomposition to avoid using the quasi-periodic Green's function. The far-field contribution is compressed using Schur-complement. The new method solved the scattering from a 1000-layer with 300000 unknown in 2.5 minutes.

▶MS-Th-E-35-3 17:00–17:30

Fast Solver for High Frequency Scattering in the 3D Cavity

Lai, Jun New York Univ.

Abstract: In this talk, we consider the time harmonic scattering of a 3D axis-symmetric cavity. An integral approach is proposed to solve the full Maxwell's equation. We prove the integral equation is uniquely solvable for any positive wavenumber. In the numerical simulation, we make use of the axis-symmetric property by designing quadratures for the Fourier modes of the singular integral and solve the system by fast direct solver to obtain efficiency and accuracy.

▶MS-Th-E-35-4 17:30–18:00

Source Transfer Domain Decomposition Method for Time-Harmonic Elastic Wave Equation with Spectral Element Method

Xiang, Xueshuang Qian Xuesen Laboratory of Space Tech.
Chen, Zhiming AMSS, Chinese Acad. of Sci.

Abstract: We extend the source transfer domain decomposition method (STDDM) proposed by the author to solve time-harmonic elastic wave equation with spectral element method. Numerical examples are included to show that STDDM can be used as an efficient preconditioner in the preconditioned GMRES method for solving the problems with constant and heterogeneous wave numbers. The results indicate that it take a few number of iterations to make GMRES convergence when the pollution error is reduced .

MS-Th-E-36 16:00–18:00 409

Advances in MCMC and related sampling methods for large-scale inverse problems - Part II of IV

For Part 1, see MS-Th-D-36
For Part 3, see MS-Fr-D-36
For Part 4, see MS-Fr-E-36

Organizer: Bui-Thanh, Tan The Univ. of Texas at Austin
Organizer: Cui, Tiangang MIT
Organizer: Marzouk, Youssef Massachusetts Inst. of Tech.

Abstract: Inverse problems convert indirect measurements into useful characterizations of the parameters of a physical system. Parameters are typically related to indirect measurements by a system of partial differential equations (PDEs), which are complicated and expensive to evaluate. Available indirect data are often limited, noisy, and subject to natural variation, while the unknown parameters of interest are often high dimensional, or infinite dimensional in principle. Solution of the inverse problem, along with prediction and uncertainty assessment, can be cast in a Bayesian setting and thus naturally tackled with Markov chain Monte Carlo (MCMC) and other posterior sampling methods. However, designing scalable and efficient sampling methods for high dimensional inverse problems that involve expensive PDE evaluations poses a significant challenge. This mini-symposium presents recent advances in sampling approaches for large scale inverse problems.

▶MS-Th-E-36-1 16:00–16:30

Metropolis-Hastings Algorithms in Function Space for Bayesian Inference of Groundwater Flow

Sprungk, Bjoern TU Chemnitz

Abstract: We consider Markov Chain Monte Carlo methods in general Hilbert spaces as they arise in Bayesian inference with PDEs, where it is necessary to draw samples from probability measures on function spaces. We focus on Metropolis-Hastings algorithms and propose a generalization of the existing pCN-Metropolis. The new algorithm exploits the geometry of the target measure which yields a higher statistical efficiency and the potential for variance and dimension independent performance as observed in numerical experiments.

▶MS-Th-E-36-2 16:30–17:00

A Bayesian Level-set Approach for Geometric Inverse Problems

Iglesias, Marco Univ. of Nottingham
Stuart, Andrew Univ. of Warwick
Lu, Yulong Univ. of Warwick

Abstract: We discuss a computational Bayesian framework for the solution of PDE-constrained inverse problems where the unknown is a geometric feature of the underlying PDE forward model. Geometric features are parameterised by means of a level-set function. The Bayesian posterior on the level-set function is explored with a grid-invariant MCMC method. We display numerical results where the proposed approach is applied to the estimation of geologic facies, electrical impedance tomography and the manufacturing of composite materials.

▶MS-Th-E-36-3 17:00–17:30

RTO - Randomize, Then Optimize

Laine, Marko Finnish Meteorological Inst.

Abstract: We present a method for sampling from posterior distributions in nonlinear inverse problems, when the measurement error and prior are Gaussian. RTO method computes a candidate sample by solving a stochastic optimization problem. In the linear case, these samples are directly from the posterior density. In the nonlinear case, we derive the form of the sample density, and then show how to use it within to obtain samples from the posterior distribution of unknowns.

▶ MS-Th-E-36-4 17:30–18:00

Minimization of A Cost Function for Approximate Sampling from Multimodal Posterior Distributions

Oliver, Dean Uni Research

Abstract: We address the problem of sampling from a posterior PDF with widely separated modes. In this approach, particles samples from the the prior are mapped to regions of high probability by minimizing a cost function involving distance from the prior sample and distance from perturbed observations. The error in the distribution of sampling can potentially be corrected by computation of a marginal density, but this correction is generally neglected in high-dimensional inverse problems.

MS-Th-E-37 16:00–18:00 301B

Networked Control Systems

Organizer: TCCT Technical Committee on Control Theory, CAA

Abstract: The use of a data network in a control loop has gained increasing attentions in recent years due to its cost effective and flexible applications. One of the major challenges in this networked control system (NCS) is the network-induced delay effect in the control loop. Network delays degrade the NCS control performance and destabilize the system. This mini-symposium will present some recent progresses in analysis and applications of networked control systems: 1) Majorization theory and its applications; 2) Stability analysis of linear systems with time-varying delay by a new kind of Lyapunov-Krasovskii function; 3) Input delay compensation of linear systems with both state and input delays; 4) Input-to-state stability for nonlinear delay systems with large delay period.

▶ MS-Th-E-37-1 16:00–16:30

Majorization Theory and Its Applications in Networked Stabilization

Qiu, Li Hong Kong Univ. of Sci. & Tech.

Abstract: In this talk we showcase an old yet new mathematical tool called majorization. It is old since it has been studied in mathematics by giants like Hardy, Littlewood, and Polya and has been widely used in statistics in the past 100 years. It is new since its applications in engineering has only appeared in the past decade or so. We will present its premiere applications in control and systems theory.

▶ MS-Th-E-37-2 16:30–17:00

Stability Analysis of Linear Systems with Time-varying Delay

Sun, Jian Beijing Inst. of Tech.

Abstract: In this talk, stability analysis problem is studied for linear systems with time-varying delay. Some less conservative results are obtained by constructing a new kind of Lyapunov-Krasovskii functional which contains some novel triple-integral terms and sufficiently uses the information about the delay. Some numerical examples are given to illustrate the effectiveness of the proposed method.

▶ MS-Th-E-37-3 17:00–17:30

Input Delay Compensation of Linear Systems with Both State and Input Delays by Nested Prediction

Zhou, Bin Harbin Inst. of Tech.

Abstract: We consider the input delay compensation of linear systems with both state and input delays. Provided the open-loop systems without input delay can be stabilized by a state feedback, a nested predictor based approach is established to predict the future states so that the delays in the input are compensated. It is shown that the compensated closed-loop system in the presence of input delay possesses the same characteristic equation as that without input delay.

▶ MS-Th-E-37-4 17:30–18:00

Input-to-state Stability for Nonlinear Systems with Large Delay Period Based on Switching Techniques

Sun, Xi-Ming Dalian Univ. of Tech.

Abstract: This paper studied the problem of input-to-state (ISS) for nonlinear systems with large delay periods (LDP). The concepts of the length rate of LDP and the frequency of LDP are introduced. First the considered system is converted into a switched delay system which may include an unstable subsystem. Then based on a piecewise Lyapunov functional, the ISS properties of the systems are developed under the constraints of the length rate and the frequency of LDP.

MS-Th-E-38 16:00–18:00 302A

Complex System Control and Applications III

Organizer: TCCT Technical Committee on Control Theory, CAA

Abstract: It’s arguable that complex systems have been studied for many years, but only after the discovery of chaos in deterministic systems did people realize that the “complexity” of complex systems is rooted into the fundamental laws of physics. Some features, such as cascading failures, coupling, nonlinearity and emergent phenomena, make the analysis and control of complex systems theoretically challenging. This mini-symposium aim to present some recent theoretical progresses in several brunches of complex system control and some further applications, including: 1) analysis and synthesis of networked control systems; 2) consensus control of multi agents with sign observations; 3) energy management of electric vehicles; 4) remote perception and controlling in smart house.

▶ MS-Th-E-38-1 16:00–16:30

Analysis and Synthesis of Networked Control Systems

Xia, Yuanqing Beijing Inst. of Tech.

Abstract: In this presentation five parts will be given. Firstly, new results on quantization over networks are given. Secondly, new results on data fusion over networks are presented. Thirdly, a new networked predictive control scheme is proposed, which can overcome the effects caused by network data dropout. Fourthly, some results on fault detection over networks are introduced. Finally, news results on control of multi flight vehicles over networks are presented.

▶ MS-Th-E-38-2 16:30–17:00

Consensus of Multi-agent Systems with Sign Observations

Fang, Haitao Acad. of Mathematics & Sys. Sci., Chinese Acad. of Sci.

Jiang, Weisen Acad. of Mathematics & Sys. Sci., Chinese Acad. of Sci.

Abstract: In multi-agent systems, to achieve consensus, relative positions with neighbors are always required. However, in many cases, exact relative positions are very difficult to be obtained. In this paper, we considered the case that each agent can only get the sign information of its neighbors, and prove in some mild conditions, consensus can be achieved in multi-agent systems with connected fixed network and a random network. Some simulation examples are provided to verify our theoretical

▶ MS-Th-E-38-3 17:00–17:30

Electric Vehicles in Smart Grid: How to Manage Energy?

Zaiyue, Yang Zhejiang Univ.

Abstract: Traditional grid is facing challenges and the world is making strides towards smart grid. Enabled by advanced information technologies, smart grid is an effective way to achieve efficient power generation, distribution and utilization. Electric Vehicle (EV) is a dynamical element in smart grid, which can address the shortage of fossil energy and car emissions. In this talk, we shall discuss how to manage the energy transmission among several entities, including grid, renewable sources, charging stations,

▶ MS-Th-E-38-4 17:30–18:00

The Remote Perception and Controlling in Smart House Based on Public Cloud Platform

Zhang, Ming Beijing Inst. of Tech.
Dai, Zhongjian Beijing Inst. of Tech.
Dai, Yaping Beijing Inst. of Tech.
Wang, Shuo Beijing Inst. of Tech.

Abstract: A solution of the smart home system based on IoT public cloud platform is proposed in this paper. The PCs or some embedded devices in traditional smart home system are replaced by the cloud platform as a server in this scheme. Several environment perception and control terminals of a family’s comfort, safety, energy consumption are designed, which can communicate with the cloud platform. This system can work in remote control and local control working mode.

MS-Th-E-39 16:00–18:20 302B

Optimal control of stochastic systems and its application to finance

Organizer: Wu, Zhen Shandong Univ.

Organizer: Wang, Guangchen Shandong Univ.

Abstract: Optimal control of stochastic systems plays a central and significant role in modern control theory. In the past decade, extensive studies have been

conducted for the so-called maximum principle, verification theorem, HJB equation and their applications to finance, economics, insurance, etc. The minisymposium aims to present some recent developments in optimal control of stochastic systems, including 1) LQ control and filtering of forward-backward stochastic systems; 2) Non-Markov zero-sum Dynkin game; 3) Maximum principle for stochastic systems driven by fractional Brownian motions; 4) Maximum principle for mean-field stochastic delay systems.

▶MS-Th-E-39-1 16:00–16:30

An LQ Optimal Control Problem of FBSDEs with Partial Information

Wang, Guangchen Shandong Univ.

Abstract: In this talk, we study an LQ optimal control problem derived by F-BSDEs. A backward separation approach is introduced. Combining it with filtering, two optimality conditions and a feedback optimal control are derived. Closed-form optimal solutions are obtained in some particular cases. As an application of the results, a recursive utility problem from financial markets is solved explicitly. (This talk is based on a joint work with Professors Zhen Wu and Jie Xiong.)

▶MS-Th-E-39-2 16:30–17:00

Non-Markov Zero-sum Dynkin Game

Zhou, Yang South China Normal Univ.

Abstract: A Non-Markov zero-sum Dynkin game problem is considered. Its associated Hamilton-Jacobi-Bellman-Isaacs equation is a backward stochastical partial differential variational inequality (BSPDVI, for short) with semi-linear differential operator. A verification theorem is established, which shows that the strong solution of the BSPDVI is the value function of the Dynkin game problem. Then the existence and uniqueness of the strong solution of the B-SPDVI are proved. Finally, we give two examples to show its applications.

▶MS-Th-E-39-3 17:00–17:30

Stochastic Maximum Principle for Controlled Systems Driven by Fractional and Standard Brownian Motions

Han, Yuecai Jilin Univ.

Abstract: The existence and uniqueness of solution for a type of backward stochastic differential equation driven by fractional Brownian motions and underlying standard Brownian motions is investigated. The necessary contions that the optimal control must satisfy for controlled systems driven by fractional Brownian motions and underlying standard Brownian motions is obtained by conditioning and Malliavin calculus.

▶MS-Th-E-39-4 17:30–18:00

Maximum Principle for Mean-field Jump-diffusion Stochastic Delay Differential Equations and Its Application to Finance

Meng, Qingxin Huzhou University

Abstract: This paper investigates a stochastic optimal control problem with delay and of mean-field type,where the controlled state process is governed by a mean-field jump-diffusion stochastic delay differential equation.Two sufficient maximum principles and one necessary maximum principle are established for the underlying systems. As an application, a bicriteria mean-variance portfolio selection problem with delay is studied.Under certain conditions, explicit expressions are provided for the efficient portfolio and the efficient frontier, which are as

▶CP-Th-E-39-5 18:00–18:20

The Connection between Dynamic Programming and Maximum Principle for Fully Coupled Forward-Backward Stochastic Control Systems

Shi, Jingtao Shandong Univ.

Abstract: This paper is concerned with the connection between dynamic programming (DP) and maximum principle (MP) for the fully coupled forward-backward stochastic control system. where the recursive cost functional is defined as one of the solution to a controlled forward-backward stochastic differential equation (FBSDE). With some smooth assumptions, relations among the value function, generalized Hamiltonian function and adjoint processes are given, when the diffusion coefficient of the forward equation does not contain the state variable z. The general case for the problem is open. A linear example is discussed as the illustration of our main result.

MS-Th-E-40 16:00–18:00 303A

Identification and Control of Complex Systems

Organizer: TCCT Technical Committee on Control Theory, CAA

Abstract: A complex system is a system formed out of many components whose behavior is emergent, which is, the behavior of the system cannot be simply inferred from the behavior of its components. The complex nature makes the identification and control of the systems theoretically challenging and technically important in real-world applications. The minisymposium aim to show the latest developments in identification and control of several classes of complex systems, including 1) system identification under quantized inputs and quantized output observations in an FIR system; 2) dissipativity-based small-gain theorem establishment for the interconnected systems; 3) identification of the time-varying gene network for brain development; 4) multi-motor driving servo systems with backlash synchronization and tracking control.

▶MS-Th-E-40-1 16:00–16:30

System Identification under Quantized Inputs and Quantized Output Observations

Guo, Jin Univ. of Sci. & Tech. Beijing

Abstract: We focus on an FIR system to investigate the system identification under quantized inputs and quantized output observations. Based on the QC-CE (quasi-convex combination estimator) and the weighted least squares, a two-step algorithm is proposed to estimate the unknown parameter. The input excitation condition is introduced, under which the key properties of the algorithm are obtained, including strong convergence, strong and mean-square convergence rates, asymptotic normality and asymptotic efficiency.

▶MS-Th-E-40-2 16:30–17:00

Adaptive Lasso-Based Variable Selection for Nonlinear Nonparametric Systems

Zhao, Wenxiao Acad. of Mathematics & Sys. Sci., Chinese Acad. of Sci.

Abstract: The Lasso introduced in statistics community finds successful applications in diverse areas. The theoretical foundation of such kinds of algorithms is mainly for linear systems. In this talk, we investigate the variable selection problem for nonlinear nonparametric systems with a Lasso-type algorithm and show that under moderate conditions the estimates derived are strongly consistent with both parameter convergence and set convergence.

▶MS-Th-E-40-3 17:00–17:30

Identification of the Time-Varying Gene Network for Brain Development with Application to Mental Diseases Studies

Wan, Lin Acad. of Mathematics & Sys. Sci., CAS

Abstract: Genetic association studies have identified dozens of susceptibility genes for mental diseases such as autism and schizophrenia. However, it remains mysterious that how these genes play their roles in the brain function. To investigate the functions of mental diseases susceptibility genes in a dynamic and systematic fashion, we develop a time-varying gene network reconstruction method using gene expression time series data of brain development. It provides new insights into the molecular mechanisms of mental diseases.

▶MS-Th-E-40-4 17:30–18:00

Synchronization and Tracking Control for Multi-motor Driving Servo Systems with Backlash

Ren, Xuemei Beijing Inst. of Tech.

Abstract: This paper presents synchronization and tracking control for multi-motor driving servo systems with backlash. A sliding mode is proposed to achieve synchronization and tracking control, where an improved performance function characterizing settling time, overshoot, steady-state error, convergence rate is introduced to attain systems with prescribed performance. The backlash compensators are adopted, where a function characterizing position deviation of motors is used for switching between normal and compensation control. Simulation results demonstrate the effectiveness of algorithm.

MS-Th-E-41 16:00–18:00 303B

Majorization Theory and Its Engineering Applications

Organizer: Chen, Wei Hong Kong Univ. of Sci. & Tech.

Organizer: Qiu, Li Hong Kong Univ. of Sci. & Tech.

Abstract: Majorization is an old mathematical tool which has been studied in mathematics by giants like Hardy, Littlewood, and Pólya and has been widely used in statistics in the past 100 years. Its engineering applications have been attracting more and more attention recently in various areas, such as wireless communication, information theory, control and estimation theory, operations research, and smart grid, etc. The minisymposium aims to present several most up-to-date research on majorization and its applications in information technology, including 1) wireless communication via majorization; 2) duration-differentiated energy services; 3) duration-differentiated energy services with different deadlines; 4) sensor scheduling with majorization.

▶MS-Th-E-41-1 16:00–16:30

Majorization Theory in Wireless Communications

Palomar, Daniel Hong Kong Univ. of Sci. & Tech.

Abstract: Majorization precisely defines the vague notion that the components of a vector are "less spread out" or "more nearly equal" than the components of another vector. Many problems arising in wireless communications involve comparing vector-valued strategies or solving optimization problems with vector or matrix-valued variables. Majorization theory is a key tool to simplify or solve these problems. This talk will introduce the basic concepts and results on majorization and illustrate its applications in wireless communications.

▶MS-Th-E-41-2 16:30–17:00

Duration-differentiated Energy Services

Negrete-Pincetic, Matias — Pontificia Universidad Catolica de Chile

Abstract: We consider duration-differentiated loads requiring a constant power for a specified duration. We give conditions, written in terms of majorization results, under which a variable power supply is adequate to meet these flexible loads, and describe how to allocate the power to the loads. We study the problem of allocating the available power to loads to maximize welfare, and show that the welfare optimum can be sustained as a competitive equilibrium in a forward market.

▶MS-Th-E-41-3 17:00–17:30

Majorization Theory in Sensor Scheduling Problems

Yang, Chao — East China Univ. of Sci. & Tech. (ECUST)

Abstract: This talk introduces the applications of majorization in the sensor scheduling problems for networked state estimation. Two problems are considered. The first is to schedule the limited communication time of a single sensor to optimize the average estimation performance. The second is to plan the limited available channels among a sensor network such that the global performance are optimized. It is shown in both problems, the optimal schedules can be obtained by applying majorization theory.

▶MS-Th-E-41-4 17:30–18:00

Duration-deadline Jointly Differentiated Energy Services

Chen, Wei — Hong Kong Univ. of Sci. & Tech.

Abstract: We propose a duration-deadline jointly differentiated energy service. The adequacy of a given supply profile is addressed, which amounts to solving a (0,1)-matrix feasibility problem. The adequacy condition is given by the non-negativity of a structure tensor. The condition reduces to a majorization relation when there is only one single deadline. We also discuss the adequacy gap in the case of an inadequate given supply.

MS-Th-E-42 16:00–18:00 301A

Cooperative Control and Multi-Agent Systems V

Organizer: TCCT — Technical Committee on Control Theory, CAA

Abstract: Recent advances in sensing, communication and computation technologies have enabled a group of agents, such as robots, to communicate or sense their relative information and to perform tasks in a collaborative fashion. The past few years witnessed rapidly-growing research in cooperative control technology. Multi-agent system (MAS) is a computerized system composed of multiple interacting intelligent agents within an environment. Multi-agent systems can be used to solve problems that are difficult or impossible for an individual agent or a monolithic system to solve. The aim of this minisymposium is to share novel approaches and innovative applications of cooperative control and MAS, including：1) distributed estimation for cyber-physical systems; 2) consensus-based distributed filter design; 3) environmental feasibility on consensus control; 4) Distributed cooperative learning approach.

▶MS-Th-E-42-1 16:00–16:30

Situation Awareness for Cyber-Physical Systems: Distributed Estimation Method

Chen, Cailian — Shanghai Jiao Tong Univ.

Abstract: The increasing applications of cyber-physical systems (CPSs) witness the fact that high-level situation awareness tasks can be accomplished with cooperative sensing, data processing, communication and control. Distributed estimation is a key process bridging the gap between the wealth of distributed information captured and the understanding of a situation of physical systems. In this talk, the speaker will present its evaluation and case study from system perspective by considering network topology, distributed estimation and consensus strategy.

▶MS-Th-E-42-2 16:30–17:00

Consensus-based Distributed Filter Design and Convergence Analysis in Sensor Networks

Zhang, Ya — Southeast Univ.

Abstract: This paper studies the distributed filtering problem of heterogeneous sensor networks. The communications among sensors and the sensing links are unreliable and randomly switching. Based on Kalman filtering algorithm and weighted average strategy, a sub-optimal filtering algorithm is proposed. The statistical convergence properties of estimation error covariances are investigated and a necessary and sufficient convergence condition is provided based on LMIs.

▶MS-Th-E-42-3 17:00–17:30

Environmental Feasibility on Consensus Control of Linear Continuous Multi-agent Systems

Song, Yunzhong — Henan Polytechnic Univ.

Abstract: Environmental feasibility on consensus control of linear continuous multi-agent systems will be touched upon. Where multi-agents output consensus decoupled with environmental disturbances will be investigated without or with internal model perturbation of the multi-agent systems, and simultaneous invariant subspace will be the main tool employed to deal with that kind of problem.

▶MS-Th-E-42-4 17:30–18:00

Distributed Cooperative Learning Approach and Its Applications

Chen, Weisheng — Xidian Univ.

Abstract: Big data is an interesting topic attracting lots of researchers. An important issue is how to deal with the data when it is too much to handle in a centralized way. Distributed cooperative learning (DCL) approach is a new learning scheme developed recently for such an issue. The RBF neural networks learned by the DCL approach have the same generalization ability. This talk will study it and its applications, and demonstrate it by simulation examples.

MS-Th-E-43 16:00–18:00 VIP4-1

Optimization algorithms and application - Part III of V

For Part 1, see MS-Th-BC-43
For Part 2, see MS-Th-D-43
For Part 4, see MS-Fr-D-43
For Part 5, see MS-Fr-E-43

Organizer: Wen, Zaiwen — Peking Univ.
Organizer: Yuan, Ya-xiang — Inst. of Computational Mathematics & Scientific/Engineering Computing
Organizer: Xia, Yong — Beihang Univ.

Abstract: This minisymposium consists 5 sessions. It highlights recent advances in theory, algorithms and applications of mathematical optimization on solving huge problems that are intractable for current methods.

▶MS-Th-E-43-1 16:00–16:30

On the Linear Convergence Rate of A Generalized Proximal Point Algorithm

Tao, Min — Nanjing Univ.
Yuan, Xiaoming — Hong Kong Baptist Univ.

Abstract: We consider a generalized PPA in the generic setting of finding a zero point of a maximal monotone operator, and show that the condition proposed by Rockafellar can also sufficiently ensure the linear convergence rate for this generalized PPA. Both the exact and inexact versions of this generalized PPA are discussed.

▶MS-Th-E-43-2 16:30–17:00

A New Look at the Reweighted L1 Minimization

LI, Donghui — South China Normal Univ.

Abstract: We reformulate the Lp-regularization problem to a smooth constrained optimization problem. Based on the reformulation, we propose a sequence L1-regularization method to solve the problem. The method is motivated by a sequential quadratic programming (SQP) method for solving a smooth constrained optimization reformulation to the problem. We find that the method is indeed a reweighted L1 minimization method. It then gives a new look at the reweighted L1-minimization method.

▶MS-Th-E-43-3 17:00–17:30

Some Optimization Problems in Petrochemical Industry

Dai, Yu-Hong — Chinese Acad. of Sci.

Abstract: In this talk, we will discuss two optimization problems applied in petrochemical industry. Firstly, the petroleum mixture problem can be formed into a bilinear problem. We managed to settle it by nonmonotone sucessive linear programming (NMSLP). Numerical experiments show that NMSLP is competive with the commecial solver PIMS in both solution quality and CPU time. Secondly, we introduce the utility problem, which is a mixed integer nonlinear problem. We exploit the structure and put forward a heuristic method. Numerical results by data in real industry are shown.

▶MS-Th-E-43-4 17:30–18:00

An Inexact Alternating Direction Algorithm for Separable Convex Optimization.

Zhang, Hongchao — Lousiana State Univ.

Abstract: We will introduce an inexact alternating direction algorithm with variable stepsize for solving separable convex optimization. This algorithm generalizes the Bregman operator splitting algorithm with variable stepsiz (BOSVS) to the multiblock case and allows to solve the convex subproblems to an adaptive accuracy. Global convergence and some preliminary numerical results will be discussed in this talk.

MS-Th-E-44 16:00–18:30 VIP2-1

Pseudo-Differential Operators in Industries and Technologies - Part II of IV

For Part 1, see MS-Th-D-44
For Part 3, see MS-Fr-D-44
For Part 4, see MS-Fr-E-44

Organizer: Wong, M.W. — York Univ.

Abstract: Pseudo-differential operators, first appeared in 1960s in the paper by Joseph J. Kohn and Louis Nirenberg in the Communications on Pure and Applied Mathematics, have been used in the explicit descriptions of solutions of Partial Differential Equations. Since wavelet transform and related transforms came to the fore and became understood by scientists and engineers in the physical sciences, biomedical sciences, atmospherical sciences and geological sciences in the context of time/space -frequency representations, pseudo-differential operators and their variants such as Weyl transforms and noncommutative quantization with operator-valued symbols have become instrumental in signal and image analysis in the role of filters. Extensions of classical pseudo-differential operators to Weyl transforms and pseudo-differential operators to H-type groups can be thought of as noncommutative quantization. The aim of this minisymposium is to provide a platform for dialogs on several developments of pseudo-differential operators in some areas of industries and technologies such as information, communication and signals.

▶MS-Th-E-44-1 16:00–16:30

Modulation Spaces, Harmonic Analysis and Pseudo-differential Operators

Toft, Joachim — Department of mathematics, Linnaeus Univ.

Abstract: We present recent results on composition, continuity and Schatten-von Neumann (SvN) properties for pseudodifferential operators (PsDOs) on modulation spaces. We present certain conditions in order for the Weyl product should be continuous on modulation spaces.
We also present appropriate conditions on modulation space symbols in order for the PsDOs should be SvN of certain degree in (0,∞]. We use the results to deduce SvN properties of PsDOs with symbols in Hörmander classes.

▶MS-Th-E-44-2 16:30–17:00

MRI Texture Heterogeneity Correlates with Tissue Pathology in Multiple Sclerosis

Zhang, Yunyan — Univ. of Calgary
Moore, Wayne — Univ. of British Columbia
Laule, Corree — Univ. of British Columbia
Bjarnason, Thor — Univ. of British Columbia
Kozlowski, Piotr — Univ. of British Columbia
Traboulsee, Anthony — Univ. of British Columbia
Li, David — Univ. of British Columbia

Abstract: Mathematical calculation of the texture in MR images demonstrates promise to detect subtle changes in tissue structure but is subject to pathological validation. Here we imaged 10 postmortem brain samples with multiple sclerosis and computed the local texture of brain areas with different severity of pathology determined by histological staining. We show that MRI texture heterogeneity correlates strongly with tissue pathology and may be a new measure of injury and repair in multiple sclerosis patients.

▶MS-Th-E-44-3 17:00–17:30

A Frame of Discrete Orthogonal Stockwell Transform

Berra, Michele — Univ. of Turin

Abstract: We define a new frame on $L^2(R)$ using the so-called DOST basis using a particular classes of windows that includes the Gaussian characterizing also the dual window. We also generalize this frame in the framework of the alpha-modulation spaces. Finally, we test the numerical efficiency of the proposed frame.

▶MS-Th-E-44-4 17:30–18:00

Time-Frequency Methods Applied to Images

Cohen, Leon — City Univ. of NY

Abstract: Over the past 30 years time-frequency methods have been generalized to apply to images. Instead of time/frequency one considers position/spatial-frequency. One seeks a formulation where we can study the local properties of images. We review the concepts that have been developed in formulating joint spatial/spatial-frequency distributions and discuss the mathematical and physical ideas that have lead to both insight and practical methods to understand and manipulate images.

▶MS-Th-E-44-5 18:00–18:30

Thresholding-based Image Denoising Using Discrete Orthonormal S-Transform

Sun, Fengrong — Shandong Univ.
Babyn, Paul — Univ. of Saskatchewan
Zhu, Hongmei — York Univ.

Abstract: S-transform is an effective time-frequency analysis technique that can provide simultaneous time and frequency distribution information similar to the wavelet transform. We introduce the ideas of wavelet transform-based image denoising into S-transform domain and propose the thresholding-based image denoising using discrete orthonormal S-transform. Simulations illustrated the favorable application performance of the method, while its successful implementation in myocardial contrast echocardiography image denoising and the spatial-temporal denoising for fluoroscopy sequences demonstrated its application prospects.

MS-Th-E-45 16:00–18:00 213A

Optimization Methods for Inverse Problems - Part III of V

For Part 1, see MS-Th-BC-45
For Part 2, see MS-Th-D-45
For Part 4, see MS-Fr-D-45
For Part 5, see MS-Fr-E-45

Organizer: LIU, XIN — AMSS
Organizer: WANG, YANFEI — The Inst. of Geology & Geophysics, CAS

Abstract: In this minisymposium, inverse problems arisen from various areas such as geoscience and petroleum engineering, related optimization models like L1 norm regularization, and advanced optimization methods for solving these models such as first order methods, subspace methods, alternating direction method of multipliers and distributed optimization approaches are discussed.

▶MS-Th-E-45-1 16:00–16:30

Synchrotron-based Computerized Tomography on Microscopic Imaging in Shale Structure Analysis

WANG, YANFEI — The Inst. of Geology & Geophysics, CAS

Abstract: X-ray computerized tomography based on synchrotron radiation, as a non-destructive technique, become an important tool and can be applied to the study of morphology, microstructure, transport properties and fracturing of shale. Two scientific issues rose: one is how to generate high level reconstructed image data using SR-CT, another is how to use these CT image data to analyzing compositional microstructures. We study sparse regularization methods for reconstruction of image and microstructure prediction using SR-CT data.

▶MS-Th-E-45-2 16:30–17:00

Linearized Primal-Dual Based Methods for L^2-TV-Based Regularization Model of Some Linear Inverse Problems

Tian, WenYi — Hong Kong Baptist Univ.

Abstract: This paper considers the optimization model with L^2 and total variation regularization terms to approximate solutions to some linear inverse problems. The model is reformulated as a saddle-point problem with consistent finite element discretization. A linearized primal-dual scheme is proposed to iteratively solve the discretized problem. Then we analyze the convergence and establish the convergence rate both in ergodic and nonergodic sense. Finally, the efficiency of the proposed method is verified in several numerical examples.

▶MS-Th-E-45-3 17:00–17:30

On the Proximal Alternating Direction Method of Multipliers

Chen, Caihua — Nanjing Univ.

Abstract: In this talk, we consider the use of the proximal alternating direction method of multipliers to solve linearly constrained separable programming problems. We first review and develop some convergence and complexity analysis results of the algorithm for convex programming. We also discuss some variants of PADMM, including the inertial PADMM and Bregaman ADMM, for convex programming and extend the algorithm to solve some specific nonconvex programming problems.

▶MS-Th-E-45-4 17:30–18:00

Approximation Algorithms for Mixed Binary Nonconvex Quadratically Constrained Quadratic Programs

Xu, Zi Shanghai Univ.

Abstract: Motivated by applications in wireless communications, this talk focus on linear conic relaxation techniques and approximation algorithms for some mixed binary quadratically constrained quadratic programs and analyzes their approximation performance. The approximation ratios or bounds which are independent of dimensions are all established for these problems. In some cases, the ratio are tight up to a constant factor. The effectiveness of the proposed algorithms are demonstrated via numerical experiments.

MS-Th-E-46 16:00–18:30 306B
cancer modeling: from genes to phenotypes

Organizer: Fathallah-Shaykh, Hassan Univ. of Alabama at Birmingham
Organizer: Bouaynaya, Nidhal Rowan Univ.

Abstract: Cancer consists of layers of multiscale complex systems including molecular networks that interact with cellular elements to produce malignant phenotypes including unchecked growth, and invasion and motility. This minisymposium includes topics presented by active researchers on models and examples of time-varying networks, brain, lung, and liver cancers and methods to estimate the parameters. The speakers will review the mathematical aspects of their equations, the biological assumptions, and detail biological hypotheses predicted by their models.

▶MS-Th-E-46-1 16:00–16:30
Identification of Cancer Drug Targets by Computing Minimal Cut Sets (MCS) in Genome-scale Metabolic Models and Utilizing the Dual Network Approach
Jungreuthmayer, Christian Austrian Inst. of Industrial BioTech. (ACIB)

Abstract: In recent years much effort has been devoted to the study of cancer metabolism. The metabolic activity of cancer cells differs largely from normal cells. Hence, metabolic modelling of cancer cells plays a key role in identifying new drug targets. We present a novel and efficient method to identify these targets. Our method is based on tissue-specific genome-scale metabolic networks, elementary flux modes, and minimal cut sets and utilizes the dual network approach.

▶MS-Th-E-46-2 16:30–17:00
Time-Varying Genomic Networks: Methods and Challenges
Bouaynaya, Nidhal Rowan Univ.
Fathallah-Shaykh, Hassan Univ. of Alabama at Birmingham

Abstract: We propose a novel outlook on the inference of time-varying genetic networks, from a limited number of noisy observations, by formulating the networks estimation as a target tracking problem. We overcome the limited number of observations (small n large p problem) by performing tracking in a compressed domain. We track the time-varying networks during the life cycle of the Drosophila Melanogaster. The recovered networks show that few genes are permanent, whereas most are transient.

▶MS-Th-E-46-3 17:00–17:30
Conducting and Permeable States of Cell Membrane Submitted to High Voltage Pulses
Poignard, Clair Inria

Abstract: We present a new model of in vitro cell permeabilization by electric pulses, which describes separately the conducting state and the permeable state of the membrane. We first derive the model based on the experimental observations and we present the numerical methods to solve the non-linear partial differential equations. We then present numerical simulations that corroborate qualitatively the experimental data dealing with the uptake of propidium iodide (PI), and we conclude by forthcoming works.

▶MS-Th-E-46-4 17:30–18:00
A Mathematical Model for MultiCellular Tumor Spheroids Growth
Michel, Thomas Univ. of Bordeaux - Inria Bordeaux Sud-Ouest
Poignard, Clair Inria

Abstract: MultiCellular Tumor Spheroids can accurately reproduce the behaviour of 3D solid tumors, they are used to understand dynamics of tumor growth and to evaluate new cancer drugs. We provide a model to describe the impact of the external concentration of nutrients on the growth of a spheroid and the distribution of proliferative cells inside the spheroid. We calibrate the model with real data.

▶MS-Th-E-46-5 18:00–18:30
Dynamics of Glioblastoma Multiforme: Multiscale Model to Clinical Implications
Fathallah-Shaykh, Hassan Univ. of Alabama at Birmingham

Abstract: Glioblastoma multiforme (GBM) is a malignant brain tumor with poor prognosis and inherent propensity to invade the brain. We apply a concise system of partial differential equations that models GBM biology at the scale of magnetic resonance imaging, to replicate the patterns of recurrence of GB-M treated by anti-angiogenesis. The findings reveal that tumor motility determines tumor growth and recurrence and uncover a novel principle linking the mechanisms of brain invasion to tumor biology.

MS-Th-E-47 16:00–18:00 108
Numerical methods for compressible multi-phase flows - Part VI of VI

For Part 1, see MS-Mo-D-08
For Part 2, see MS-Mo-E-08
For Part 3, see MS-We-E-47
For Part 4, see MS-Th-BC-47
For Part 5, see MS-Th-D-47

Organizer: Deng, Xiaolong Beijing Computational Sci. Research Center
Organizer: Wei, Suhua Inst. of Applied Physics & Computational Mathematics
Organizer: Tian, Baolin Insitute of Applied Physics & Computational Mathematics
Organizer: Tiegang, Liu Beihang Univ.
Organizer: Sussman, Mark Florida State Univ.
Organizer: Wang, Shuanghu IAPCM

Abstract: Compressible multi-phase flows appear in many natural phenomena, and are very important in many applications, including space science, aerospace engineering, energy, homeland security, etc. Numerical calculation is a key for understanding many related problems. More and more numerical methods are being developed and improved. In this mini-symposium, novel numerical methods will be presented to show the progress in the area of compressible multi-phase flows, including interface capturing/tracking methods, phase change calculations, mixing methods, fluid-structure interaction methods, multi-physics calculations, adaptive mesh refinement, and high performance computing.

▶MS-Th-E-47-1 16:00–16:30
Modified Ghost Fluid Method Applied to Treat Compressible and Incompressible Flow Coupling
Tiegang, Liu Beihang Univ.

Abstract: This work is devoted to extending the modified ghost fluid method (MGFM) to treat compressible and incompressible fluid coupling. By solving shock relationship in the compressible medium and a derived equation of interfacial pressure continuity together to predict the ghost fluid states, this approach not only ensures numerical stability and maintains the advantages of simplicity and high efficiency, but also provides a more accurate interface boundary condition. Specific applications to underwater bubble collapse are are presented.

▶MS-Th-E-47-2 16:30–17:00
Computations of Low-speed Multi-equation Models
Niu, Yang-Yao Tamkang Univ.

Abstract: Computations for modeling low-speed compressible phenomena in multi-fluid flows are performed. Time-marching preconditioned methodology is used as the algorithmic framework because of its inherent capability of handling multiple flow regimes, such as the incompressible bulk liquid flow, low Mach number compressible liquid and vapor phase mixture flows. Computational results representative of water faucet, air – water shock tube, bubbly flow problems based on with the mixture and 4-equation two-fluid models are presented.

▶CP-Th-E-47-3 17:00–17:20
The Interaction between Toroidal Swimmers in Stokes Flow
Huang, Jianjun Worcester Polytechnic Inst.

Abstract: Here we analyze the fluid dynamic interaction of toroidal swimmers using the method of regularized Stokeslets. We interpret these as three-dimensional, zero Reynolds number analogs of finite vortex dipoles in an ideal fluid. We then examine the stability of relative equilibria that can form for these swimmers when they are initially placed in tandem or abreast.

▶CP-Th-E-47-4 17:20–17:40
Almost Complete Separation of A Fluid Component from Mixture Using the Burgers' Networks of Micro-separators
Watanabe, Shinya Ibaraki Univ.
Matsumoto, Sohei National Inst. of Advanced Industrial Sci. & Tech.
Ono, Naoki Shibaura Inst. of Tech.

Abstract: Two types of networks consisting of micro-separators are proposed which can separate the target component from fluid mixture almost completely. Each separator outputs into two outlets mixtures with slightly higher and lower concentrations, respectively. The outlet concentration difference is modelled by a quadratic map of the inlet concentration. Pressure and flow rate distributions in the network are analyzed, then concentration distribution is governed by systems of coupled quadratic maps. In the continuum the systems become the Burgers equation or its variable-coefficient variant, with no-flux boundary conditions. For one network the initial and boundary value problem is exactly solvable via Cole-Hopf transformation. It is proved that the target component becomes concentrated on one side of a transition layer corresponding to a stationary shock regardless of initial concentration distribution. Another network behaves similarly. MEMS circuits based on the idea are constructed to separate almost pure hydrogen from mixture using thermal diffusion.

▶ CP-Th-E-47-5 17:40–18:00

Thermodynamically Consistent Modelling and Computations for Two-phase Flows

Guo, Zhenlin — Univ. of California Irvine

Abstract: We present a novel phase-field model to study the two-phase flows with thermocapillary effects which allows for the different properties (densities, viscosities and heat conductivities) of each component. The model equations are derived under the thermodynamic framework and the compatibility with the laws of thermodynamics is achieved for the first time. In addition, important modelling properties Onsager reciprocal relations and Galilean invariance have been verified as well. To investigate this model numerically, we provide for the first time, an energy law preserving continuous finite element scheme. To implement the numerical methods more efficiently, we design an adaptive mesh that can automatically adjust to resolve the relevant scales of the phase-field model, ensuring accuracy while minimizing computational cost. Some numerical examples are computed using a continuous finite element method, where the results are compared to the corresponding analytical solutions as validations for our model.

MS-Th-E-48 16:00–18:00 212B

Image restoration: new algorithms and new applications - Part I of III

For Part 2, see MS-Fr-D-48
For Part 3, see MS-Fr-E-48

Organizer: Sgallari, Fiorella — Univ. of Bologna
Organizer: Chan, Raymond — The Chinese Univ. of Hong Kong

Abstract: The field of digital image restoration is concerned with the reconstruction or estimation of uncorrupted images from noisy, blurred ones. This blurring may be caused by optical distortions, object motion during imaging, or atmospheric turbulence. There are existing or potential applications of image restoration in many scientific and engineering fields, e.g. aerial imaging, remote sensing electron microscopy, and medical imaging. From these arise some real challenging problems related to image reconstruction/restoration that open the way to some new fundamental scientific questions closely related with the world we interact with and Mathematics has become one of the main driving forces of the modern development of image restoration.
The purpose of this mini-symposium is to gather the leading researchers in the areas of image restoration/reconstruction to present a series of talks that will expose the current state of knowledge in the algorithmic and application field. Our goal is also to establish connections between different techniques, talk about important issues in the emerging application fields and generate novel ideas for future development.

▶ MS-Th-E-48-1 16:00–16:30

Illusory Shapes via Corner Fusion

Kang, Sung Ha — Georgia Tech

Abstract: We propose a method for constructing illusory shapes from convex corners. Corner bases are fused together by elastica energy to construct both foreground illusory shapes and background occluded shapes. Robust numerical schemes are developed, and several generic examples will be presented.

▶ MS-Th-E-48-2 16:30–17:00

Multigird Regularization Method for Image Deblurring with Arbitrary Boundary Conditions

Donatelli, Marco — Univ. of Insubria
Buccini, Alessandro — Univ. of Insubria

Abstract: We consider the image deblurring problem. We propose a multiresolution representation of the point spread function to allow the method to be independent of the structure of the blurring matrix. The grid transfer operator is a linear B-spline used also for a post-smoothing denoising at each coarser level. The effectiveness of the method is further improved using as smoother a non-stationary preconditioning regularization method recently proposed in the litterature and adding the nonnegative constraint.

▶ MS-Th-E-48-3 17:00–17:30

Convex Image Denoising via Non-Convex Regularization

Morigi, Serena — Univ. of Bologna
Sgallari, Fiorella — Univ. of Bologna

Abstract: Natural image statistics motivate the use of non-convex non-smooth regularizations over convex regularizations for restoring images. However, they are rarely used in practice due to the challenge to find a good minimizer. We propose a Convex Non-Convex (CNC) denoising variational model and an efficient minimization algorithm based on the ADMM approach. We provide theoretical convexity conditions for both the CNC model and the optimization sub-problems arising in the ADMM-based procedure, such that convergence is guaranteed.

▶ MS-Th-E-48-4 17:30–18:00

Constrained TVp -L2 Model for Image Restoration

Sgallari, Fiorella — Univ. of Bologna
Morigi, Serena — Univ. of Bologna

Abstract: TV model for image restoration can be formulated as a MAP estimator which uses a half-Laplacian image-independent prior favoring sparse image gradients. We propose a generalization of the TV prior based on a half-Generalized Gaussian Distribution with parameter p and an automatic estimation of it to fit images'gradient distribution. The restored image is computed by an ADMM procedure. A novel result in multivariate proximal calculus is presented. Numerical examples show the efficiency of the approach.

MS-Th-E-49 16:00–18:00 107

Mathematical modeling of infectious diseases - Part I of II

For Part 2, see MS-Fr-D-49

Organizer: Wang, Xueying — Washington State Univ.

Abstract: Mathematical modeling plays an important role in understanding the spread and control of infectious diseases in populations. Mathematical models have been increasingly used to guide public health policy decisions and explore questions in infectious disease control. This minisymposium will bring together researchers employing a variety of mathematical techniques to study relevant phenomena of infectious diseases.

▶ MS-Th-E-49-1 16:00–16:30

Revisiting the Cholera Outbreaks of John Snow's Time

Tien, Joe — The Ohio State Univ.

Abstract: John Snow's celebrated investigations of cholera in 19th century London proved a seminal step in establishing the germ theory of disease. In fact there is still more to learn from the cholera outbreaks of John Snow's time. In this talk, we will examine cholera data from the Bills of Mortality of London, and see how interesting patterns in the data together with simple mathematical modeling lead to the reconstruction of an ancient cholera genome.

▶ MS-Th-E-49-2 16:30–17:00

Mathematical Modeling and Analysis of Cholera Epidemics

Wang, Xueying — Washington State Univ.

Abstract: In this work, we propose novel epidemic models for cholera dynamics. First, we develop a generalized ODE model by incorporating a general formulation of cholera transmission pathways and intrinsic bacteria growth; we then analyze the local and global dynamics of this model. Secondly, we extend the ODE model to PDE models with inclusion of the bacterial and human diffusion and bacterial convection. We investigate the traveling wave solutions and disease threshold dynamics of PDE models.

▶ MS-Th-E-49-3 17:00–17:30

Modeling Cholera on Community Networks

Shuai, Zhisheng — Univ. of Central Florida

Abstract: Cholera is an infectious disease that can be transmitted to humans directly by person-to-person contact or indirectly through ingestion of contaminated water. Basic cholera models that include both direct and indirect transmission and assume homogeneous mixing in the host population are reviewed. Detailed models that incorporate spatial heterogeneity and mathematical tools from graph theory are applied to understand cholera dynamics on community networks. Joint work with Marisa Eisenberg, Joseph Tien, Pauline van den Driessche.

▶ MS-Th-E-49-4 17:30–18:00

Basic Reproduction Numbers for Non-homogeneous Epidemic Models

Wang, Jin — Univ. of Tennessee at Chattanooga

Abstract: The basic reproduction number, commonly denoted R0, is of fundamental importance in epidemic models. Although threshold dynamics associated with R0 have been well established for autonomous systems representing homogeneous environments, the analysis and computation of R0 for non-homogeneous epidemic models remain a challenge. Here we discuss

R0 for time periodic and spatially heterogeneous models, representing two typical types of non-homogeneity. We present efficient methods to compute R0, and demonstrate the application through non-trivial examples.

MS-Th-E-50 16:00–18:30 207
Mathematical and Numerical Aspects of Electronic Structure Theory - Part III of V

For Part 1, see MS-Th-BC-50
For Part 2, see MS-Th-D-50
For Part 4, see MS-Fr-D-50
For Part 5, see MS-Fr-E-50

Organizer: Lin, Lin Univ. of California at Berkeley
Organizer: Lu, Jianfeng Duke Univ.

Abstract: Electronic structure theory and first principle calculations are among the most challenging and computationally demanding science and engineering problems. This minisymposium aims at presenting and discussing new developments of mathematical analysis, and numerical methods for achieving ever higher level of accuracy and efficiency in electronic structure theory. This includes ground state and excited state density functional theory calculations, wavefunction methods, together with some of their applications in computational materials science and quantum chemistry. We propose to bring together experts on electronic structure theory, which include not only mathematicians, but also physicists working actively in the field.

▶MS-Th-E-50-1 16:00–16:30
Efficient Spectral-element Methods for Electronic Schrodinger Equation
Shen, Jie Purdue Univ.

Abstract: We present efficient spectral-element methods, based on Legendre and Laguerre polynomials, for direct approximation of the electronic Schrodinger equation in one spatial dimension. A spectral-element approach is used to treat the singularity in nucleus-electron Coulomb potential, and with the help of Slater determinant, we construct special basis functions to obey the antisymmetric property of the fermionic wavefunctions. Numerical tests are presented to show the efficiency and accuracy of the proposed methods.

▶MS-Th-E-50-2 16:30–17:00
Numeric Atom-centered Orbital Based All-electron Electronic Structure Theory for Accurate, Large Simulations
Blum, Volker Duke Univ.

Abstract: We describe recent methodological progress and applications of electronic structure theory methods implemented in a numeric atom-centered orbital framework (FHI-aims). This basis choice enables simulations of materials and molecules (periodic and non-periodic) from light to numerically converged accuracy, for DFT including hybrid functionals and many-body perturbation theory. Recent developments include a massively parallel dense eigenvalue solver "ELPA" and a localized "resolution of identity" that enables exact-exchange for hybrid DFT up to thousands of atoms.

▶MS-Th-E-50-3 17:00–17:30
Hierarchical Tensors and Tensor Networks for Quantum Chemistry
Schneider, Reinhold Inst. for Mathematics

Abstract: n tensor product approximation, Hierarchical Tucker tensor format (Hackbusch) and Tensor Trains (TT) (Tyrtyshnikov) have been introduced recently offering stable and robust approximation by a low order cost . If $\mathcal{V} = \bigotimes_{i=1}^{d} \mathbb{C}^2$, these formats are equivalent to tree tensor networks states and matrix product states (MPS) originally introduced for the treatment of quantum spin systems. Considering the electronic Schrödinger equation, we use an occupation number labeling of Slater determinants, and show that the discrete Fock space becomes isometric to d-fold tensor product of a a two-dimensional Hilbert space. %We use hierarchical tensor representations, which are equivalent to tree tensor networks, in particularly in the form of matrix product states. For the computation of an approximate ground solution this problem can be casted into an optimization problem constraint by the restriction to tensors of prescribed multi-linear ranks $\mathbf{r}$. Dirac Frenkel variational principle developed in a similar fashion as for Multi-Configurational Hartree (-Fock) by observing the differential geometric structure of the novel tensor formats. This provides a variational formulation of the QC (Quantum Chemistry) DMRG (Density Renormalization Group) algorithm We propose a dynamical low rank approximation, corresponding to the Dirac-Frenkel variational principle, for solving a constraint optimization problem. The approach can be applied to ground state calculations as well as to dynamical problems. Convergence of (Riemannian) gradient algorithms can be shown. A simple optimization methods is provided by alternating direction methods, which reveals the DMRG (density matrix renormalization group) algorithm. This approach has been applied applied by G.C. Chan et al. and O. Legeza et al. to analyse the dissociation of diatomic molecules and to transition metal complexes, supporting that the presented approach has a certain potential to treat some strongly correlated electronic systems.

▶MS-Th-E-50-4 17:30–18:00
A Mathematical Aspect of Hohenberg-Kohn Theorem
Zhou, Aihui Acad. of Mathematics & Sys. Sci., Chinese Acad. of Sci.

Abstract: Hohenberg-Kohn theorem plays a fundamental role in density functional theory , which has become a basic tool for the study of electronic structure of matter. In this presentation, we shall talk about the Hohenberg-Kohn theorem for a class of external potentials and present a mathematical rigorous proof.

▶MS-Th-E-50-5 18:00–18:30
Compressed Modes and Compressed Density Matrices
Lai, Rongjie Rensselaer Polytechnic Inst.

Abstract: I will discuss our recent work on a new use of sparsity-promoting techniques to produce "compressed modes" - modes that are sparse and localized in space - for efficient solutions of L1 regularized variational Schrodinger equations in mathematics and physics. As lifted versions of compress modes, I will also discuss our recent work on compressed density matrices and their linear scaling algorithms.

MS-Th-E-51 16:00–18:00 209A
Recent Developments in the Modeling, Simulation and Analysis of Mathematical Models Arising from Biology - Part I of III

For Part 2, see MS-Fr-D-51
For Part 3, see MS-Fr-E-51

Organizer: Jain, Harsh Florida State Univ.
Organizer: Zhao, Kun Tulane Univ.

Abstract: Mathematical modeling is an effective and powerful tool in understanding complex biological phenomena. These models, using tools from diverse areas of mathematics ranging from partial and ordinary differential equations to group theory and topology, provide deep insights into the complex nature of biology that would otherwise be difficult to capture experimentally or in a clinical setting. Active research areas in mathematical biology include modeling of human vascular system, chemotaxis, wound healing, population dynamics, angiogenesis, cancer, morphogenesis and epidemiology. Speakers in this mini-symposium will discuss current research progress on the modeling, analysis and numerical simulation of models in these areas.

▶MS-Th-E-51-1 16:00–16:30
Collective Dynamics in Active Biological Systems
Ryan, Shawn Kent State Univ.

Abstract: Two coupled PDE/ODE models capable of exhibiting remarkable collective behavior will be presented. First, a bacterium is represented as a point dipole subject to hydrodynamic and excluded volume interactions. Simulations and analysis of the corresponding kinetic theory reveal the physical mechanisms behind the striking decrease in effective viscosity and the non-trivial correlations emerging during collective swimming. Second a model for foraging ants is introduced illustrating a transition to a collective state and local lane formation.

▶MS-Th-E-51-2 16:30–17:00
Distance, Community Detection, and Propagation on Graphs with Decay
Tien, Joe The Ohio State Univ.

Abstract: In many biological situations we encounter weighted graphs with "decay". Examples include organisms moving between habitat patches in a fragmented landscape, pathogen transport in a hydrologic network, and electrical signals spreading and attenuating on a neuronal network. I will discuss a generalized inverse of the graph Laplacian that plays a fundamental role in understanding how different decay rates at the nodes affect graph structure and dynamics on the graph.

▶MS-Th-E-51-3 17:00–17:30
On the Stability of Networks
Fathallah-Shaykh, Hassan Univ. of Alabama at Birmingham

Abstract: Global asymptotic stability is of importance from a theoretical as well as an application point of view in several disciplines. We study a system of cubic polynomials that models biological networks. We show that the property that the interconnection matrix is Lyapunov diagonally stable is a key feature that determines convergence to a single equilibrium. The results are applied to chains of negative edges, cycles, and to interconnected graphs. We will give numerical examples.

▶MS-Th-E-51-4 17:30–18:00

Analysis of Fecal Microbiota Transplantation in the Treatment of Clostridium Difficile Infection

Mio, Washington — Florida State Univ.

Abstract: Fecal microbiota transplantation (FMT) shows a high success rate in the treatment of Clostridium difficile infection (CDI). However, the mechanism by which CDI is resolved through FMT is not well understood. We present a multiscale approach to analysis of data in networks and Riemannian manifolds that combined with metagenomic sequencing let us develop a CDI biomarker that accounts for bacterial interactions and also is effective in monitoring the effects of FMT on CDI.

MS-Th-E-52 16:00–18:00 212A

Recent Development of Mathematical Models in Computational Biology - Part III of V

For Part 1, see MS-Th-BC-52
For Part 2, see MS-Th-D-52
For Part 4, see MS-Fr-D-52
For Part 5, see MS-Fr-E-52

Organizer: Zhang, Lei — Peking Univ.
Organizer: Ge, Hao — Peking Univ.
Organizer: Lei, Jinzhi — Tsinghua Univ.

Abstract: One of the central problems in biology is to understand the design principles of complex biological systems. Mathematical and computational models of biological processes can be characterized both by their level of biological detail and by their mathematical complexity. In this minisymposium, we focus on recent findings of computational models and methods to gain insights of the complexity of cellular life and efficiently analyze the experimental observations. Topics of interests include stem cells, developmental patterning, gene regulatory networks, neuron networks, uncertainty quantification of biological data, etc.

▶ MS-Th-E-52-1 16:00–16:30

Transition Paths of Metastable Bio-chemical Reacting Systems

Liu, Di — Michigan State Univ.

Abstract: Based on the framework of transition path theory (TPT), we extended the probability current between two adjacent reacting states to single reacting states as well as reacting trajectories, thereby give the definition of transition state (TS) as states with maximum velocity strength. Simple examples have shown the success of this approach.

▶ MS-Th-E-52-2 16:30–17:00

Cycle Symmetries and Circulation Fluctuations for Markov Processes with Cycle Structure

Jiang, Da-Quan — Peking Univ.

Abstract: For a recurrent Markov chain, we prove several equalities which characterize the symmetry of the forming times of cycles. The equalities are then applied to prove that the sample circulations satisfy a large deviation principle. The rate function has an interesting symmetry, which implies the Gallavotti-Cohen type fluctuation theorem of the sample net circulations. We also obtain other fluctuation theorems for sample circulations. Similar results hold for diffusion processes on the circle.

▶ MS-Th-E-52-3 17:00–17:30

Stem Cell Regeneration: from Model to Simulation

Lei, Jinzhi — Tsinghua Univ.

Abstract: This talk presents the modelling of stem cell regeneration through the multi-scale model with cross talk between genetic and epigenetic regulation. Numerical scheme to study the model with GPU is also introduced to simulate the long-term regeneration of a group of stem cells with modifications of histone modification in each cell cycle.

▶ MS-Th-E-52-4 17:30–18:00

A Model for Clonal Expansion in Blood Generation

Chou, Tom — UCLA

Abstract: We develop a mechanistic model for how labelled stem cells generate peripheral blood in the hematopoietic system. We model clones in three pools: the progenitor cell pool in the bone marrow, the peripheral blood pool, and the sampled blood. The model includes regulatory interactions through a phenomenological carrying capacity in the bone marrow. Our results are fit to longitudinal data on rhesus macaques, and show that two combinations of parameters determnine the observed clone-size distributions.

MS-Th-E-53 16:00–18:00 311B

Stochastic modelling, control and optimization in finance II

Organizer: Ludkovski, Mike — UC Santa Barbara
Organizer: Leung, Tim — Columbia Univ.
Organizer: Li, Lingfei — The Chinese Univ. of Hong Kong
Organizer: Chen, Nan — The Chinese Univ. of Hong Kong

Abstract: This minisymposium will explore applications of stochastic control to utility maximization problems, including new developments motivated by models from behavioral finance and risk measures

▶ MS-Th-E-53-1 16:00–16:30

Asymptotic Methods for Portfolio Optimization Problems

Hu, Ruimeng — Univ. of California, Santa Barbara
Fouque, Jean-Pierre — Univ. of California, Santa Barbara

Abstract: We revisit the portfolio optimization problems under stochastic volatility models, and using asymptotic methods with respect to volatility time scales. In the case of one factor and power utility, the problem is linearized and well-understood. However, the problem with general utility is still open. Here we address the case of general utility and prove asymptotically the optimality of the zeroth order strategy within a class of Markovian feedback control.

▶ MS-Th-E-53-2 16:30–17:00

Empirical Pricing Kernel: A Revisit

Xie, Jinming — The Chinese Univ. of Hong Kong
Li, Duan — The Chinese Univ. of Hong Kong

Abstract: We revisit the empirical pricing kernels (EPK) estimated from index option and index prices. Using a much longer sample, we find that the EPKs consistently demonstrate oscillating patterns. These oscillating patterns provide a nonlaboratorial evidence for the Friedman and Savage three-piece utility function, under which the utility function is convex with moderate wealth levels, which further confirms our finding that the EPK is increasing in a subinterval with small magnitude of losses and gains.

▶ MS-Th-E-53-3 17:00–17:30

The Ross Recovery Theorem and Log Optimal Portfolio

Wang, Yiwei — The Chinese Univ. of Hong Kong
Chen, Nan — The Chinese Univ. of Hong Kong

Abstract: We set up a framework that relates Ross recovery theorem with stochastic portfolio theory and obtain the recovery result from the long term perspective, particularly from the log optimal portfolio theory.

MS-Th-E-54 16:00–18:00 VIP1-2

Modeling and Simulations of Complex Biological Systems - Part II of IV

For Part 1, see MS-Th-D-54
For Part 3, see MS-Fr-D-54
For Part 4, see MS-Fr-E-54

Organizer: Liu, Xinfeng — Univ. of South Carolina
Organizer: Ju, Lili — Univ. of South Carolina

Abstract: This mini-symposium aims to bring together researchers focusing on using modeling and numerical approach to study complex biological systems including (but not limited to) cell signaling pathways, complex bio-fluids, biofilms, cell polarization, developmental and cell biology, and stem cells, and etc. Such complex biological systems in general consist of multiple interacting components that exhibit complicated temporal and spatial dynamics. Furthermore, feedback, nonlinearities and multiple time and length scales often make such systems extremely difficult to describe, model or predict. The invited speakers will discuss the challenges of modeling such complex systems, introduce new computational techniques to simulate them and, where possible, present novel analytical techniques to extract meaningful information.

▶ MS-Th-E-54-1 16:00–16:30

A New Approach to Feedback for Robust Signaling Frederic Y. M. Wan Department of Mathematics University of California, Irvine Irvine, CA 92697-3875 USA*

Wan, Frederic — Univ. of California, Irvine

Abstract: The patterning of many developing tissues is orchestrated by gradients of morphogens through an elaborate set of regulatory interactions. Such interactions are thought to make sgradients robust – i.e. resistant to changes in response to genetic or environmental perturbations. Just how this might be done is a major unanswered question. Empirical evidence of feedback regulating signaling gradients has been reported in the literature. The present paper undertakes a different approach to the role of feedback in robust signaling gradients (and therewith robust biological developments). This talk presents a new approach to some feedback processes that would lead to robust development.

*The research is supported in part by NIH Grants R01－GM067247 and P50－GM076516. The R01 was awarded through the Joint NSF/ NIGMS Initiative to Support Research in the Area of Mathematical Biology.

▶ MS-Th-E-54-2 16:30–17:00

A Mechanochemical Model for Cell Polarity by Coupling A Reaction Diffusion System with Membrane Tension

Zhang, Lei Peking Univ.

Abstract: Development and regeneration require plant and animal cells to make decisions based on their locations. In this talk, I will introduce a hybrid model for cell polarity by coupling a reaction diffusion system with membrane tension. Simulations demonstrate that membrane tension affects the spatial profile of Rac-GTP’s distribution, the polarization time and the sensitivity to attractant. Our model can first explain results of aspiration-release experiment and the pseudopod-neck-cell body morphology severing experiment.

▶ MS-Th-E-54-3 17:00–17:30

Stem Cells and Regeneration: Feedback, Niche, and Epigenetic Regulation

Nie, Qing Univ. of California, Irvine

Abstract: In developing and renewing tissues, terminally differentiated cell types are typically specified through the actions of multistage cell lineages. Such lineages commonly include a stem cell and multiple progenitor cell stages, which ultimately give rise to terminally differentiated cells. In this talk, I will present several modeling frameworks with different complexity on multistage cell lineages driven by stem cells, which account for diffusive signaling molecules, regulatory networks, individual cells, mechanics, and evolution. Questions of our interest include role of feedbacks in regeneration, stem cell niche for tissue spatial organization, crosstalk between epigenetic and genetic regulations. In several cases, we will also present direct comparisons between our modeling outputs and some existing and new in-vivo and in-vitro data.

▶ MS-Th-E-54-4 17:30–18:00

Dispersal in Advective Environments

Lou, Yuan Ohio State & Renmin Univ

Abstract: We consider some mathematical models in one-dimensional advective environments. Individuals are exposed to unidirectional flow, with the possibility of being lost through the boundary. We will investigate the persistence and range of a single species. The talk is based on joint works with King-Yeung Lam, Frithjof Lutscher, and Peng Zhou.

MS-Th-E-55 16:00–18:00 106

Wavelet Methods for Inverse Problems Modelling Real World Systems - Part II of IV

For Part 1, see MS-Th-D-55
For Part 3, see MS-Fr-D-55
For Part 4, see MS-Fr-E-55

Organizer: Siddiqi,Prof., Abul Sharda Univ.,NCR
Organizer: Al-Lawati, M.A. Sultan Qaboos Univ.

Abstract: In a direct problem an effect is determined by a cause while in an inverse problem cause is determined from an effect. In an image processing the direct problem is to find out how a given sharp photograph would look like while camera is incorrectly focused.A related inverse problem is to find sharp photograph from a given blurry image.Inventors of CAT and MRI were awarded Nobel Prize of Medicine and Physiology respectively in 1979 and 2003.Inverse problems typically involve certain quantities based on indirect measurements of these quantities.Seismic exploration,CAT,MRI,X-ray are examples of inverse problems. Bio metric identifiers are measurements from human body;examples are ear,face,facial thermogram,hand thermogram,hand vein,hand geometry,finger print,iris,retina,signature and voice..The direct and indirect problems of biometrics correspond to the analysis and synthesis of biometric information,respectively.Recognition of face is a direct problem while face reconstruction is an an inverse problem.Refinement of Fourier methods,called wavelet methods including curve lets,shear lets play important role for study of inverse problems occurring in above themes. The symposium is devoted to updated research on applications of wavelets to the above problems.

▶ MS-Th-E-55-1 16:00–16:30

Wavelet in Black-Scholes Model

Zahra, Noore Sharda Univ.
Al Lawati, Mohamed Sultan Qaboos Univ.

Abstract: Black -Scholes model is an important ingredient of financial engineering. Wavelet methods have played very significant role in this area. Recently fractional Black- Scholes model has been studied. The role of wavelet methods in such model is not fully explored. In this talk variants of wavelet methods for fractional Black- scholes model will be examined. Volatility is an inverse problem related to Black- Scholes model. Wavelet methods for solution of such problems will be elaborated.

▶ MS-Th-E-55-2 16:30–17:00

Use of Wavelet and Its Variant in Biometric Voting Machine

Zahra, Noore Sharda Univ.
Arichandran, K MIMOSA,Kuala Lumpur

Abstract: The objective of voting is to allow voters to cast their vote. Technology is being used more and more as a tool to assist voters. Almost all voting system around the world include the steps like voter identification and authentication, vote casting, vote counting and election results. The role of wavelet methods will be examined in this process.

▶ MS-Th-E-55-3 17:00–17:30

Applications of Wavelet Methods to Medical Imaging

Siddiqi,Prof., Abul Sharda Univ.,NCR

Abstract: Medical imaging involves several important parts such as Image Reconstruction, Processing and understanding. Several branches of Mathematics have been used to study this field. An inverse problem, where the unknown parameters of a system are estimated from the known reaction of the system to external signals is frequently encountered in medical imaging. Wavelet method and their variants are quite useful in study of such problems. Updated results of the field are presented.

MS-Th-E-56 16:00–18:30 403

Mathematical trends, challenges and future applications for liquid crystal theories - Part II of IV

For Part 1, see MS-Th-D-56
For Part 3, see MS-Fr-D-56
For Part 4, see MS-Fr-E-56

Organizer: Majumdar, Apala Univ. of Bath
Organizer: Wang, Changyou Purdue Univ.
Organizer: Zhang, Pingwen Peking Univ.

Abstract: Liquid crystals are mesogenic phases of matter intermediate between the solid and liquid phases of matter. Liquid crystals typically exhibit partial ordering and are consequently, highly sensitive to light, electric fields, mechanical and rheological effects. The proposed minisymposium focuses on key questions in liquid crystal research, based on defects, atomistic to continuum modelling, phase transitions, pattern formation and hydrodynamics. The minisymposum will comprise four themed sessions on (i) analysis, (ii) modelling, (iii) simulations and (iv) related areas, with invited talks from physicists, mathematicians and materials scientists, thus providing an ideal platform for the cross-fertilization of expertise from around the globe.

▶ MS-Th-E-56-1 16:00–16:30

Properties of Minimizers to the Maier- Saupe Energy for Liquid Crystals

Phillips, Dan Purdue Univ.
Bauman, Patricia Purdue Univ.

Abstract: We prove regularity properties and determine bounds for local minimizers to an energy derived from Maier-Saupe theory that is used to characterize order in nematic liquid crystal materials

▶ MS-Th-E-56-2 16:30–17:00

Energy-Minimizing Nematic Elastomers

Bauman, Patricia Purdue Univ.

Abstract: We prove weak lower semi-continuity and existence of energy-minimizers for a free energy describing stable deformations and the corresponding director configuration of an incompressible nematic liquid-crystal elastomer subject to physically realistic boundary conditions. The energy is a sum of the trace formula developed by Warner, Terentjev and Bladon (coupling the deformation gradient and the director field) and the bulk term for the director with coefficients depending on temperature. A key step in our analysis is to prove that the energy density has a convex extension to non-unit length director fields. Our results apply to the setting of physical experiments in which a thin incompressible elastomer in R^3 is clamped on its sides and stretched perpendicular to its initial director field, resulting in shape-changes and director re-orientation.

▶ MS-Th-E-56-3 17:00–17:30

The Radial Hedgehog Solution in the Landau-de Gennes Theory: Interplay between Geometry and Temperature

Majumdar, Apala Univ. of Bath

Abstract: We study the radial-hedgehog solution in the Landau-de Gennes theory for nematic liquid crystals, on a three-dimensional spherical shell, with Dirichlet radial boundary conditions. We derive delicate energy estimates as

a function of the shell's aspect ratio and temperature and prove that the radial hedgehog solution is the unique global energy minimizer for this boundary-value problem, for sufficiently low temperatures. This is joint work with Giacomo Canevari, Duvan Henao, Adriano Pisante and Mythily Ramaswamy.

▶ MS-Th-E-56-4 17:30–18:00

On the Behaviour of Smectic Liquid Crystals Subject to Small Perturbations

Snow, Ben — Univ. of Strathclyde

Abstract: After a brief review of Stewart's dynamic theory for smectic A (SmA) liquid crystals (with relevant elastic energy density given by De Vita & Stewart), results will be presented regarding the behaviour of SmA subjected to small perturbations in the form of a shear wave incident at the interface between a sample of SmA and an isotropic solid, and a disturbance to a known steady flow pattern in SmA in the presence of an obstacle.

▶ MS-Th-E-56-5 18:00–18:30

Superstructures from Liquid Crystal Colloids

Ravnik, Miha — Univ. of Ljubljana

Abstract: Liquid crystal colloids are interesting for a variety of mechanisms that can be used to create complex optical and photonic structures. Here, we present selected liquid crystal colloidal structures, as recently achieved by numerical modelling and experiments. Central to the structures are complex conformations of topological defects. More specifically, we show 2D and 3D colloidal crystals, Penrose P1 tiling with quasicrystalline and surface conditioned structures from multiple length scales.

MS-Th-E-57 16:00–18:00 402A

Modeling, Applications, Numerical Methods, and Mathematical Analysis of Fractional Partial Differential Equations I - Part III of V

For Part 1, see MS-Th-BC-57
For Part 2, see MS-Th-D-57
For Part 4, see MS-Fr-D-57
For Part 5, see MS-Fr-E-57

Organizer: Wang, Hong — Univ. of South Carolina
Organizer: Karniadakis, George — Brown Univ.

Abstract: Fractional Partial Differential Equations (FPDEs) are emerging as a new powerful tool for modeling many difficult complex systems, i.e., systems with overlapping microscopic and macroscopic scales or systems with long-range time memory and long-range spatial interactions. They offer a new way of accessing the mesoscale using the continuum formulation and hence extending the continuum description for multiscale modeling of viscoelastic materials, control of autonomous vehicles, transitional and turbulent flows, wave propagation in porous media, electric transmission lines, and speech signals. FPDEs raise modeling, computational, mathematical, and numerical difficulties that have not been encountered in the context of integer-order partial differential equations. The aim of this minisymposium is to cover the recent development in mathematical and numerical analysis, computational algorithms, and applications in the context of FPDEs and related nonlocal problems.

▶ MS-Th-E-57-1 16:00–16:30

High-Order Accurate Local Schemes for Fractional Differential Equations

Hesthaven, Jan — EPFL

Abstract: We discuss high-order methods inspired by the multi-step Adams methods for systems of fractional differential equations. The schemes are based on an expansion in a weighted space. We discuss the local truncation error and its behavior with respect to the step-size h and the order P. We develop an error indicator, based on the Milne device and illustrate the behavior for linear and nonlinear problems.

▶ MS-Th-E-57-2 16:30–17:00

A Novel Second-order Algorithm for Riesz Derivatives and Its Applications

Ding, Hengfei — Tianshui Normal Univ.
Li, Changpin — Shanghai Univ

Abstract: A novel 2nd-order algorithm for Riesz derivatives is established through constructing a new generating function and applying the shift technique. Applying this algorithm to Riesz type partial differential equations in one or two space dimensions can easily lead to unconditionally stable difference schemes. Following this idea, much higher-order algorithms for Riesz derivatives can be constructed which can be conveniently applied to Riesz spatial partial differential equations. Numerical experiments are also included which support the established numerical methods.

▶ MS-Th-E-57-3 17:00–17:30

WSGD OPERATORS, WSLD OPERATORS, TEMPERED-WSGD OPEARTORS, AND THEIR APPLICATIONS

Weihua, Deng — Lanzhou Univ.

Abstract: In this talk, we first introduce several classes of the high order discretizations for the space fractional derivatives, the space tempered fractional derivatives, and the fractional substantial derivatives; for the convenience of presentation, they are respectively called WSGD operators, WSLD operators, and tempered-WSGD operators. Then we discuss their applications in solving the space fractional diffusion equation, space tempered fractional diffusion equations.

▶ MS-Th-E-57-4 17:30–18:00

High Order Approximations for the Fractional Differential Equations

Sun, Zhi-zhong — Southeast Univ.

Abstract: Our work includes two parts : (1) A new high-order compact finite difference scheme is derived for the fractional sub-diffusion equation. It is proved that the difference scheme is unconditionally stable and convergent in L_∞-norm by the energy method. (2) A fourth-order difference approximation is derived for the space fractional derivatives. Then the proposed compact difference scheme for the spartial differential equation is proved to be unconditionally stable and convergent in $L2$ norm.

MS-Th-E-58 16:00–18:30 401

Theoretical and numerical studies of phase field model - Part II of IV

For Part 1, see MS-Th-D-58
For Part 3, see MS-Fr-D-58
For Part 4, see MS-Fr-E-58

Organizer: Wang, Cheng — Univ. of Massachusetts Dartmouth
Organizer: Qiao, Zhonghua — The Hong Kong Polytechnic Univ.
Organizer: Wang, Xiaoping — Hong Kong Univ. of Sci. & Tech.

Abstract: Phase field equations, which treat the phase variable as a continuous function instead of a sharp interface, model a great number of physical and biological phenomena, such as phase transformations of materials at different scales, the process in biological growth and development, and the topological change involved in multi-phase flows. This mini symposium is focused on the developments of the phase field models. Both the theoretical analysis for these highly nonlinear PDEs and the numerical approximations are of great interests.

▶ MS-Th-E-58-1 16:00–16:30

AN UNCONDITIONALLY ENERGY STABLE FINITE DIFFERENCE SCHEME FOR A STOCHASTIC CAHN-HILLIARD EQUATION

Qiao, Zhonghua — The Hong Kong Polytechnic Univ.
Zhang, Hui — Beijing Normal Unversity

Abstract: We present an unconditionally energy stable difference scheme for the MMC-TDGL equation, a stochastic Cahn-Hilliard equation. The method is based on a convex splitting of the energy functional. For the non-stochastic case, the energy stability is proved rigorously; for the stochastic case, we prove it in the mean sense. The resulted scheme is nonlinear and thus solved by Newton iteration, where GMRES algorithm is adopted to compute each Newton step. For the long time simulation, an adaptive time stepping strategy is developed base on the variation of the energy. The numerical experiments verify the property of the energy decay, the efficiency of the adaptive time stepping and the effect of the stochastic term.

▶ MS-Th-E-58-2 16:30–17:00

Numerical Simulation of Two-phase Fluid Systems Governed by A Diffuse Interface Model Equipped with Van Der Waals Equation of State

Sun, Shuyu — King Abdullah Univ. of Sci. & Tech.
Qiao, Zhonghua — The Hong Kong Polytechnic Univ.

Abstract: We consider multi-component two-phase systems modeled by a diffusive interface model equipped with van der Waals equation of state (EOS). We propose an efficient numerical solution of the modeling system, focusing on discrete energy stability, local mass conservation and numerical accuracy. Our algorithm consists of a finite volume-based method for spatial discretization and a convex splitting-based semi-implicit marching scheme for temporal discretization, which is proved to be unconditionally energy stable under certain conditions.

▶ MS-Th-E-58-3 17:00–17:30

Convergence of Discontinuous Galerkin Methods for the Allen-Cahn and Cahn-Hilliard Equations and Their Sharp Interface Limits

Feng, Xiaobing — The Univ. of Tennessee

Abstract: This talk is concerned with theoretical aspects of discontinuous Galerkin (DG) finite element methods for two best known phase field models, namely, the Allen-Cahn and Cahn-Hilliard equations. The focuses of the talk will be on discussing the recent developments on establishing the convergence of the numerical interfaces to the sharp interface limits of the both phase field models, namely, the mean curvature flow and the Hele-Shaw flow, as both the numerical mesh parameters and the phase field parameter tend to zero, and to present the main ideas for establishing those results, as well as to discuss possible generalizations of the ideas and results to other related phase field models. This is a joint work with Yukun Li of the University of Tennessee at Knoxville, and Yulong Xing of the the University of Tennessee at Knoxville and the Oak Ridge National Laboratory (ORNL).

▶MS-Th-E-58-4 17:30–18:00

Isotropic-nematic Interface in the Framework of Landau-de Gennes Theory

Wang, Wei — Zhejiang Univ.

Abstract: Isotropic and nematic are two important phases for liquid crystals materials. In this talk, we will discuss the isotropic-nematic problem in the framework of Landau-de Gennes theory. Specifically, we will discuss the stability of uniaxial interface profile and derive the sharp interface model for the hydrodynamics of isotropic-nematic two-phase flow by using the matched asymptotic expansion method.

▶MS-Th-E-58-5 18:00–18:30

A Second Order Accurate in Time Unconditionally Stable, Uniquely Solvable Scheme for Cahn-Hilliard-Navier-Stokes System

Wang, Xiaoming — Florida State Univ.

Abstract: Cahn-Hilliard-Navier-Stokes system is one of the well established diffuse interface models for two phase flows. We present a second order in time accurate, unconditionally stable, and uniquely solvable numerical scheme for this system. The algorithm combines the idea of pressure projection for the momentum equations and convex splitting for the phase field equation. Our numerical experiments confirm the theoretical findings. This is a joint work with Daozhi Han.

MS-Th-E-59 16:00–18:00 402B

Energy-Driven Pattern Formation - Part II of IV

For Part 1, see MS-Th-D-59
For Part 3, see MS-Fr-D-59
For Part 4, see MS-Fr-E-59

Organizer: Kohn, Robert — New York Univ.

Abstract: Energy-driven pattern formation examines how energy minimization leads to the formation of defects and microstructure in a variety of physical systems. Examples include the wrinkling of a stretched elastic membrane, the twinning produced by martensitic phase transformation, and the defects seen in liquid crystals. In these and many other examples, the physics is modelled by a nonconvex variational problem regularized by a higher-order term with a small coefficient, and energy-driven pattern formation can be studied by considering the limiting behavior of minimizers as the small parameter tends to zero. Another recurrent theme is the use of ansatz-free bounds to identify and explore the features of energy-minimizing configurations. A third recurrent theme is dynamics, since the patterns of interest are sometimes transient states of steepest-descent processes.

▶MS-Th-E-59-1 16:00–16:30

Chiral Skyrmions: New Phases in Condensed Matter

Melcher, Christof — RWTH Aachen Univ.

Abstract: Chiral symmetry breaking described by Lifshitz invariants gives rise to a class of topological solitons, the so-called chiral skyrmions. This form of chirality occurs in various condensed matter systems including ferromagnets and liquid crystals. We shall discuss the stabilization of isolated chiral skyrmions and skyrmions lattices emerging as new phases in appropriate parameter regimes.

▶MS-Th-E-59-2 16:30–17:00

The Energy Scaling Law of A Thin Film Bonded to A Compliant Substrate, and the Wrinkling of A Floating Elastic Sheet.

Nguyen, Hoai-Minh — Ecole Polytechnique Federale de Lausanne EPFL

Abstract: This talk is on the energy scaling law of thin films. Two problems are discussed: 1) the compliance of a thin film to a substrate where a herringbone pattern is "optimal"; 2) the wrinkling of a floating elastic film where a cascade pattern achieves the law. Ansatz-free proofs showing that no pattern can achieve a better law are mentioned. The proofs use some non-standard interpolation inequalities. This is joint work with Bob Kohn.

▶MS-Th-E-59-3 17:00–17:30

Low Density Phases in A Uniformly Charged Liquid

Knuepfer, Hans — Univ. of Heidelberg

Abstract: We consider a macroscopic limit for the Ohta-Kawasaki energy, used to described phase separation for diblock-copolymers. We first investigate existence and shape of minimizers of the energy with prescribed volume (of the one phase) in the full space setting. We then consider the situation of periodic configurations with prescribed density. We show that in a certain regime, the energy Gamma-converges to a homogenized problem. This is joint work with C. Muratov und M. Novaga.

▶MS-Th-E-59-4 17:30–18:00

Metastability and Access to Ground States in A Class of Variational Models for Self-Assembly

Choksi, Rustum — McGill Univ.

Abstract: We consider a class of non-convex variational models for self-assembly, focusing on metastability and access to a ground state. We explore a simple strategy for assessing whether or not a particular computed metastable state is a global minimizer. The method is based upon finding a"suitable" global quadratic lower bound to the free energy. This is joint work with D. Shirokoff (NJIT) and J.C. Nave (McGill).

MS-Th-E-60 16:00–18:00 310

Mathematical methods in biomedical applications - Part I of III

For Part 2, see MS-Fr-D-60
For Part 3, see MS-Fr-E-60

Organizer: Amigo, Jose — Universidad Miguel Hernandez
Organizer: Liang, X. San — Nanjing Inst. of Meteorology
Organizer: Small, Michael — Univ. of Western Australia

Abstract: Mathematics is being successfully applied to a number of important topics in biology and medicine like biofluids, data analysis, drug design and discovery, epidemiology, evolution, genetics, image processing, immunology, medical instrumentation, neuroscience, plant growth, population dynamics (including ecology and microbiology), tumor propagation, virus dynamics, etc. The list of tools include virtually the whole applied mathematics. To cite just the most familiar ones: discrete dynamical systems, ordinary and time-delay differential equations, graph and network theory, integral transforms, numerical and computational mathematics, partial and stochastic differential equations, statistics, probability, and time series analysis. All this research has contributed and is increasingly contributing both to a better understanding of complex biological phenomena and to find practical ways of action. On the wake, new branches of applied mathematics have emerged, e.g., mathematical biology, theoretical biology, and computational neuroscience. But the most important consequence is the improvement in health care and life quality that results from, say, early and better diagnoses, more efficient drugs, plague control, or biotechnological know-how, all of which owe much to the mathematical research.

This being the case, the scope of the minisymposium hereby proposed is to give researchers the opportunity to share their latest applications of mathematical methods to biology and medicine in a multi- and interdisciplinary environment. The topics addressed have been intentionally left open with the objective of having a broader participation. Thus, researchers in computational neuroscience can benefit very much from a network-based approach or time series analysis. Researchers in deterministic models can get further inspiration from stochastic methods or fractional analysis. Moreover, specialists in one particular field can learn new, possibly unexpected applications of their technical skills or hear about other approaches.

With this scope in mind, the organizers of this minisymposium have invited a reduced number of experts who work on applications of mathematics to medicine and biology. Their theoretical backgrounds cover mainly nonlinear dynamics, computational neuroscience, time series analysis, network theory, and partial differential equations, thus a representative blend of current research. Specially important are the actual and potential applications to the biomedical industry of topics such as complex fluids, drug discovery, computational methods and information analysis, all of them included in the minisymposium. For instance, the parametric study of the flow in ventricular catheters for the treatment of hydrocephalus presented in one of the communications, has led new designs which are patent pending.

If approved, this minisymposium will be certainly a great place to create synergies in an area of mathematics which has scientific interest, applications to the biomedical industry, and social impact.

▶MS-Th-E-60-1 16:00–16:30

Parametric Study of the Flow in Ventricular Catheters

Amigo, Jose — Universidad Miguel Hernandez
Galarza, Marcelo — Univ. Hospital of Murcia
Gimenez, Angel — Universidad Miguel Hernandez de Elche
PELLICER, OLGA — MIGUEL HERNANDEZ Univ.
Valero, Jose — Univ. Miguel Hernandez of Elche

Abstract: Hydrocephalus is a medical condition characterized by an abnormal accumulation of cerebrospinal fluid in the brain ventricles. A catheter is inserted in one of the ventricles and then connected to an external valve to drain the excess of fluid. To uniformize the flow pattern, we have carried out a parametric study of the cerebrospinal fluid flow via numerical catheter models. As a result we formulate some basic principles for ventricular catheter design.

▶ MS-Th-E-60-2 16:30–17:00

Self-organization of Interacting Agents and Applications to Population Dynamics

Escudero, Carlos — Universidad Autonoma de Madrid

Abstract: We study the stochastic process of two-species coagulation as a model for population dynamics. Our approach consists in direct numerical simulations to describe this process at the microscopic level as well as the rigorous analysis of kinetic equations that describe it at the mesoscopic level. The conclusions of both analyses are put in the context of social interactions of insects.

▶ MS-Th-E-60-3 17:00–17:30

Comparing Structural and Functional Clusters for Dynamic Network Data

Xu, Xiaoke — Dalian Nationalities Univ.

Abstract: In social networks and biological networks, a structural cluster (community) refers to the occurrence of groups of nodes in a network that are more densely connected internally than with the rest of the network. In this study, we proposed a technique for the detection of functional clusters in discrete event data. The novel method can be used to detect functional clusters for dynamic network data (such as neural spike data and short message communication data).

▶ MS-Th-E-60-4 17:30–18:00

Cardio-respiratory Coordination During Sleep

Wessel, Niels — Humboldt-Universität zu Berlin

Abstract: Obstructive apnoeas and hypopnoeas (AHE) are defined by reduced ventilation which is caused by obstructions of the upper airways during sleep. In order to characterise the autonomic regulation during AHE, we concentrate on the mutual influence of the cardiac and respiratory oscillations on their respective onsets, the cardio-respiratory coordination (CRC). We find that the occurrence of CRC is significantly more frequent during AHE than in normal respiration and is more frequent after these events.

CP-Th-E-61	16:00–18:00	101
Stochastic differential equation		

Chair: Karthikeyan, Shanmugasundaram — Periyar Univ.

Abstract:

▶ CP-Th-E-61-1 16:00–16:20

Controllability of Nonlinear Stochastic Dynamical Systems with State Delays

Karthikeyan, Shanmugasundaram — Periyar Univ.

Abstract: This paper is concerned with the relative controllability for a class of control systems governed by nonlinear stochastic systems with multiple delays in state. Sufficient conditions for relative controllability are established by using the Banach fixed point principle. An example is provided to illustrate the application of the result.

▶ CP-Th-E-61-2 16:20–16:40

Stochastic Fuzzy Differential Equations - A Tool for Stochastic Systems with Imprecise Values

Malinowski, Marek T. — Univ. of Zielona Gora

Abstract: To handle dynamics of systems operating in random and vague/fuzzy environment, we propose to consider stochastic fuzzy differential equations. This constitutes a new branch of research in modeling uncertain phenomena. We examine equations whose solutions have increasing and decreasing fuzziness. The existence and uniqueness of solutions is investigated. Also, stability properties of solutions are established. Several examples are studied to indicate applicability of the theory introduced in modeling population growth, stock price, short-term interest rate.

▶ CP-Th-E-61-3 16:40–17:00

DETERMINING TRANSMISSION EIGENVALUES OF ANISOTROPIC INHOMOGENEOUS MEDIA FROM FAR FIELD DATA

Peters, Stefan — AG inverse problems, Univ. Bremen

Abstract: We characterize interior transmission eigenvalues of penetrable anisotropic acoustic scattering objects by a technique known as inside-outside duality. Under certain conditions on the anisotropic material coefficients of the scatterer, the inside-outside duality allows to rigorously characterize interior transmission eigenvalues from multi-frequency far field data. This theoretical characterization moreover allows to derive a simple numerical algorithm for the approximation of interior transmission eigenvalues.

▶ CP-Th-E-61-4 17:00–17:20

Path Integration Methods for Weak Solutions of Stochastic Differential Equations

Chen, Linghua — Norwegian Univ. of Sci. & Tech.

Abstract: The numerical path integration method is used to approximate the evolution of the probability density of the solution process of stochastic differential equations, driven by either traditional white noise or more general Levy type noise.
In this paper we firstly analyze the close connection between the discretized path integration operators and their corresponding integro-differential operators. Under rather standard assumptions, convergence results are proved that the iteration of discretized operation approximates the semi-groups generated by the original continuous equations.
Next we look at the realization of the path integration operator on a digital computer, and demonstrate the convergence of the algorithm. Various examples are presented and compared with other numerical methods. We conclude that the path integration method gives rather satisfactory results, and it copes with a quite wide family of problems arisen from different fields.

▶ CP-Th-E-61-5 17:20–17:40

Regularity of Solutions of Stochastic Tidal Dynamics Equation with Additive Noise

Suvinthra, Murugan — Bharathiar Univ., Coimbatore

Abstract: In this work we consider the stochastic analogue of tidal dynamics equation developed by Marchuk and Kagan (1984). The tidal dynamics model is a coupled system relating the horizontal flow to the surface height of the ocean. The randomness is assumed to be Gaussian noise of additive type. We analyze the regularity of solutions of the stochastic tidal dynamics equation with randomness being considered for both the equations. Existence of strong solutions to the system is established by using Galerkin approximation and local monotonicity argument introduced by Minty and Browder (1963). The uniqueness of solution is observed to be pathwise and the regularity of solution is discussed by using an equivalent Sobolev norm obtained by means of Fourier transform. It is concluded that the regularity of the strong solution could be improved with suitable assumptions on the initial data and external forces acting on the system.

CP-Th-E-62	16:00–18:00	102
Physics and Statistical Mechanics		

Chair: Sahoo, Pradyumn Kumar — Birla Inst. of Tech. & Sci.-Pilani, Hyderabad Campus

Abstract:

▶ CP-Th-E-62-1 16:00–16:20

Kaluza-Klein cosmological model in f(R,T) gravity with Λ (T)

Sahoo, Pradyumn Kumar — Birla Inst. of Tech. & Sci.-Pilani, Hyderabad Campus

Abstract: A new class of Kaluza-Klein cosmological models in f(R, T) theory of gravity have been investigated for a specific choice of the functional f(R, T) = f1(R) + f2(T). The exact solutions of the field equations are obtained by considering two different aspects of the volumetric expansion. Keeping an eye on the accelerating nature of the universe in the present epoch, the dynamics and physical behaviour of the models have been discussed.

▶ CP-Th-E-62-2 16:20–16:40

The Schrodinger Model and Its Applications.

David, Darlington S. Y. — William V. S. Tubman Univ.
Ben, Christian — Univ. of Liberia
Fatigun, Adetona — Univ. of Ado Ekiti

Abstract: In this paper, the Schrodinger model was investigated. Our results show that the time-independent operators correspond to the observables of the quantum system. Also, from the Schrodinger model, it was proven that the model can be used to represent physical quantities such as quanta energy, quanta momentum and harmonic oscillator. Our results also show that operators are very useful tools for the representation of the eigenfunctions of the harmonic oscillator. Eigenfunctions can also be orthogonal basic of unit vector in an n-dimensional vector space that is obtained by solving the Schrodinger equation.

▶ CP-Th-E-62-3 16:40–17:00

Cosmological Consequences of Interacting Holographic Ricci Dark Energy in F(R,T) Gravity

Chattopadhyay, Surajit — Pailan College of Management & Tech., Kolkata

Abstract: Accelerated expansion of the current universe is well established through observational studies and well discussed in the literature. The origin of dark energy responsible for the cosmic acceleration is one of the serious problems in modern cosmology. Another approach toward understanding this accelerated expansion is modified gravity.The present work reports study on the interacting Ricci dark energy in a modified gravity theory named f(R, T) gravity. In the specific model $f(R,T) = \mu R + \nu T$ we have observed a quintom-like behavior of the equation of state parameter and a transition from matter dominated to dark energy density has been observed through fraction density evolution. The statefinder parameters reveal that the model interpolates between dust and LCDM phases of the universe.

▶ CP-Th-E-62-4 17:00–17:20

F(T) Gravity and Wormhole Solutions

Rani, Shamaila Univ. of Management & Tech., Lahore

Abstract: A wormhole is a hypothetical path to connect different regions of the universe. This path can be regarded as a tunnel or bridge from which the observer may traverse easily. In general relativity, the exotic matter (which violates the energy conditions) constitutes basic ingredient to develop mathematical structure of wormhole. The violation of null energy condition is the necessary tool to form wormhole solutions which also allow two way travel. The search for a realistic source which provides this violation (while normal matter may satisfy the energy conditions) has gained a lot of interest now-a-days. This search introduced modified theories of gravity in wormhole scenario. In f(T) gravity, the effective energy- momentum tensor is responsible for the corresponding violation while normal matter threads wormhole solutions.

▶ CP-Th-E-62-5 17:20–17:40

Application of Advanced Divergent Series Summation Techniques for Molecule Vibrational Energy Spectrum Calculations. Analytical Properties of Complex-valued Energy Function of Different Molecules.

Duchko, Andrei V.E. Zuev Inst. of atmospheric optics/ Tomsk Polytechnic Univ./

Abstract: The Rayleigh – Schrödinger perturbation theory is applied to energy levels calculation of excited vibrational states for different molecules. The calculations are carried out for the vibrational states that correspond to three- to seven-fold vibrational excitations. Perturbation series diverge in the case of strong resonance interactions. Nevertheless, considering vibrational energy of each excited state not as a real number, but as a complex function and applying corresponding analytical functions theory, we were able not only to get the exact value of energy, but to find the reason of divergence, and to choose the best summation technique. Our summation technique is based on high-order Pade-Hermite approximations. Further research shows that series behavior completely depends on the singularities of complex energy function inside unit circle. This analysis helped us to make the first exact definition of resonance interaction and to develop a unique technique for vibrational energy spectrum calculations avoiding resonances.

▶ CP-Th-E-62-6 17:40–18:00

Two-channel Totally Asymmetric Simple Exclusion Process with Langmuir Kinetics: An Application to Intracellular Transport

Dhiman, Isha Indian Inst. of Tech. Ropar
Gupta, Arvind Indian Inst. of Tech. Ropar

Abstract: Mobility is one of the important attributes of life. Interestingly, the intracellular dynamics are based on filaments and motor proteins, which carry load in the form of essential minerals and transport it within a cell by converting the energy released from the hydrolysis of adenosine triphosphate (ATP). The motor proteins move in a cytoskeletal network formed by filaments. Their motion along the tracks of a network can be studied in a simplified manner using a multi-channel model. In this study, we propose a two-channel system resembling the dynamics of motor proteins along two coupled parallel filaments, in which shifting to adjacent filaments is also allowed. The stochastic binding unbinding of proteins to filaments is modeled using Langmuir kinetics. We have used singular perturbation technique on mean-field equations to obtain stationary phase diagrams. Particularly, the consequences of variation in attachment-detachment rates are investigated. The theoretical predictions agree well with Monte-Carlo simulations.

CP-Th-E-63 16:00–18:20 103

Finance and Management Science

Chair: Ghazali, Puspa Liza Univ. of Sultan Zainal Abidin

Abstract:

▶ CP-Th-E-63-1 16:00–16:20

IMPLEMENTATION OF INTEGRATION MODEL FOR HEALTH AND EDUCATION FUND IN MALAYSIA

Ghazali, Puspa Liza Univ. of Sultan Zainal Abidin

Abstract: Everyone knows that there are various names used in the takaful or insurance business, but does anyone know about the transparency in customer quotations if they do not hide the important data or 'inner works' . This is important for customers to make the right selection when buying insurance or takaful products. Therefore, a new design of premium life tables and also the implementation of the model should be made because to satisfy the customer and free of hidden agenda. By using the mudharabah or wakala model of Integration Model, Malaysia government will has a new Model Islamic Fund in Malaysia to help people and government for health and education fund in Malaysia.

▶ CP-Th-E-63-2 16:20–16:40

Maximizing Portfolio Return: Graph Theory Based Selection

Mukherjee, Tuhin Univ. of Kalyani
Mitra, Gautam Univ. of Burdwan

Abstract:
Graph theory is one of the discrete mathematical tools which is used in this paper to select the best portfolio among a set of given portfolios. Empirical verification is done in the context of Indian stock market during 2014 (when stock market was expected to go up due to emergence of newly formed NDA government.). An innovative methodology has been proposed to compute a balance index. The finding turned out to be consistent with other well-known techniques of portfolio selection. To the best of our knowledge, graph theory has not been used previously for the above purpose. This new outlook opens number of challenging research areas in Mathematical Finance.

▶ CP-Th-E-63-3 16:40–17:00

Modified Path Simulation Method for Valuation of Asian American Options

Lesmono, Dharma Universitas Katolik Parahyangan
Permana, Ferry Jaya Universitas Katolik Parahyangan
Chendra, Erwinna Parahyangan Catholic Univ.

Abstract: In this paper, we use a modified path simulation method for valuation of Asian American Options. This method is a modification of the path simulation model proposed by Tiley. We assume that the behavior of the log return of the underlying assets follows the Variance Gamma (VG) process, since its distribution is heavy tail and leptokurtic. We provides sensitivity analysis of this method and compares the obtained prices to Asian European option prices.

▶ CP-Th-E-63-4 17:00–17:20

Value-at-Risk (VaR) under Variance Gamma (VG) Process

Permana, Ferry Jaya Universitas Katolik Parahyangan
Lesmono, Dharma Universitas Katolik Parahyangan
Chendra, Erwinna Parahyangan Catholic Univ.

Abstract: VaR is used as a standard tool to measure the potential loss in value of risky asset or portfolio. Calculation of VaR is commonly based on the assumption that the log return of asset or portfolio is normally distributed. In this paper we calculate the VaR by assuming the log return of asset or portfolio follows the VG process. Performance of the method is investigated by applying that method to real data in Indonesia market

▶ CP-Th-E-63-5 17:20–17:40

ANALYSIS OF PORTFOLIO OPTIMIZATION: EVIDENCE FROM INDONESIAN STOCK MARKET

Nugrahani, Endar Bogor Agricultural Univ.

Abstract: Markowitz mean-variance portfolio optimization theory is implemented for all stocks listed in Indonesian stock market for the last five years. The analysis also presents Sharpe's diagonal model with the assumption that the market index is the only common factor with reference to which stocks varied. The results show that well diversified portfolios provide higher returns at a specified risk level compared to portfolios which consist of individual sectors stocks.

▶ CP-Th-E-63-6 17:40–18:00

Counterparty Credit Risk with A New Reduced Form Model with Default Contagion

Li, Wang The Univ. of Manchester

Abstract: We propose a new reduced-form model with default dependence. Our model includes both exogenous economic-wide events and interaction between companies' credit events. And it generates considerable default dependence level and allows for recovery from credit events. The model is applied to compute Credit Value Adjustment for a CDS contract with wrong-way risk. By choosing a stochastic square root jump-diffusion (SSRJD) process to be the default independent process and combining with a contingent shift, our approach results in a two-dimensional partial integro-differential equation (PIDE) for survival probability, price of credit default swaps (CDS) and credit value adjustment (CVA). We also discuses the finite scheme and its efficiency and accuracy is analysed with examples of survival/default probabilities and CDS prices using analytical solutions if available. Finally, the survival/default

probabilities, CDS prices and CVA are compared to the results of previous contagion models.

▶CP-Th-E-63-7 18:00–18:20

Stochastic Volatility Double Jump-diffusions Model: the Importance of Distribution Type of Jump Amplitude

SUN, Youfa Guangdong Univ. of Tech.

Abstract: This research examines if there exists an ideal distribution for jump amplitude in the sense that with this distribution, the stochastic volatility double jump-diffusions (SVJJ) model would potentially have a superior option market fit. We provide a general methodology for pricing vanilla options via a Fourier cosine series expansion method, in the setting of Heston's SVJJ (HSVJJ) model that may allow a range of jump amplitude distributions. Example applications include the normal distribution, the exponential distribution and the asymmetric double exponential distribution, for the reason of analytical tractability for options and economical interpretation. An illustrative example examines the implications of HSVJJ model in capturing option 'smirks'. This example highlights the impacts on implied volatility surface of various jump amplitude distributions, through both extensive model calibrations and carefully designed implied-volatility impacting experiments.

CP-Th-E-64 16:00–18:00 104

Other Mathematical Topics and their Applications

Chair: Komal, Komal H.N.B. Garhwal Univ., Srinagar(Garhwal), Uttarakhand

Abstract:

▶CP-Th-E-64-1 16:00–16:20

Fuzzy Reliability Analysis of A Fire Pump System with Components Following Different Membership Functions

Komal, Komal H.N.B. Garhwal Univ., Srinagar(Garhwal), Uttarakhand

Abstract: Reliability plays a crucial role to enhance the performance of any complex industrial system constituted by number of repairable components following different types of failures/repairs. Data uncertainty due to various practical constraints is always influence the system reliability and consequently make a challenge for decision maker to extract some concrete decisions for enhancing system performance . System components' failure/repair data uncertainty and their different types of patterns increase the difficulty of system analysts to analyse and enhance the system performance. To overcome these problems, this paper presents a novel approach in which different types of fuzzy membership functions are used to incorporate different types of uncertainties and Tw(weakest t-norm) based approximate fuzzy arithmetic operations are adopted for fuzzy reliability analysis of complex repairable systems. Proposed approach has been applied to analyse the reliability of a fire pump system and the computed results are compared with traditional and existing fuzzy lambda-tau(FLT)approaches.

▶CP-Th-E-64-2 16:20–16:40

Study of Einstein Theory of Gravitation for Gödel Type Solution

Pandey, S. Motilal Nehru National Inst. of Tech. Allahabad

Abstract: In this paper, we have studied higher order theory of gravity which is based on conformal non-invariance of gravitational wave equations. These waves are inevitable consequences of Einstein theory which are non-conformally invariant unlike electromagnetic waves which are conformally invariants. We study these field equations by considering its solutions in heterogeneous space-time of Gödel type and compare its result with Einstein field equation with cosmological constant.

▶CP-Th-E-64-3 16:40–17:00

Second Order Slip Effects on Entropy Generation of MHD Nanofluid Flow over A Stretching Surface with Thermal Radiation Effect

A.K., Abdul Hakeem Sri Ramakrishna Mission Vidyalaya CAS
B., Ganga Providence College for Women, Coonoor

Abstract: The aim of the present paper is to analyze the second order slip effects on entropy generation of an incompressible, viscous and electrically conducting water based nanofluid boundary layer flow over a stretching surface with thermal radiation effect. A system of governing non-linear partial differential equations is transformed to ordinary differential equations with help of Lie group transformation. The analytical results are derived in terms of Kummer' s function and the numerical results are obtained by shooting method. The entropy generation is calculated using the entropy relation by substituting the velocity and temperature fields obtained from the momentum and energy equations. The effects of pertinent physical parameters on entropy generation, skin friction coefficient and the reduced Nusselt number are discussed. A comparative analysis of present results with previously published results is given.

▶CP-Th-E-64-4 17:00–17:20

Inexact Tensor-free Chebyshev-Halley Class

Eustaquio, Rodrigo Federal Technological Univ. of Parana

Abstract: This work introduces a class of methods for solving nonlinear systems. This new class can be seen as a generalization of the Chebyshev-Halley class. It is known that the methods latter class could have cubic convergence rate, that means, higher order convergence rate than Newton's method. However, Chebyshev-Halley class methods are computationally expensive, requiring second-order derivatives information. The new class of methods, named the inexact tensor-free Chebyshev-Halley class, does not calculate second-order derivatives and finds the next iterate by approximately solving two linear systems. In addition to giving a proof of the convergence of these new methods, it is shown that, depending on reasonable assumptions, the methods of this class can have superlinear, quadratic, superquadratic or cubic convergence rates. Numerical evidence that demonstrates significant improvement when utilizing the proposed inexact tensor-free methods, is presented.

▶CP-Th-E-64-5 17:20–17:40

2D Single Station Passive Location Iterative Algorithm in Geocentric Coordinate System

Lihai, Ji Inst. of Applied Physics & Computational Mathematics
Junping, Yin Inst. of Applied Physics & Computational Mathematics
Xiaoying, Wang School of Mathematics & Physics, North China Electric Power Univ.

Abstract: This paper mainly considers the iteration algorithm of passive location for 2D small samples and large samples under the geocentric coordinates system. For small samples, we give the probability of elliptical locating region by probability density curves. For large samples, we develop the localization algorithm of generalized least squares in the terrestrial coordinates conditions. The location algorithm of small samples provides a better initial value for iterative location of large samples, which can efficiently improve the convergence speed of the iterative positioning. In theory, we analyze the positioning accuracy of positioning error by covariance matrix of generalized least squares. Then the numerical simulations results demonstrate the analyze positioning precision of static target by various algorithm. Meanwhile, we give the dependencies between positioning precision and moving speed when positioning for the mobile target by iterative algorithm of generalized least squares.

CP-Th-E-65 16:00–18:20 105

Dynamical Systems and Nonlinear Analysis

Chair: Sambath, Muniyagounder Bharathiar Univ.

Abstract:

▶CP-Th-E-65-1 16:00–16:20

Pattern Formation for A Cross-diffusive Predator-prey Model with Predator Saturation and Competition Response

Sambath, Muniyagounder Bharathiar Univ.

Abstract: In this paper, we investigate the emergence of spatiotemporal patterns of a predator-prey system with cross diffusion. First we compute the critical lines of Hopf and Turing bifurcations in a spatial domain by using bifurcation theory. More specifically, the exact Turing region is given in a two parameter space. Our results confirm that cross diffusion can create stationary patterns, which enrich the finding of pattern formation in an ecosystem.

▶CP-Th-E-65-2 16:20–16:40

Convergence of Infinite Family of Multivalued Generalized Nonexpansive Mappings Using SP and Noor Iterative Procedures

Chugh, Renu Deptt. of Mathematics, Maharishi Dayanand Univ., Rohtak

Abstract: Different iterative procedures have been used to approximate fixed points of multivalued mappings. Many authors have intensively studied the fixed point theorems and got some results. They extended these results to many discipline branches, such as control theory, convex optimization, variational inequalities, differential inclusion and economics. In 2014, Chang et al. proved the convergence theorems for some multi-valued generalized non expansive mappings. Motivated by this results, we extend the results of Chang et al. from one countable family to 3- countable family and prove weak and strong convergence results of SP and Noor iterative procedures to common fixed point of countable family of multivalued generalized non expansive mappings in a Uniformly Convex Banach space. Also, by using C++ program, we provided a numerical example which shows that the rate of convergence

of two different iterative procedures used in our results have better rate of convergence than other existing iterative procedures.

▶CP-Th-E-65-3 16:40–17:00

Existence of Solutions of Fractional Differential Equations with Non Instantaneous Impulses

Annamalai, Anguraj PSG College of Arts & Sci.,

Abstract: We consider a new class of Fractional Integro-differential equations with non instantaneous impulses . We establish an existence theorem for abstract fractional integro-differential equations with initial conditions under non instantaneous impulsive moments. The results are obtained by using the fixed point theorem for condensing map and resolvant operator

▶CP-Th-E-65-4 17:00–17:20

On the Existence of Solutions to Boundary Value Problems for First-order Fuzzy Delay Differential Equations

Hongzhou, Wang Beijing Inst. of Tech.

Abstract: In this paper, we consider existence of solutions to first-order fuzzy delay differential equation with two-point boundary value condition. Firstly, we study a class of linear fuzzy differential equation with boundary value condition x(0) = α x(T), where α ∈R. Some necessary conditions are provided with α in different intervals. Based on these results and upper and lower solutions method, we obtain some existence results about first-order nonlinear differential equation with the same boundary value condition.

▶CP-Th-E-65-5 17:20–17:40

Sharp Interface Model for Solid-state Dewetting Problems with Weakly Anisotropic Surface Energies

Wang, Yan National Univ. of Singapore

Abstract: Based on an energy variational approach, we propose a sharp interface model for simulating solid-state dewetting of thin films with (weakly) anisotropic surface energies. The morphology evolution of thin films is governed by surface diffusion and contact line migration. For the contact line migration, we introduce a relaxation kinetics with a finite contact line mobility by energy gradient flow method. We implement the mathematical model in an explicit finite-difference scheme with cubic spline interpolation for evolving marker points. Following validation of the mathematical and numerical approaches,we simulate the evolution of thin-film islands, semi-infinite films, and films with holes. The numerical results capture many of the complexities associated with solid-state dewetting experiments.

▶CP-Th-E-65-6 17:40–18:00

Plane Waves at the Interface of Two Dissimilar Thermo-viscoelastic Half-spaces with Voids

Bhagwan, Jai Government College for Women, Tosham (Bhiwani)

Tomar, Sushil Kumar Panjab Univ., Chandigarh

Abstract: Reflection and transmission phenomena of plane waves striking obliquely at the plane interface between two dissimilar thermo-viscoelastic half-spaces with voids have been investigated. Two problems have been considered: (a) when a set of coupled dilatational waves is made incidence at the interface; (b) when a shear wave is made incidence at the interface. The theory of thermo-viscoelastic material with voids developed by Iesan (2011) has been employed for mathematical treatment. Potential method has been adopted to solve the equations of motion for two-dimensional problem. The equations giving the amplitude and energy ratios corresponding to various reflected and transmitted waves have been presented in closed form. Numerical computations have been performed for a specific model to study the dependence of various amplitude and energy ratios on the angle of incidence. Effects of various parameters on the amplitude ratios have been investigated and the corresponding results are depicted graphically.

▶CP-Th-E-65-7 18:00–18:20

Wavelet-Based FDTD and Tunable High Resolution Estimator for Calculation of Band Structures in Two-Dimensional Phononic Crystals

Yan, Zhizhong Beijing Inst. of Tech.

Abstract: This paper discusses the wavelet-based Finite Difference Time Domain (FDTD) method and a tunable high resolution estimator with a specific problem of sound wave propagation through phononic crystals. If the band structures of a phononic crystal are calculated by the traditional FDTD method combined with the fast Fourier transform (FFT), some disadvantages, such as time consuming and the numerical instability of FDTD iterations are encountered. Moreover, good frequency estimation can only be ensured by the post-processing of sufficiently long time series. In this paper, a wavelet-based FDT-D and a tunable high resolution estimator based on a bank of filters are proposed to overcome these difficulties. Numerical results for two-dimensional phononic crystal show that, the wavelet-based FDTD method improves the efficiency of the time stepping algorithm and the stability of iterations, and tunable high resolution estimator shows the advantages over the FFT-based spectral estimation.

MS-Th-E-66 16:00–18:00 VIP4-3

Theory and applications of Painleve type equations - Part II of II

For Part 1, see MS-Th-D-66

Organizer: Takenawa, Tomoyuki Tokyo Univ. of Marine Sci. & Tech.

Organizer: Dzhamay, Anton Univ. of Northern Colorado

Abstract: Last few decades have seen major developments in the theory of differential Painlevé equations. Their solutions, called Painlevé transcendents, are nonlinear special function that are playing an increasingly important role in many nonlinear problems in Mathematical Physics in areas such as Integrable Systems, Random Matrices, and others. Recently a lot of progress has been made in understanding the discrete analogues of Painlevé equations and their connections to Algebraic Geometry and Representation Theory. The purpose of this minisumposium is to bring together researchers working in this active area to discuss recent advances in the theory and their applications to other fields.

▶MS-Th-E-66-1 16:00–16:30

Lax Pairs of Discrete Painleve Equations Arising from the Integer Lattice

Nakazono, Nobutaka The Univ. of Sydney

Shi, Yang the university of Sydney

Joshi, Nalini The Univ. of Sydney

Abstract: Construction of the Lax pairs of the ordinary difference equations called discrete Painleve equations from those of the partial difference equations called ABS equations via the periodic type reduction are well investigated. In this talk we will show new method to obtain the Lax pairs of discrete Painleve equations from the integer lattice associated with ABS equation.

▶MS-Th-E-66-2 16:30–17:00

Symmetry and Combinatorics of Discrete Integrable Systems

Shi, Yang the university of Sydney

Joshi, Nalini The Univ. of Sydney

Nakazono, Nobutaka The Univ. of Sydney

Abstract: Symmetry plays a central role in the study of integrable systems. Using the tools from representation theory of affine Weyl groups, we uncover various properties and relations between the different discrete integrable systems. In particular, the objects fundamental to this work are the polytopes (higher dimensional generalization of Polygons) associated with the symmetry groups, of which interesting geometric and combinatorial aspects will be discussed.

▶MS-Th-E-66-3 17:00–17:30

Exact WKB Analysis for the Second Painleve Equation

Iwaki, Kohei Research Inst. for Mathematical Sci.

Abstract: We analyze the second Painleve equation (P2) via the exact WKB analysis. In particular, we discuss connection problems for non-linear or parametric Stokes phenomena for a WKB-type formal solution of P2.

▶MS-Th-E-66-4 17:30–18:00

A Bilateral Extension of the Ramanujan Entire Function

Morita, Takeshi Osaka Univ.

Abstract: In this talk, we give a bilateral extension of the “Ramanujan entire function” and study the connection problem on the q-difference equations which satisfied by the extended Ramanujan entire function. We also introduce the multi-sum type q-Borel-Laplace transformations to study the connection problems.

SL-Th-1 19:00–20:00 Ballroom C

Special Lecture

Chair: Cook, L. Pamela

Abstract:

▶SL-Th-1 19:00–20:00

Predicting Population Extinction, Disease Outbreaks and Species Invasions Using Branching Processes

Allen, Linda J. S. Texas Tech University

Abstract:

Friday, August 14, 2015

IL-Fr-1 8:30–9:30 Ballroom A
Invited Lecture
Chair: Esteban, Maria
Abstract:

▶ IL-Fr-1 8:30–9:30
Approximate likelihoods
Reid, Nancy University of Toronto

Abstract: In complex models likelihood functions may be difficult to compute, or depend on assumptions about high order dependencies that may be difficult to verify. A number of methods have been devised to compute inference functions either meant to approximate the true likelihood function, or to provide inferential summaries that balance statistical efficiency with ease of computation. Examples include variational approximations, composite likelihood, quasi-likelihood, indirect inference, and Laplace-type approximations. This talk will survey various approximations to likelihood and likelihood inference, with a view to identifying common themes and outstanding problems.

IL-Fr-2 8:30–9:30 Ballroom B
Invited Lecture
Chair: Cuminato, Jose A.
Abstract:

▶ IL-Fr-2 8:30–9:30
On Lagrangian Decomposition for Energy Optimization
Sagastizábal, Claudia Instituto Nacional de Matemática Pura e Aplicada

Abstract: Real-life optimization problems often depend on data subject to unknown variations that can be due to imprecise measurements or to the stochastic nature of the data itself. When decisions need to be taken with high precision, it is important to employ methods that are reliable when subject to data variability. For complex problems such as those arising in the energy sector, advanced nonsmooth optimization techniques combined with Lagrangian decomposition provide a satisfactory answer to such concerns. We review recent approaches, including those referred to as having on-demand accuracy, for different Lagrangian functions. Throughout, the main concepts are illustrated by a simple example on optimal power management.

IL-Fr-3 8:30–9:30 Ballroom C
Invited Lecture
Chair: Kang, Hyeonbae
Abstract:

▶ IL-Fr-3 8:30–9:30
Mathematical models and methods for noninvasive bioimpedance imaging
Seo, Jin Keun Yonsei University

Abstract: In complex models likelihood functions may be difficult to compute, or depend on assumptions about high order dependencies that may be difficult to verify. A number of methods have been devised to compute inference functions either meant to approximate the true likelihood function, or to provide inferential summaries that balance statistical efficiency with ease of computation. Examples include variational approximations, composite likelihood, quasi-likelihood, indirect inference, and Laplace-type approximations. This talk will survey various approximations to likelihood and likelihood inference, with a view to identifying common themes and outstanding problems.

IL-Fr-4 10:00–11:00 Ballroom A
Invited Lecture
Chair: Zhang, Pingwen
Abstract:

▶ IL-Fr-4 10:00–11:00
Applied Mathematics for Business Decision Making: The Next Frontiers
Kempf, Karl Intel Corporation

Abstract: Humans have been making decisions for hundreds of thousands of years. Over those years situations have become much more complex and therefore the decisions much more difficult. This is especially true in today's business world where the difference between a good decision and a bad decision can be worth billions of dollars. On the one hand, applied mathematicians have developed a variety of powerful tools and techniques to support good decision making. This power has been magnified many times over by the invention and continuous improvement of the digital computer. On the other hand, the legacy of hundreds of thousands of years of human decision making before the advent of computers is intuition. As most humans faced with decisions recognize, sometimes intuition is helpful and sometimes it is misleading. This paper provides a rudimentary background on the rise of both intuition and analytics. It then provides quantitative data on the shortcomings of intuitive decision making and the benefits of decision making aided by analytics drawn from 25 years of work directed at improving business decision making at Intel Corporation. Finally it identifies the next frontier in applied mathematics for decision making in business as the beneficial merger of intuition and analytics. A few encouraging examples are displayed to help quantify the power of analytics guiding intuition and intuition guiding analytics.

IL-Fr-5 10:00–11:00 Ballroom B
Invited Lecture
Chair: Gao, Xiaoshan
Abstract:

▶ IL-Fr-5 10:00–11:00
Correlations: From Classical to Quantum
Luo, Shunlong Academy of Mathematics and Systems Science, CAS

Abstract: The concept of correlations permeates our world in a profound and ubiquitous way. The gist of science is to classify and quantify correlations, and to reveal relations between different correlations. Correlations are many faceted and constitute basic resources that can be measured, manipulated, and utilized. With the advent of quantum information theory, which concerns the general study of information processing capability of quantum systems and ushers a new vista full of challenging mathematical problems and marvelous physical potentialities, correlations are playing an increasingly instrumental and significant role in the description and exploitation of nature. In this talk, we present an overview of some quantitative and informational aspects of correlations in both classical and quantum regimes, with focus on the interplay between classical and quantum, and their implications for quantum foundations and applications. We discuss classification and quantification of correlations, touch upon various topics such as classical correlations, quantum discord, quantum steering, quantum entanglement, and quantum nonlocality. Coexistence of correlations, including marginal problem and monogamy of correlations, is put in the context of setting fundamental constraints to physical laws, and is linked to Bohr's complementary principle and Heisenberg's uncertainty relations. We speculate that an informational approach to science via correlations may shed light on, and reconcile the tension between, quantum mechanics, which has unprecedented predictive power in microscopic world, and relativity theory, which has equally unprecedented predictive power for cosmological phenomena.

IL-Fr-6 10:00–11:00 Ballroom C
Invited Lecture
Chair: Trefethen, Lloyd N.
Abstract:

▶ IL-Fr-6 10:00–11:00
Formal series and numerical integrators: some history and some new techniques
Serna, Jesús Sanz Universidad de Valladolid

Abstract: This paper provides a brief history of B-series and the associated Butcher group and presents the new theory of word series and extended word series. B-series (Hairer and Wanner 1976) are formal series of functions parameterized by rooted trees. They greatly simplify the study of Runge-Kutta schemes and other numerical integrators. We examine the problems that led to the introduction of B-series and survey a number of more recent developments, including applications outside numerical mathematics. Word series (series of functions parameterized by words from an alphabet) provide in some cases a very convenient alternative to B-series. Associated with word series is a group G of coeffcients with a composition rule simpler than the corresponding rule in the Butcher group. From a more mathematical point of view, integrators, like Runge-Kutta schemes, that are affine equivariant are represented by elements of the Butcher group, integrators that are equivariant with respect to arbitrary changes of variables are represented by elements of the word group G.

IL-Fr-7 11:10–12:10 Ballroom A
Invited Lecture
Chair: Fonseca, Irene
Abstract:

▶ IL-Fr-7 11:10–12:10
TBA

Carlsson, Gunnar Stanford University

Abstract:

IL-Fr-8 11:10–12:10 Ballroom B
Invited Lecture

Chair: Strakos, Zdenek

Abstract:

▶ IL-Fr-8 11:10–12:10

Modeling, simulation and control of constrained multiphysics systems

Mehrmann, Volker Technische Universität Berlin

Abstract: Automated modeling of dynamical systems with multiphysical components has reached a very high level of maturity. Equation based modeling packages allow to couple different physical system models together in a very convenient way. Unfortunately the resulting systems of equations are not always well suited for analysis, numerical simulation, control or optimization. As a consequence, typically a mathematically oriented remodeling or regularization step has to be carried out, to reformulate the equations for the use in classical simulation, optimization and control tools. We present a remodeling concept that creates from a given automatically generated model (including over- and under-determined as well as control systems) a new system which has the same solution set, but which is well provably well suited for simulation, control and optimization and which also gives error and perturbation bounds. As a further advantage of the new approach, we show that all the variables keep their physical meaning. For components of the multiphysics system which are described by partial differential equations, we show that this approach can also be carried out already on the infinite dimensional level, so that subsequent discretization in space keeps the features also on the space-discrete level. We demonstrate the advantages of the new approach with several industrial examples and also present some of the current challenges.

IL-Fr-9 11:10–12:10 Ballroom C
Invited Lecture

Chair: Yang, Ziheng

Abstract:

▶ IL-Fr-9 11:10–12:10

Inference for stochastic processes in cancer evolution

Tavaré, Simon Cancer Research UK Cambridge Institute

Abstract: Each tumour evolves as a population of cells within its host. At a simplistic level, it is mutations in the DNA of the tumour cells that govern the way the tumour evolves. As a result, ideas from molecular population genetics may be used to study the properties of this evolution, particularly with respect to origination, growth, metastasis and relapse. In this talk I will describe some stochastic models that have been developed to study tumour evolution, including cellular Potts models and their relatives. With the advent of cheap DNA sequencing it is now possible to identify mutations in tumour cells, thus begging the question about how inference about tumour evolution might be performed.

After outlining the basic biology and aspects of ancestral inference, I will describe how Approximate Bayesian Computation methods can be used to estimate relevant biological parameters, and I will illustrate the methods with examples from glioblastoma and colorectal cancer.

MS-Fr-D-01 13:30–15:30 311A
The mathematical problems in information technology - Part I of II

For Part 2, see MS-Fr-E-01

Organizer: Chen, Xiuqing Beijing Univ. of Posts & Telecommunications

Abstract: The aim of this mini-symposium is to bring together specialists in the fields of mathematical problems in information technology, to intensify the mathematical research on three important research fields as follows. 1. Differential equations in telecommunications, such as, solitary wave. 2. Probability and Statistics in information technology. 3. Optimization and Scientific Computation in telecommunications.

▶ MS-Fr-D-01-1 13:30–14:00

A Note on Aubin-Lions-Dubinskii Lemmas

Chen, Xiuqing Beijing Univ. of Posts & Telecommunications

Abstract: Strong compactness results for families of functions in seminormed nonnegative cones in the spirit of the Aubin-Lions-Dubinskii lemma are proven, refining some recent results in the literature. The first theorem sharpens slightly a result of Dubinskii (1965) for seminormed cones. The second theorem applies to piecewise constant functions in time and sharpens slightly the results of Dreher and Juengel (2012) and Chen and Liu (2012). An application is given, which is useful in the study of porous-medium or fast-diffusion type equations.

▶ MS-Fr-D-01-2 14:00–14:30

Water-mark Scheme of LDPC in High Speed Optical Communication

Zhang, Wenbo Beijing Univ. of Posts & Telecommunications

Abstract: LDPC is a FEC algorithm used in high speed communications, since it allow the noise threshold to be set very close to Shannon limit. BP algorithm is a decoding algorithm for LDPC which can provide excellent results and can be practically implemented. In this talk, the water mark LDPC (WMLDPC) scheme, which is a new scheme involving channel information, is introduced. Simulations show that performance of WMLDPC scheme is much better than that of traditional scheme.

▶ MS-Fr-D-01-3 14:30–15:00

Functional Law of Iterated Logarithm for Single Server Queue

Guo, Yongjiang Beijing Univ. of Posts & Telecommunications

Abstract: For GI/G/1 queue, we transfer the problem of the law of iterated logarithm for queue length process, busytime process and the workload process into problems related to reflected Brownian Motion. By using properties of reflected Brownian Motion, we get the functional law of iterated logarithm forqueue length process, busy time process and the workload process and determine the parameters. The method based on strong approximation can be applied for multi-class queue network.

▶ MS-Fr-D-01-4 15:00–15:30

Network Coding Link Optimization Problems

Zhuo, Xinjian Beijing Univ. of Posts & Telecommunications

Abstract: Considering a multicast scenario, we want to minimize the links used for network coding while achieving the desired throughput. In this paper, we use a hybrid algorithm of particle swarm optimization algorithm with mutation. The simulation result shows that the hybrid algorithm can not only maintain the diversity of the population, but also greatly improve the convergent speed. It can be concluded that the hybrid algorithm has better performance.

EM-Fr-D-02 13:30–15:30 309A
Differential Algebra and Related Topics - Part VII of VIII

For Part 1, see EM-Mo-D-02
For Part 2, see EM-Mo-E-02
For Part 3, see EM-Tu-D-02
For Part 4, see EM-Tu-E-02
For Part 5, see EM-We-D-02
For Part 6, see EM-We-E-02
For Part 8, see EM-Fr-E-02

Organizer: Feng, Ruyong Acad. of Mathematics & Sys. Sci.,CAS
Organizer: Guo, Li Rutgers Univ. at Newark, USA
Organizer: Gao, Xiao-Shan Acad. of Mathematics & Sys. Sci., Chinese Acad. of Sci.

Abstract: This meeting is to offer an opportunity for participants to present original research , to learn of reserch progress and new developments on differential algebra and related topics, particularly, the applications of differential algebra to control theory, physics, chemistry, biology and so on.

▶ EM-Fr-D-02-1 13:30–14:00

Generalized Morphisms, A Way to Turn Homological Algorithms into Closed Formulas

Barakat, Mohamed RWTH Aachen

Abstract: Homological algebra has the reputation of being the theory of abstract notions and lengthy complex constructions. Generalized morphism is a computer friendly notion which turns many of these constructions into simple closed formulas, easily implementable on a computer. I will demonstrate two applications of constructive spectral sequences.

▶ EM-Fr-D-02-2 14:00–14:30

A Renormalisation Operator on Multivariable Meromorphic Functions

Paycha, Sylvie Univ. of Potsdam

Abstract: The Rota-Baxter operator given by the projection of meromorphic functions in one variable to their holomorphic part is generalised to a projection map on germs of meromorphic functions in several variables with linear poles. This generalised Rota-Baxter type decomposition uses in an essential way thedifferential algebra structure on germs of meromorphic functions and serves as a renormalisation map. This is joint work with Li Guo and Bin Zhang.

▶ EM-Fr-D-02-3 14:30–15:00

Picard-Vessiot Theory and Infinitesimal Symmetries of Linear Differential Equations

Blazquez Sanz, David Universidad Nacional de Colombia - Medellin

Abstract: We study the Lie algebra of infinitesimal symmetries of a system

of linear ordinary differential equations. We show the interplay between the Galois group and the Lie algebra of symmetries. We show that it suffices to study vertical symmetries whose components are polynomials in the unknown functions. Such symmetries are solutions of some associated equations. In particular, the existence of rational symmetries constrains the Galois group of the equation.

▶ EM-Fr-D-02-4 15:00–15:30

Non-commutative Picard-Vessiot Theory over Constants

Heiderich, Florian — National Research Univ. Higher School of Economics

Abstract: As a generalization of the Picard-Vessiot theories for differential and for difference equations we propose a non-commutative Picard-Vessiot theory for linear functional equations over a constant base field. Non-commutativity appears in three forms: The operators can have non-symmetrical product rules (skew-derivations for instance). The underlying rings are not necessarily commutative. Instead of affine group schemes as Galois groups possibly non-commutative Hopf algebras appear.

MS-Fr-D-03 13:30–15:30 306A

Propagation Phenomena of Reaction-Diffusion Models in Biology - Part III of IV

For Part 1, see MS-Th-D-03
For Part 2, see MS-Th-E-03
For Part 4, see MS-Fr-E-03

Organizer: Li, Wan-Tong — Lanzhou Univ.
Organizer: Ruan, Shigui — Univ. of Miami

Abstract: With the tide of globalization, biological invasions and pathogen transmission, which in turn can affect ecosystem or threaten public health, become focal spots in literature. In mathematical biology, there are many reaction-diffusion models arising from various applications such as animal dispersal, geographic spread of epidemics. To model/illustrate these problems/phenomena and investigate/evaluate the corresponding control strategy, it has been proved that the corresponding propagation modes are very important and useful. This minisymposium focus on the recent advances of propagation phenomena of different reaction-diffusion models in biology. In particular, the traveling wave solutions, asymptotic spreading, entire solutions, generalized transmission and threshold dynamics with their applications of reaction-diffusion models will be discussed.

▶ MS-Fr-D-03-1 13:30–14:00

Spreading Fronts of Invasive Species and Disease

Lin, Zhigui — Yangzhou Unversity

Abstract: This talk deals with a diffusive logistic model with a free boundary. We aim to use the dynamics of such a problem to describe the spreading of a new or invasive species. We prove a spreading-vanishing dichotomy for this model . Moreover, we show that when spreading occurs, for large time, the expanding front moves at a constant speed. We also consider an SIS epidemic model with free boundary.

▶ MS-Fr-D-03-2 14:00–14:30

Traveling Wave Solutions of A Diffusion Equation with State-Dependent Delay

Lin, Guo — Lanzhou Univ.

Abstract: The equation with state-dependent delay does not satisfy the standard comparison principle. We construct a proper wave profile set such that the comparison principle is applicable. By fixed point theorem and the theory of asymptotic spreading, we present the existence and nonexistence of traveling wave solutions.

▶ MS-Fr-D-03-3 14:30–15:00

A Reaction-Diffusion SIS Epidemic Model in An Almost Periodic Environment

Wang, Bin-Guo — School of Mathematics & Statistics, Lanzhou Univ.

Abstract: In this talk, a susceptible-infected-susceptible (SIS) almost periodic reaction-diffusion epidemic model is introduced by means of establishing the theories and properties of the basic reproduction ratio R_0. Particularly, the asymptotic behaviors of R_0 with respect to the diffusion rate D_I of the infected individuals are obtained. Furthermore, the uniform persistence, extinction and global attractivity are presented in terms of R_0. Our results indicate that the interaction of spatial heterogeneity and temporal almost periodicity tends to enhance the persistence of the disease. This talk is based on a joint work with Wan-Tong Li and Zhi-Cheng Wang.

▶ MS-Fr-D-03-4 15:00–15:30

Threshold Dynamics of A Time Periodic Reaction-diffusion Epidemic Model with Latent Period

Wang, Zhi-Cheng — Lanzhou Univ.

Abstract: In this talk we first propose a time-periodic reaction-diffusion epidemic model which incorporates simple demographic structure and the latent period of infectious disease. Then we introduce the basic reproduction number R0 for this model and prove that the sign of R0-1 determines the local stability of the disease-free periodic solution. By using the comparison arguments and persistence theory, we further show that the disease-free periodic solution is globally attractive if R0-1, while there is an

MS-Fr-D-04 13:30–15:30 308

Topological Data Analysis and Dynamics I

Organizer: Hiraoka, Yasuaki — Tohoku Univ.
Organizer: Mischaikow, Konstantin — Rutgers Univ.
Organizer: Kokubu, Hiroshi — Kyoto Univ.
Organizer: Nishiura, Yasumasa — Tohoku Univ., WPI-AIMR

Abstract: This is the first half of the multiple minisymposiums “Topological Data Analysis and Dynamics I & II”. The purpose of this multiple minisymposiums is to collect researchers studying theory, computations, and applications of topological data analysis (TDA). TDA is a rapidly growing research field, and offers powerful geometric and topological tools to understand complicated data sets, time series, dynamics, and so on. In this first half of the multiple minisymposiums, we aim to study some of the new specific mathematical and computational research topics such as inverse problems, Auslander-Reiten theory, and efficient computations.

This minisymposium is organized as follows. The first speaker Yasuaki Hiraoka (Kyushu University, minisymposiums organizer) will give a survey talk about TDA including persistence modules, quiver representations, stability, and several applications for the audience of this symposium. The second speaker Marcio Gameiro (University of São Paulo) will give a talk about continuation methods of point cloud data by using persistence diagrams. This research is motivated by applications, especially materials science, in which we want to design atomic arrangements realizing some specific properties of persistence diagrams. To such an inverse problem, Gameiro develops a method combining pseudo-inverse Newton operators and continuations of bifurcation branches in dynamical systems. The third speaker Emerson Escolar (Kyushu University) will give a talk about persistence modules on commutative ladders. This subject deals with a generalization of persistence modules on quivers which are not Gabriel types. One of the novel techniques used in his research is the Auslander-Reiten theory in representation theory. By this technique, he generalizes a concept of persistence diagrams of the generalized persistence modules as functions on Auslander-Reiten quivers. In addition, he develops a fast algorithm based on matrix reductions and discrete Morse theory, and applies them to the analysis of pressurizations of silica glasses. The fourth speaker Hubert Wagner (IST Austria) will talk about fast computations of persistence modules.

▶ MS-Fr-D-04-1 13:30–14:00

Topological Data Analysis and Dynamics: Theory, Computation, and Applications

Hiraoka, Yasuaki — Tohoku Univ.

Abstract: In this talk, I will survey the two series of mini-symposium: Topological Data Analysis and Dynamics I and II. Our aim of the two mini-symposium is to combine recent theoretical and algorithmic progresses on topological data analysis and possible applications in several fields of science such as fluid dynamics, materials science and statistics.

▶ MS-Fr-D-04-2 14:00–14:30

Point Cloud Deformations by Continuation of Persistence Diagrams

Gameiro, Marcio — Univ. of Sao Paulo

Abstract: Given a point cloud u0 and a its corresponding persistence diagram v0, we apply continuation to the persistence diagrams to find a new point cloud u (close to u0), that have a prescribed persistence diagram v (close to v0). We present the details and the algorithms to perform the continuation as well as some results.

▶ MS-Fr-D-04-3 14:30–15:00

Matrix Method for Persistence Modules on Commutative Ladders of Finite Type

Escolar, Emerson — Kyushu Univ.
Hiraoka, Yasuaki — Tohoku Univ.

Abstract: Motivated by applications, a recent paper extends the ideas of persistent homology to the commutative ladder quivers. We discuss an algorithm to compute indecomposable decompositions of persistence modules over finite type commutative ladders. We express the persistence module as a map between two representations of A_n, which we write as a matrix. The

Auslander-Reiten quiver of A_n encodes the permissible row and column operations that one can perform on this matrix.

▶ MS-Fr-D-04-4 15:00–15:30

Efficient Persistent Homology Computations

Wagner, Hubert IST Austria

Abstract: I will discuss practical efficiency of persistent homology computations. I present a number of techniques implemented in the PHAT library. In particular, a specialized data-structure, called BitTree, designed to efficiently handle column additions. A comprehensive benchmark will demonstrate the practical impact of the described optimizations. This will also show what types and sizes of data can be efficiently handled by the current generation of software.

Joint work with Uli Bauer, Michael Kerber and Jan Reininghaus.

MS-Fr-D-05 13:30–15:30 215

Geometric Understanding of Data in 3D and Higher - Part II of III

For Part 1, see MS-Th-E-05

For Part 3, see MS-Fr-E-05

Organizer: Lai, Rongjie Rensselaer Polytechnic Inst.

Organizer: Zhao, Hongkai UC Irvine

Abstract: Rapid development of data acquisition technology stimulates research on developing new computational tools for analyzing and processing data to make more effective decisions. In many problems, coherent structures of data allows us to model data as a low dimension manifold in a high dimension space. More recently, there has been increasing interests in using geometric based method to analyze and infer underlying structures from the given data. This minisymposium aims to bring together people from different research groups with common interest. We hope that this symposium can propel further collaborations and developments in this field.

▶ MS-Fr-D-05-1 13:30–14:00

A Novel Geometric Multiscale Approach to Structured Dictionary Learning on High Dimensional Data

Chen, Guangliang San Jose State Univ.

Abstract: Many real data sets have high ambient dimensions, but they are often intrinsically low-dimensional. We exploit such an assumption for efficiently representing high-dimensional data by using an adaptive, sparsifying dictionary. We construct the dictionary directly from the data based on a novel geometric multi-resolution analysis and we will show that it also relates to dictionary learning on the Grassmannian. In this talk, we present our constructions and associated advantages and demonstrate applications to image processing.

▶ MS-Fr-D-05-2 14:00–14:30

Understanding Data from Incomplete Distance Information via Solutions of Geometric PDEs.

Lai, Rongjie Rensselaer Polytechnic Inst.

Abstract: To have global understanding of data from local or incomplete set of pairwise distance is an important problem that has many applications such as 3D modeling, sensor network etc. In this talk, I will discuss our recent work of solving geometric differential equations based on data from incomplete distance. I will also demonstrate applications of this method for reconstruction and understanding distance data based on solutions of differential equations.

▶ MS-Fr-D-05-3 14:30–15:00

Data Analysis Tools for Large-scale Computer Vision and Multi-media Information Retrieval

Bronstein, Alexander Tel Aviv Univ.

Abstract: The rapid growth of the amounts of produced and consumed visual and multi-media information challenges existing tools and practices used in the organization, search, and analysis of such data. I will address problems in large-scale computer vision such as content-based retrieval, image-based localization, and 3D reconstruction of large scenes from collections of images, and show the construction of several geometric tools attempting to tackle these challenges.

▶ MS-Fr-D-05-4 15:00–15:30

Fast Multiscale Optimal Transport for Point Clouds in High Dimensions

Maggioni, Mauro Duke Univ.

Abstract: We describe a novel algorithm for computing optimal transportation distances and corresponding plans between point clouds in high-dimensions, with assumptions on the geometry of the point cloud, in particular low intrinsic dimensionality. These distances are widely used in shape analysis, computer vision, and image retrieval tasks, and many other applications. We verify empirically that the algorithms scale linearly in the number of points, both in terms of computational complexity and memory usage.

MS-Fr-D-06 13:30–15:30 201

Data-driven methods for quantifying uncertainty of multiscale dynamical systems - Part III of IV

For Part 1, see MS-Th-D-06

For Part 2, see MS-Th-E-06

For Part 4, see MS-Fr-E-06

Organizer: Harlim, John The Pennsylvania State Univ.

Organizer: Sapsis, Themistoklis MIT

Organizer: Giannakis, Dimitrios New York Univ.

Abstract: A major challenge in contemporary applied science is to design efficient models for predicting dynamical behavior resulting from complex interaction of multiple scale processes. This task, implicitly, requires one to account for uncertainties of the models due to initial conditions, boundary conditions, model errors, and observation errors. A promising interdisciplinary approach to address such issue is with a data-driven statistical methods that combine ideas from dynamical systems theory, stochastic processes, statistics, and data analysis. This special session aims to bring together researchers from across the spectrum of disciplines related to data-driven methods to discuss the development and application of emerging ideas and techniques for these important and difficult practical issues.

▶ MS-Fr-D-06-1 13:30–14:00

Towards Optimal Control of Gliders for Velocity Field Assimilation

Moore, Richard New Jersey Inst. of Tech.

Abstract: Autonomous vehicles, or gliders, offer flexible platforms for the collection of physical oceanography data, and are being deployed in a number of projects of scientific interest around the world. The gliders have a small capacity for locomotion but are strongly advected by a noisy velocity field that they infer through direct and indirect measurement. We discuss the viability and computational efficiency of optimal control techniques to improve the efficiency of the velocity field assimilation.

▶ MS-Fr-D-06-2 14:00–14:30

Uncertainty Quantification (and Sensitivity!) in Fluid Dynamics and Control

Brunton, Steven Univ. of Washington

Abstract: Fluid systems are characterized by high-dimensional, nonlinear dynamics, although they often evolve on low-dimensional attractors. The behavior of these attractors are particularly relevant for feedback flow control. In this talk, I will discuss the role of uncertainty quantification in understanding the sensitivity of fluid flows to disturbances and actuation. This will encompass a recent advances in data-driven modeling, including the dynamic mode decomposition (DMD), the finite-time Lyapunov exponent (FTLE), and generalized polynomial chaos (gPC).

▶ MS-Fr-D-06-3 14:30–15:00

Statistical Learning for Model Reduction with ATLAS

Maggioni, Mauro Duke Univ.

Crosskey, Miles Duke Univ.

Weare, Jonathan Univ. of Chicago

Abstract: We discuss ATLAS, a statistical learning framework for model reduction of high-dimensional dynamical systems with few intrinsic degrees of freedom. The algorithm is highly parallelizable and only requires short trajectories of the system (treated as a black-box), and learns from these short paths an ensemble of accurate local reduced models. It then pastes them together to create a global model, which is guaranteed to be accurate for large times. We present several examples.

▶ MS-Fr-D-06-4 15:00–15:30

Timescale Separation and Forecasting with Dynamics-adapted Kernels

Giannakis, Dimitrios New York Univ.

Abstract: We discuss kernel methods for extracting intrinsic timescales of dynamical systems and nonparametric forecasting. These so-called cone kernels utilize the time ordering of the data to approximate the generator of the dynamics operating in the phase-space manifold. The associated kernel eigenfunctions provide dimension reduction coordinates which favor slow intrinsic timescales of the dynamics. We present applications in spatiotemporal decomposition and nonparametric forecasting of toy dynamical systems and comprehensive climate models.

MS-Fr-D-07 13:30–15:30 202A

Recent Developments in Modeling and Numerical Simulations of Geophysical Flows - Part I of II

For Part 2, see MS-Fr-E-07

Organizer: Alina, Chertock North Carlina State Univ.
Organizer: Kurganov, Alexander Tulane Univ.
Organizer: Lukacova, Maria Univ. of Mainz, Inst. of Matehmatics

Abstract: This minisymposium focuses on complex problems arising from geophysical flows and their numerical simulations. The models are typically governed by hyperbolic systems of conservation and balance laws, which are difficult to be solved numerically due to the presence of (possibly singular) geometric source terms, nonconservative exchange terms as well as multiscale phenomena in singular limit cases. These may lead to the loss of hyperbolicity, nonlinear resonance, very complicated wave structures and, as a result, to appearance of spurious oscillations and slow convergence of numerical methods. Therefore accurate modeling and development of robust, highly accurate and efficient numerical methods for these systems is a very important and challenging task.
The organizers of the minisymposium are: Alina Chertock, Alex Kurganov and Maria Lukacova-Medvidova

▶ MS-Fr-D-07-1 13:30–14:00

A New Hydrostatic Reconstruction Scheme Motivated by the Wet-dry Front

Noelle, Sebastian RWTH Aachen Univ.

Abstract: We consider well-balanced, positivity preserving numerical schemes for the shallow water equations. It has recently been noted by Berthon et al. and Morales et al. that the widely used hydrostatic reconstruction method (HR) due to Audusse et al. converges slowly for some downhill flows. In this paper, we propose a one-line change of the intermediate bottom height in the HR method which cures this imperfection. The new choice of the intermediate bottom is motivated by a subtle splitting of the source term at the wet-dry front. After proving positivity, well-balancing and an entropy inequality, we demonstrate the impact of the new HR method by numerical experiments for some downhill flows.

▶ MS-Fr-D-07-2 14:00–14:30

Central-Upwind Schemes for Systems of Balance Laws

Alina, Chertock North Carlina State Univ.

Abstract: I will present second-order well-balanced central-upwind schemes for systems of hyperbolic balance laws and their applications to the Euler equations of gas dynamics with gravity and shallow water equations with Coriolis forces. The schemes are capable of exactly preserving steady-state solutions expressed in terms of a nonlocal equilibrium variable. A crucial step in the construction of the schemes is a well balanced piecewise linear reconstruction of equilibrium combined with a well-balanced evolution in time.

▶ MS-Fr-D-07-3 14:30–15:00

Asymptotic Preserving Schemes for Singular Limit Flows

Lukacova, Maria Univ. of Mainz, Inst. of Matehmatics

Abstract: In the present talk we will describe new asymptotic preserving schemes fo some singular limit flows that arise in geophysics. The main idea is to split a fully nonlinear system in the stiff linear part, governing fast waves, and a nonstiff nonlinear part, decribing slow motions. IMEX type time discretization and specific FV-type space discretization yield to time-space asymptotic accurate schemes, which can be proven theoretically and shown experimentally.

▶ MS-Fr-D-07-4 15:00–15:30

Central-Upwind Schemes for Shallow Water Models

Kurganov, Alexander Tulane Univ.

Abstract: I will describe Riemann-problem-solver-free central-upwind schemes for the Saint-Venant system and related shallow water models. The main difficulties are to preserve a delicate balance between the flux and source terms and to ensure positivity of the computed water depth (and/or other quantities, which are supposed to remain nonnegative). I will present a general approach of designing well-balanced positivity preserving central-upwind schemes and illustrate their performance on a number of shallow water models.

MS-Fr-D-08 13:30–15:30 202B

Minisymposium on Inverse Problems in Wave Propagation - Part II of II

For Part 1, see MS-Th-E-08

Organizer: Bao, Gang Zhejiang Univ.
Organizer: Li, Peijun Purdue Univ.
Organizer: Triki, Faouzi Joseph Fourier Univ.

Abstract: Inverse problems in wave propagation have played a fundamental role in diverse scientific areas such as radar and sonar, geophysical exploration, medical imaging, near-field optical microscopy, and nano-optics. Due to the complexity of material properties and uncertainty in physical models and parameters, precise modeling and accurate computing present challenging and significant mathematical and computational questions, and remain the subject matter of much ongoing research.
The minisymposium aims to recent mathematical and computational studies of inverse problems in various wave propagation models, including acoustic, electromagnetic, optical, elasticity, and quantum wave propagation. It seeks to bring together leading researchers in these fields to present recent developments, promote exchange of ideas, and discuss new directions including treatment of multi-frequency and near-field data, and multi-wave imaging. The talks will cover all the aspects of inverse scattering problems like asymptotic techniques, sensitivity analysis, numerical computation, and wave propagation in complex and random media.

▶ MS-Fr-D-08-1 13:30–14:00

A Direct Imaging Method for Inverse Obstacle Scattering from Phaseless Far-Field Data

Zhang, Bo Acad. of Mathematics & Sys. Sci., CAS

Abstract: In this talk, we consider the inverse problem of reconstructing acoustic obstacles from phaseless far-field data in inverse obstacle scattering. We propose a direct imaging algorithm for reconstruction of an acoustic obstacle, using only phaseless far-field data. Our algorithm does not need to know the type of boundary conditions on the obstacle in advance and is capable to reconstruct multiple obstacles with different boundary conditions and even with different scales. Numerical examples are also provided illustrating that the reconstruction algorithm is stable, accurate and robust to noise. This is a joint work with Haiwen Zhang.

▶ MS-Fr-D-08-2 14:00–14:30

Inverse Transport and Acousto-optic Imaging

Schotland, John Univ. of Michigan

Abstract: A method to reconstruct the optical properties of a highly-scattering medium from acousto-optic measurements is proposed. The method is based on the solution to an inverse problem for the radiative transport equation with internal data. A stability estimate and a direct reconstruction procedure are described.

▶ MS-Fr-D-08-3 14:30–15:00

An Efficient Neumann Series-based Algorithm for Thermoacoustic and Photoacoustic Tomography with Variable Sound Speed

Zhao, Hongkai UC Irvine

Abstract: We present an efficient algorithm for reconstructing an unknown source in Thermoacoustic and Photoacoustic Tomography based on the recent advances in understanding the theoretical nature of the problem. We work with variable sound speeds that might be also discontinuous across some surface. The latter problem arises in brain imaging. The algorithmic development is based on an explicit formula in the form of a Neumann series.

▶ MS-Fr-D-08-4 15:00–15:30

Determining the Waveguide Conductivity in A Hyperbolic Equation from A Single Measurement on the Lateral Boundary

Beilina, Larisa Chalmers Univ. of Tech. & Gothenburg Univ.
Cristofol, Michel Aix-Marseille Univ., Institut de Mathematiques
Li, Shumin Univ. of Sci. & Tech. of China
Niinimaki, Kati Royal Inst. of Tech.
Soccorsi, Eric Aix-Marseille Univ.

Abstract: We consider the multidimensional inverse problem of determining the coefficient in the principal part of a hyperbolic equation in an infinite cylindrical domain, from a single boundary observation of the solution. We prove a Hölder stability with the aid of a Carleman estimate specifically designed for hyperbolic waveguides. The coefficient in the principal part is assumed to depend on x only or both x and t. We further provide some numerical simulations.

MS-Fr-D-09 13:30–15:30 203A

Mathematical Modeling and the analysis in dissipative systems - Part I of II

For Part 2, see MS-Fr-E-09

Organizer: EI, SHIN-ICHIRO Hokkaido Univ.
Organizer: Nagayama, Masaharu Hokkaido Univ.

Abstract: In this minisymposium, we aim to merge mathematical modeling and the theoretical analysis for phenomena arising in dissipative systems including chemical reactions and biological systems by introducing from each field both of models for real phenomena and techniques for nonlinear differential equations. As mathematical models, we deal with nonlinear parabolic

equations of reaction-diffusion types and higher dimensional ODEs. Through the interaction between modeling and mathematical techniques, many joint works with researchers from both fields are expected.

▶ MS-Fr-D-09-1 13:30–14:00

The Collective Motion of Camphor Papers in A Cylindrical Channel

Nagayama, Masaharu Hokkaido Univ.

Abstract: Billiard and jamming like motions of camphor papers placed over water have recently been observed in cylindrical channels. We investigate the mechanisms of these motions by constructing a mathematical model for the camphor system. In particular, we study the motion of two camphor papers by means of numerical simulation and mathematical analysis. As a result of our investigations, we have uncovered various morphologies of the camphor paper motions.

▶ MS-Fr-D-09-2 14:00–14:30

Reaction-advection-diffusion Equations with Free Boundaries

Lou, Bendong Tongji Univ.

Abstract: In this talk we consider reaction-advection-diffusion equations in one dimension, with two free boundaries satisfying the Stefan conditions. The model is used to describe the population dynamics in advective environments. We study the influence of the advection coefficient on the long time behavior of the solutions. Among others, we find that a solution may converges to a traveling wave with tadpole-like profile.

▶ MS-Fr-D-09-3 14:30–15:00

Reaction-advection-diffusion Model of the Epidermis

KOBAYASHI, YASUAKI Hokkaido Univ.

Abstract: We propose a model of epidermis consisting of the calcium concentration and the differentiation stage, where calcium excitation occurs at a certain stage of differentiation, and calcium ions accelerate differentiation. We investigate how the spatio-temporal fluctuations of the lower structure affect the upper structure. In particular, we show that small-scale fluctuations both in time and space are significantly reduced due to calcium dynamics, while large scale ones are not reduced.

▶ MS-Fr-D-09-4 15:00–15:30

A Mathematical Model of Planar Cell Polarity

Akiyama, Masakazu Research Inst. for Electronics Sci., Hokkaido Univ.

Abstract: Many cells within epithelial tissues display polarity along a particular axis. This axis is perpendicular to the tissue plane and apicobasal axis of the cell. This phenomenon is called "planar cell polarity, PCP", and is a common phenomenon found in many multicellular organisms. In this talk, we will introduce our mathematical model and simulation result. Despite of our model is very simple formulation, it can reproduce various aspects of the PCP.

MS-Fr-D-10 13:30–15:30 206B

Stochastic Dynamics with Applications - Part II of III

For Part 1, see MS-Th-E-10

For Part 3, see MS-Fr-E-10

Organizer: Duan, Jinqiao Illinois Inst. of Tech

Abstract: Nonlinear systems are often under random influences. The uncertainties may be due to external fluctuations or unresolved scales. These random influences may affect system evolution at various spatial and temporal scales, subtly or profoundly. Taking uncertainty into account is essential in modeling various complex phenomena in biological, physical and chemical systems.

The objective of this special session is to bring together experts from multiple disciplines with complementary views and approaches to stochastic dynamics in the context of applications.

The topics to be discussed include: Overview of stochastic dynamics, stochastic approaches for multi-scale modeling, impact of noise, non-Gaussian dynamics, statistical physics near or out of equilibrium, adaptive dynamics, biological modeling, stochastic modeling in systems biology

▶ MS-Fr-D-10-1 13:30–14:00

A Reduction Principle for Stochastic Hyperbolic-parabolic Equations with Two Time-scales

Fu, Hongbo Wuhan Textile Univ.

Abstract: This talk focuses on averaging principle for stochastic hyperbolic-parabolic equations with slow and fast time-scales. Under suitable conditions, the existence of an averaging equation eliminating the fast variable for this coupled system is proved. As a consequence, an effective dynamics for slow variable which takes the form of stochastic wave equation is derived.

▶ MS-Fr-D-10-2 14:00–14:30

Stochastic Homogeneization on Manifolds

Li, Xue-Mei The Univ. of Warwick

Abstract: We consider a family of stochastic differential equations on manifolds with a small parameter epsilon and study the convergence of their slow motions.

▶ MS-Fr-D-10-3 14:30–15:00

Stochastic Dynamics: Advances and Perspectives

Duan, Jinqiao Illinois Inst. of Tech

Abstract: Dynamical systems arising in engineering and science are often subject to random influences ("noise"). To understand dynamics under uncertainty, topological, geometric and analytical approaches are taken to examine the quantities that carry dynamical information and the structures that act as dynamical skeletons.The speaker will first present an overview of available theoretical and numerical techniques for investigating stochastic dynamical systems, highlighting some delicate and profound impact of noise on dynamics. Then, he will focus on understanding stochastic dynamics by examining "escape probability", in the context of prototypical examples in biophysical and physical settings.

▶ MS-Fr-D-10-4 15:00–15:30

Metastability in Stochastic Burgers Equation

Chen, Xiaopeng Shantou Univ.

Abstract: The stochastic center manifold is considered for the stochastic Burgers equation with initial value problem. Then the metastability in the stochastic Bergers equation is described by the stochastic center manifold.

MS-Fr-D-11 13:30–15:30 203B

Matrix computations using structures and other innovative techniques - Part III of III

For Part 1, see MS-Th-D-11

For Part 2, see MS-Th-E-11

Organizer: Xia, Jianlin Purdue Univ.

Organizer: Chen, Jie IBM Thomas J. Watson Research Center

Abstract: This minisymposium is concerned with a wide range of innovative matrix computation techniques, including structures, randomization, splitting preconditioning, etc. The techniques make it feasible to develop new fast and reliable direct or iterative solutions. In particular, certain block or hierarchical structures can be used to obtain effective preconditioners or nearly linear complexity direct solvers for challenging numerical problems. Interesting applications to imaging, PDE/integral equation solutions, optimization, parallel computing, and engineering simulations will also be shown.

▶ MS-Fr-D-11-1 13:30–14:00

On Convergence of AVMM for Solving Equality-Constraint Quadratic Programming Problems

Bai, Zhong-Zhi Chinese Acad. of Sci.

Abstract: We discuss unique solvability of the equality-constraint quadratic programming problem, establish a class of preconditioned alternating variable minimization with multiplier (PAVMM) methods for iteratively computing its solution, and demonstrate asymptotic convergence property of these PAVMM methods. We also discuss an algebraic derivation of the PAVMM method by making use of matrix splitting.

▶ MS-Fr-D-11-2 14:00–14:30

Krylov and Saunders Subspace Methods

Choi, Sou-Cheng NORC at the Univ. of CHicago

Abstract: Large-scale linear systems, linear least-squares problems, and eigenvalue problems are pervasive in science and engineering applications. For high-performance computing, we establish a suite of Krylov and Saunders subspace methods, MINRES-QLP and GMRES-URV, for solving these problems that neither suffer hard breakdowns nor evade singular square matrices or linear operators. For linear systems and least-squares problems, by leveraging rank-revealing matrix factorizations, our methods minimize both solution and residual norms of a sequence of subproblems whose

▶ MS-Fr-D-11-3 14:30–15:00

Preconditioners for Weighted Toeplitz Least Squares Problems

Pan, Jianyu East China Normal Univ.

Abstract: We will talk about the fast algorithms for solving weighted Toeplitz regularized least squares problems. Based on augmented system formulation, we develop a new HSS preconditioner. The advantage of the proposed preconditioner is that the blurring matrix, weighting matrix, and regularization matrix can be decoupled so that the resulting preconditioner is not expensive to apply. The spectrum distribution and choice of parameters are discussed in details. Numerical results are reported to demonstrate the performance.

MS-Fr-D-12 13:30–15:30 208B
Orthogonal Polynomials, Special Functions, and their Applications - Part II of III
For Part 1, see MS-Th-E-12
For Part 3, see MS-Fr-E-12

Organizer: Qiu, Weiyuan — Fudan Univ.
Organizer: Wong, Roderick — City Univ. of Hong Kong
Organizer: Zhang, Lun — Fudan Univ.
Organizer: Zhao, Yuqiu — Sun Yat-sen Univ.

Abstract: Special functions and orthogonal polynomials is a very classical subject with numerous applications in both pure and applied mathematics. Tremendous progresses in this area have been achieved recently and new connections with other research areas such as random matrices, Riemann-Hilbert problems, etc. have been found. It is the aim of this minisymposim to provide a forum for researchers with diverse backgrounds whose research interests overlap with special functions and orthogonal polynomials. The s-peakers will report the latest developments in these areas, exchange their expertise, experience and insights. We hope this minisymposium will strengthen the connections among people in the relevant areas and stimulate future research.

▶ MS-Fr-D-12-1 13:30–14:00
Painleve III Asymptotics of Hankel Determinants for A Singularly Perturbed Laguerre Weight
Dai, Dan — City Univ. of Hong Kong, Hong Kong

Abstract: We consider the Hankel determinants associated with the singularly perturbed Laguerre weight $w(x) = x^{\alpha}e^{-x-t/x}$, $x \in (0, \infty)$, $t > 0$ and $\alpha > 0$. When the matrix size $n \to \infty$, we obtain an asymptotic formula for the Hankel determinants, valid uniformly for $t \in (0, d]$, $d > 0$ fixed. A particular Painlevé III transcendent is involved in the approximation, as well as in the large-n asymptotics of the leading coefficients and recurrence coefficients for the corresponding perturbed Laguerre polynomials.

▶ MS-Fr-D-12-2 14:00–14:30
Numerics for classical applications of Riemann – Hilbert problems
Olver, Sheehan — The Univ. of Sydney

Abstract: We overview several classical problems that can be reduced to Riemann – Hilbert problems and solved numerically, falling into three categories: integral representations, differential equations and inverse spectral problems.

▶ MS-Fr-D-12-3 14:30–15:00
Asymptotics of Discrete Orthogonal Orthogonal Polynomials
Zhao, Yuqiu — Sun Yat-sen Univ.

Abstract: We develop the Riemann-Hilbert method to study the asymptotics of two types of orthogonal polynomials. The first type of orthogonality is on infinite nodes with an accumulation point. To illustrate our method, we consider the Tricomi-Carlitz polynomials. Another type of orthogonality is characterized so that the weight composed of both absolutely continuous measure and discrete measure. We take a special class of the sieved Pollazek Polynomials as an example. (Joint work with Xiao-Bo Wu, Yu Lin and Shuai-Xia Xu).

▶ MS-Fr-D-12-4 15:00–15:30
Asymptotic Expansions for the First Painleve Transcendent
Li, Yutian — Hong Kong Baptist Univ.

Abstract: The asymptotic expansions of the first Painleve transcendent is well studied in the literature, and they are involved in the problem of connection formulas. In this talk, we shall review the existing results, and establish a new asymptotic expansion for the oscillatory case. Our result is based on techniques from singular perturbation problems with resonance.

MS-Fr-D-13 13:30–15:30 VIP3-2
Progress in hyperbolic problems and applications - Part V of VI
For Part 1, see MS-We-E-13
For Part 2, see MS-Th-BC-13
For Part 3, see MS-Th-D-13
For Part 4, see MS-Th-E-13
For Part 6, see MS-Fr-E-13

Organizer: Wang, Ying — Univ. of Oklahoma
Organizer: Tesdall, Allen — City Univ. of New York, College of Staten Island

Abstract: Hyperbolic conservation laws form the basis for the mathematical modeling of many physical systems, and describe a wide range of wave propagation and fluid flow phenomena, including shock waves in nonlinear situations. For one dimensional systems with small data, a well-posedness theory of entropy weak solutions is well known. Analysis in several space dimensions, however, remains an enormous challenge. In this minisymposium, recent results in the theory and numerical analysis of hyperbolic problems will be presented. A variety of computational techniques, including finite volume, finite element, spectral, WENO, and discontinuous Galerkin methods, will be represented.

▶ MS-Fr-D-13-1 13:30–14:00
Highly Tuned Hybrid MPI/OpenACC Implementation with GPUDirect Communication for Electromagnetic and Fluid Solvers Based on High Order Spectral Element Discretization
MIN, MISUN — Argonne National Laboratory

Abstract: I will present highly tuned hybrid MPI/OpenACC implemetation for solving electromagnetic and fluids systems. I will demonstrate performance and anlysis up to 16,384 GPUs on the multi-GPU systems, such as the Cray XK7 supercomputer Titan. High-order numerical approaches are considered based on spectral element discretization. Discussions include efficient preconditioning algorithms for solving convection-diffusion type equations arising in semiconductor and material processing applications.

▶ MS-Fr-D-13-2 14:00–14:30
A Fast Explicit Operator Splitting Method for Modied Buckley-Leverett Equations
Wang, Ying — Univ. of Oklahoma
Kao, Chiu-Yen — Clarmeont McKenna College
Kurganov, Alexander — Tulane Univ.

Abstract: In this talk, I will discuss a fast explicit operator splitting method to solve the modified Buckley-Leverett equations which include a third-order mixed derivatives term resulting from the dynamic effects in the pressure difference between the two phases. The method splits the original equation into two equations, one with a nonlinear convective term and the other one with high-order linear terms so that appropriate numerical methods can be applied to each of the spliting equations.

▶ MS-Fr-D-13-3 14:30–15:00
No Blow-up in Some Variational Wave Systems in Liquid Crystals
Zheng, Yuxi — The Pennsylvania State Univ.

Abstract: We consider a full nonlinear variational wave system modeling nematic liquid crystals, which has splay, twist and bend capabilities. If the splay and bend coefficients are equal, we show that the solutions to initial value problems do not develop spontaneous singularities in time. The talk is based on joint work with Jingchi Huang.

▶ MS-Fr-D-13-4 15:00–15:30
Spectrum of the Discontinuous Galerkin Spatial Discretization on Structured Two-dimensional Grids
Qin, Ruibin — Guizhou Normal Univ.
Krivodonova, Lilia — Univ. of Waterloo

Abstract: We present an analysis of the eigenvalues of the discontinuous Galerkin spatial discretization with the upwind flux applied to the two-dimensional linear advection equation on structured rectangular and parallelogram grids. We firstly derive a formula for the eigenvalues on an one-dimensional uniform grid in terms of the sub-diagonal [p/p+1] Pade approximation of exp(-z). Then, we will extend the results to the spectrum of the DG spatial discretization in two-dimensional cases.

MS-Fr-D-14 13:30–15:30 111
Effective dynamics of stochastic partial differential equations - Part II of III
For Part 1, see MS-Th-E-14
For Part 3, see MS-Fr-E-14

Organizer: Wang, Wei — Nanjing Univ.
Organizer: Gao, Hongjun — Nanjing Normal Univ.

Abstract: Stochastic partial differential equations (SPDEs) are appropriate mathematical models for many multiscale systems with uncertain and fluctuating influences. A complex system often contains different scales both in time and space, which make numerical simialtion difficult, so effective and simplifed system, governing the evolution of the system over long time scale, is desirable. The simplified system provide an effective model to be applied to simulate the complex system. This minisymposium aim to present new methods and results on the effective description complex system and application in science and engineering.

▶ MS-Fr-D-14-1 13:30–14:00
Effective Dynamical Reduction for Stochastic Partial Differential Equations
Duan, Jinqiao — Illinois Inst. of Tech

Abstract: SPDEs arise naturally modeling multiscale systems under random influences. We consider macroscopic dynamics of microscopic systems described by SPDEs and characterized by small scale heterogeneities or fast scale random fluctuations, and are thus difficult for analysis and expensive for numerical simulation. Effective models are desirable as they capture crucial dynamical features of the original systems but are more amenable for analysis and computation. The speaker presents recent advances and results in effective modeling for SPDEs.

▶ MS-Fr-D-14-2 14:00–14:30

On the Eigenfunctions of the Complex Ornstein-Uhlenbeck Operators and Applications

Liu, Yong Peking Univ.

Abstract: In this talk, we show that the complex Hermite polynomials are the eigenfunctions of complex Ornstein-Uhlenbeck operators, and obtain a product formula of Hermite polynomials. Using this formula, we give the relation between real Wiener-Ito chaos and the complex Wiener-Ito chaos (or: multiple integrals). As an application, we prove the fourth moment theorem or say: the Nualart-Peccati criterion) for the complex Wiener-Ito multiple integrals. This is a joint work with Yong Chen

▶ MS-Fr-D-14-3 14:30–15:00

Identification of the Point Sources in Some Stochastic Wave Equations

Guanglin, Rang Wuhan Univ.

Abstract: We introduce and study a type of (one dimensional) wave equations with noisy points ources. We study the existence and uniqueness problem of the equations. Then, we assume that the locations of point sources are unknown but wecan observe the solution at some other location continuously in time. We propose an estimator to identify the point source locations and prove the convergence of our estimator.

▶ MS-Fr-D-14-4 15:00–15:30

Slow foliation of a slow－fast stochastic evolutionary system

Chen, Guanggan Sichuan Normal Univ.

Abstract: This work is concerned with the dynamics of a slow－fast stochastic evolutionary system quantified with a scale parameter. A slow invariant foliation is established for this system. It is shown that the slow foliation converges to a critical foliation in probability distribution, as the scale parameter tends to zero. Furthermore, the geometric structure of the slow foliation is investigated.

MS-Fr-D-15 13:30–15:30 213B

PDEs and applications: theory and computation - Part III of IV

For Part 1, see MS-Th-D-15
For Part 2, see MS-Th-E-15
For Part 4, see MS-Fr-E-15

Organizer: Wang, Ying Univ. of Oklahoma
Organizer: Nie, Hua Shaanxi Normal Univ.

Abstract: Partial differential equations (PDEs) have been widely used in the mathematical modeling of physical and biological phenomena, including mixed type equations. Many problems of an applied nature reduce to finding specific solutions and properties of PDEs of elliptic, parabolic, or of mixed type; in particular, problems of plane transonic flow of a compressible medium, and problems in the theory of envelopes. In this mini-symposium, recent results in the theory and computation of PDEs and their applications will be presented. The goal of this mini-symposium is to provide a platform for the world experts in the area of PDEs, both theory and computation, to report the recent progresses, exchange ideas and build up collaborative works. We anticipate that our speakers will have expertise in a wide-ranging array of topics, possibly including: (i) qualitative and quantitative properties enjoyed by solutions to nonlinear partial differential equations of elliptic, parabolic, or of mixed type. (ii) numerical schemes derived for various types of PDEs. (iii) physical and biology modeling involving nonlinear partial differential equations of elliptic, parabolic, or of mixed type.

▶ MS-Fr-D-15-1 13:30–14:00

Interplay of Dissipation and Dispersion in Two-phase Flow

Wang, Ying Univ. of Oklahoma

Abstract: In this talk, I will introduce the modified Buckley-Leverett (MBL) equation describing two-phase flow in porous media. The MBL equation differs from the classical Buckley-Leverett (BL) equation by including a diffusive-dispersive combination. The dispersive term is a third order effects in the pressure difference between the two phases. I will show that the solution of the finite interval [0;L] boundary value problem converges to that of the half-line [0;infty) boundary value problem as L-¿infty.

▶ MS-Fr-D-15-2 14:00–14:30

Steady-state Bifurcations for the Activator-depleted Substrate Model

Wang, Yan-e Shaanxi Normal Univ.

Abstract: This paper concerns an activator-depleted substrate system in a bounded domain. Under no-flux boundary conditions, asymptotic stability properties of positive constant steady states are discussed firstly. Then, the steady state bifurcations with a one-dimensional kernel and a two-dimensional kernel are intensively studied in R1. The main tools adopted here include stability theory, bifurcation theory, the techniques of space decomposition and implication function theory. Finally, we illustrate our results with numerical simulations.

▶ MS-Fr-D-15-3 14:30–15:00

Fundamental Solutions for A Class of Homogeneous Fractional Elliptic Equations

Cao, Yi Shaanxi Normal Univ.

Abstract: We consider a class of elliptic non-local equations with homogeneous kernel k(x,y) in this paper. If the kernel k(x,y)=1, then we obtain the fractional Laplace equation. By constructing a super(sub) solution, we give the existence of a unique fundamental solutions, which is bounded on one side. A Liouville-type result demonstrate that the fundamental solution is the unique nontrivial solution that are bounded on one side in a neighborhood of the origin.

▶ MS-Fr-D-15-4 15:00–15:30

Geometrical Singular Perturbation Methods and Application to A Generalized KdV-mKdV Equation

Du, Zengji jiangsu normal Univ.

Abstract: This talk deals with a generalized KdV-mKdV equation . By employing the geometrical singular perturbation theory and the linear chain trick, we establish the existence result of solitary wave solutions when the average delay is sufficiently small, for a special convolution kernel.

MS-Fr-D-16 13:30–15:30 205A

System of Conservation Laws and Related Models - Part III of IV

For Part 1, see MS-Th-D-16
For Part 2, see MS-Th-E-16
For Part 4, see MS-Fr-E-16

Organizer: Li, Yachun Shanghai Jiao Tong Univ.
Organizer: Wang, Weike Shanghai Jiao Tong Univ.
Organizer: Wang, Yaguang Shanghai Jiaotong Univ.
Organizer: Xie, Chunjing Shanghai Jiao Tong Universit

Abstract: This minisymposium focuses on the analysis for system of conservation laws and related models. It covers the following topics: 1. Multidimensional conservation laws and transonic flows; 2. Compressible Navier-Stokes system and singular limits for fluid dynamics; 3. Free boundary problems arising in fluid mechanics and related models.

▶ MS-Fr-D-16-1 13:30–14:00

Steady Transonic Shocks in Compressible Euler Flows

Yuan, Hairong Department of Mathematics, East China Normal Univ.

Abstract: I will introduce the physical phenomena of transonic shocks, and review some progresses on the mathematical studies of related boundary value problems of the steady compressible Euler equations. The talk is based upon joint works with many collaborators.

▶ MS-Fr-D-16-2 14:00–14:30

Rarefaction Waves for Collisional Fluid Plasmas

Duan, Renjun The Chinese Univ. of Hong Kong

Abstract: The motion of collisional fluid plasmas is often governed by the compressible Navier-Stokes-Poisson system. In the talk, we are concerned with the large time behaviour of the system in the case when the electric potential takes distinct far-field data. For that, we mainly present the construction of rarefaction waves in terms of the quasineutral Euler system, and then use the energy method to show that the profile is time-asymptotically stable under small perturbation.

▶ MS-Fr-D-16-3 14:30–15:00

Self-similar 2d Euler Solutions with Vorticity of Mixed Sign

Elling, Volker Univ. of Michigan

Abstract: We construct a class of self-similar 2d incompressible Euler solutions that have initial vorticity of mixed sign. The regions of positive and negative vorticity form algebraic spirals.

▶ MS-Fr-D-16-4 15:00–15:30

Global Solutions to Some Gas-vaaum Interface Problems of Compressible Fluids

Luo, Tao Georgetown Univ.

Abstract: Some recent results will be presented on the global solutions to some gas-vaaum interface problems of compressible fluids including inviscid

flow with damping convergent to Barenblatt solutions (joint with Huihui Zeng) and viscous flows with self-gravitation convergent to Lane-Emden solutions (joint with Zhouping Xin & Huihui Zeng).

MS-Fr-D-17 13:30–15:30 205B
Singular limits in mathematical physics - Part V of V

For Part 1, see MS-We-E-17
For Part 2, see MS-Th-BC-17
For Part 3, see MS-Th-D-17
For Part 4, see MS-Th-E-17

Organizer: Cheng, Bin — Univ. of Surrey
Organizer: Secchi, Paolo — Univ. of Brescia
Organizer: Ju, Qiangchang — Inst. of Applied Physics & Computational Mathematics (IAPCM)
Organizer: Jiang, Ning — Tsinghua Univ., Beijing

Abstract: This minisymposium will address recent advances in analytical and numerical studies of singular limits of multiscale physical models as certain parameters approach zero or infinity. It shall cover such areas as incompressible and fast rotating limits in fluid dynamics, hydrodynamical limits of complex fluid and kinetic models, and relaxations. The singular nature of these models makes it challenging to rigorously justify and quantify their limits and to numerically simulate them in a way consistent with theory. Novel techniques and results in partial differential equations, stochastic differential equations and numerical analysis will be discussed.

▶ CP-Fr-D-17-1 13:30–13:50
A Simple, Efficient and Accurate Method for Computing the Order-disorder Phase Transition in Double Well Energy Functionals.

Shirokoff, David — New Jersey Inst. of Tech.

Abstract: A wide variety of materials that exhibit energy driven pattern formation are governed by an underlying non-convex energy functional. Although numerically finding and verifying local minima to these functionals is relatively straight-forward, the non-convex nature of the functionals makes the computation and verification of global minimizers much more difficult. Here the verification of the global minimizers is important for understanding the material phase diagram. In this talk I will focus on mass-constrained global minimizers for a class of double well energy functionals: including Ohta-Kawasaki and phase-field crystals. I will derive sufficient conditions to show that a candidate minimizer is a global minimizer, and using convex relaxations show that the approach works very well to verify when the constant (disordered) state is the global minimizer. I will then extend the discussion to non-constant states.

▶ CP-Fr-D-17-2 13:50–14:10
Transient Energy Growth Analysis of A Standing-wave Thermoacoustic System

Zhao, Dan — Nanyang Technological Univ. Singapore
Li, Shihuai — Nanyang Technological Univ.
Zhang, Zhiguo — Zhejiang Univ. of Sci. & Tech.
Yang, Wenming — National Univ. of Singapore

Abstract: In this work, a generalized model of a standing-wave thermoacoustic system with a Neumann and Dirichlet boundary condition is developed, providing a platform on which to gain insights on the effects of the heat source location, the number of eigenmodes and the mean temperature ratio on triggering limit cycles. The classical time-lag N – τ model is used to capture the heat source' s dynamics. Coupling the model with a Galerkin series expansion of the acoustic waves present enables the time evolution of flow disturbances and their transient growth rate to be calculated via singular value decomposition method. It is found that the most 'dangerous' heater locations are periodically present. In addition, it is shown that either the presence of mean temperature gradient or the increase of eigenmodes number can result in the shift of the extreme heat source locations. Finally, Rayleigh index is defined and estimated to determine the heat-to-sound coupling.

MS-Fr-D-18 13:30–15:30 209B
Mathematics and Optics - Part III of IV

For Part 1, see MS-Th-D-18
For Part 2, see MS-Th-E-18
For Part 4, see MS-Fr-E-18

Organizer: Santosa, Fadil — Inst. for Mathematics & its Applications
Organizer: Bao, Gang — Zhejiang Univ.
Organizer: Weinstein, Michael — Columbia Univ.

Abstract: The importance of optics and is summarized in the 2013 US National Academy of Sciences report "Optics and Photonics: Essential Technology for Our Nation". Envisioned technologies which rely on optics include communications, imaging, sensing, and computing. What is clear from the report is that the Mathematical Sciences is poised to make significant contributions to the progress in technology. Indeed there is a growing research activity at the nexus of the Mathematical Sciences and the Optical Sciences. Together with advances in materials science and nano-structure fabrication, there is a growing role for mathematical tools, both computational and analytical.
The goal of this minisymposium is to highlight research in the mathematical sciences that deal with problems arising in optics and photonics. Topics that will be discussed in the sessions include optics in meta-materials, cloaking, photonic bandgap structures, design and control of optical devices, plasmonics, and nonlinear phenomena in optics. These topics will be emphasized during the Institute for Mathematics and its Applications (IMA) annual thematic program "Mathematics and Optics", 2016-17. The minisymposium is an invitation to mathematical scientists to participate in the IMA program.

▶ MS-Fr-D-18-1 13:30–14:00
Uniqueness and Stability Results for Inverse Scattering Problems by Minimum Far-field Measurements

Liu, Hongyu — Hong Kong Baptist Unversity

Abstract: In this talk, the speaker will present several uniqueness and stability results in determining impenetrable obstacles by minimum acoustic or electromagnetic far-field measurements. The obstacles are of general polyhedral type, which may consist at the same time, both solid and crack-type components. In the general case, one can recover them by N far-field measurements, where N denotes the space dimensions. If there are no crack-type components presented, then only a single far-field measurement is needed.

▶ MS-Fr-D-18-2 14:00–14:30
Multiscale Modeling and Computation of Nano Optical Responses

Liu, Di — Michigan State Univ.

Abstract: We introduce a new framework for the multiphysical modeling and multiscale computation of nano-optical responses. The semi-classical theory treats the evolution of the electromagnetic field and the motion of the charged particles self-consistently by coupling Maxwell equations with Quantum Mechanics. To overcome the numerical challenge of solving high dimensional many body Schr odinger equations involved, we adopt the Time Dependent Current Density Functional Theory (TD-CDFT). In the regime of linear responses, this leads to a linear system of equations determining the electromagnetic eld as well as the current and electron densities simultaneously. A self-consistent multiscale method is proposed to deal with the well separated space scales. Numerical examples arepresented to illustrate the resonant condition.

▶ MS-Fr-D-18-3 14:30–15:00
ON TRANSFORMATION-OPTICS BASED INVISIBILITY

Zhou, Ting — Northeastern Univ.

Abstract: I shall discuss the transformation optics based design of electromagnetic cloaking from the inverse problems point of view. In order to avoid the difficulty posed by the singular structure required for ideal cloaking, we study the regularized approximate cloaking. In particular, as it converges to the ideal one, we will see different types of boundary conditions appearing at the interior of the cloaking interface. Some of them is of non-local pseudo-differential type.

▶ MS-Fr-D-18-4 15:00–15:30
Imaging with Metallic Nanoparticles

Triki, Faouzi — Joseph Fourier Univ.

Abstract: In the talk we are interested in the reconstruction of a local change in the refractive index at the proximity of a nanoparticle surface. After introducing the biosensing model we analyze the uniqueness and stability of the inversion.

MS-Fr-D-19 13:30–15:30 307B
From individual interactions to collective behaviour in socio-economics and life sciences - Part I of II

For Part 2, see MS-Fr-E-19

Organizer: During, Bertram — Univ. of Sussex
Organizer: Wolfram, Marie-Therese — Radon Inst. for Computational & Applied Mathematics

Abstract: Complex, real-life systems in sociology, economics, and life sciences often consist of a large number of interacting individuals which may form patterns or develop a collective behaviour. The research on microscopic models of such systems and their kinetic, mean-field and hydrodynamic limits have recently gained a lot of momentum. The aim of the mini-symposium is to highlight recent advances on kinetic and PDE modelling in this area. The session focuses on applications such as congestion models, flocking, population dynamics as well as price and opinion formation.

▶MS-Fr-D-19-1 13:30–14:00

On A Boltzmann Type Price Formation Model

Wolfram, Marie-Therese — Radon Inst. for Computational & Applied Mathematics

Abstract: In this talk we propose a simple agent based trade model with s-tandard stochastic price fluctuations, in whichtrading events are modelled as kinetic collisions. We prove that solutions of this Boltzmann type model converge to solutions of a parabolic free boundary price formation model by Lasry & Lions as the transaction rate tends to infinity. In addition we study the model in different asymptotic limits and illustrate our results with numerical simulations.

▶MS-Fr-D-19-2 14:00–14:30

On Minimisers for the Interaction Energy

Canizo, Jose A. — Universidad de Granada

Abstract: The existence of compactly supported global minimisers for continuum models of particles interacting through a potential is shown under almost optimal hypotheses. The main assumption on the potential is that it is catastrophic or not H-stable, which is the complementary assumption to that in classical results on thermodynamic limits in statistical mechanics. The proof also provides some properties of the minimisers.

▶MS-Fr-D-19-3 14:30–15:00

Modelling Myxobacteria – From Micro to Macro

Manhart, Angelika — Univ. of Vienna

Abstract: Myxobacteria are soil-living single-cell organisms that can form complex macroscopic patterns such as aggregates and, most fascinating, interacting waves. I will present the derivation and interpretation of two types of models: A Boltzmann-type model based on simple microscopic interaction rules with a quadratic collision kernel and a Vicsek type model. For both models macroscopic limits and their properties will be discussed.

▶MS-Fr-D-19-4 15:00–15:30

Synchronization in Multiagent Systems with Reaction Delays and Multiplicative Noise

Haskovec, Jan — King Abdullah Univ. of Sci. & Tech.

Abstract: We consider a Cucker-Smale type system with reaction delays and multiplicative noise and derive conditions for asymptotic synchronization in terms of the alignment intensity, noise strength and length of the delay. The main analytical tool is a decay estimate for a novel type of a Lyapunov functional. Moreover, we show that our analysis provides a new result concerning asymptotic behavior of delayed geometric Brownian motion. We also provide results of numerical simulations.

MS-Fr-D-20 13:30–15:30 210B

Computational Inverse Problems - Part III of IV

For Part 1, see MS-Th-D-20
For Part 2, see MS-Th-E-20
For Part 4, see MS-Fr-E-20

Organizer: Jin, Bangti — Univ. College London
Organizer: Lu, Xiliang — Wuhan Univ.

Abstract: Inverse problems arise in a wide variety of applications, e.g., medical imaging, tomography, anomalous diffusion and compressed sensing. Their efficient and stable numerical solution is however very challenging due to the ill-posed nature of inverse problems. There have been significant progress in recent years, in novel application, new mathematical techniques and efficient optimization algorithms. In this mini-symposium, we aim to present and discuss recent advances in the area.

▶MS-Fr-D-20-1 13:30–14:00

Towards Dynamic High Resolution Photoacoustic Tomography

Lucka, Felix — UCL

Abstract: The acquisition time of current high-resolution 3D photoacoustic tomography devices limits their ability to image dynamic processes. The talk will demonstrate how to overcome this deficit by combining recent advances in spatio-temporal sub-sampling schemes, compressed sensing and inverse problems with the development of tailored data acquisition systems. Results for simulated and experimental data will be presented. Joint work with Marta Betcke, Simon Arridge, Ben Cox, Nam Huynh, Edward Zhang and Paul Beard.

▶MS-Fr-D-20-2 14:00–14:30

Dynamic X-ray Tomography with Level Set Regularization

Siltanen, Samuli — Univ. of Helsinki

Abstract: X-ray tomography recovers an attenuation function f from a set of line integrals of f. Moving objects can be imaged using several pairs of X-ray sources and detectors “filming” the object from many directions at the same time. However, new regularized inversion methods are needed for imaging based on such special type of data. A novel level-set type method is introduced for that purpose, enforcing continuity in space-time. Computational results are shown, including measured data.

▶MS-Fr-D-20-3 14:30–15:00

Oracle-type Posterior Contraction Rates in Bayesian Inverse Problems

Lu, Shuai — School of Mathematical Sci., Fudan Univ.

Abstract: We discuss Bayesian inverse problems in Hilbert spaces. The focus is on a fast concentration of the posterior probability around the unknown true solution as expressed in the concept of posterior contraction rates.

▶MS-Fr-D-20-4 15:00–15:30

$L^0(\Omega)$ Optimization for Optimal Control Problems and Imaging

Ito, Kazufumi — North Carolina State Univ.

Abstract: A general class of non convex and non smooth optimization methods for optimal control and inverse problems are discussed. A Lagrange multiplier theory is developed for the necessary optimality and a complementarity condition is obtained for primal and dual variables. Based on the theory a numerical optimization method based on the primal-dual active set method is developed.

MS-Fr-D-21 13:30–15:30 309B

Minisymposium on discontinuous Galerkin method: recent development and applications - Part VIII of VIII

For Part 1, see MS-Tu-D-21
For Part 2, see MS-Tu-E-21
For Part 3, see MS-We-D-21
For Part 4, see MS-We-E-21
For Part 5, see MS-Th-BC-21
For Part 6, see MS-Th-D-21
For Part 7, see MS-Th-E-21

Organizer: Xu, Yan — Univ. of Sci. & Tech. of China
Organizer: Shu, Chi-Wang — Brown Univ.

Abstract: Over the last few years, discontinuous Galerkin (DG) methods have found their way into the main stream of computational sciences and are now being successfully applied in almost all areas of natural sciences and engineering. The aim of this minisymposium is to present the most recent developments in the design and theoretical analysis of DG methods, and to discuss relevant issues related to the practical implementation and applications of these methods. Topics include: theoretical aspects and numerical analysis of discontinuous Galerkin methods, non-linear problems, and applications. Particular emphasis will be given to applications coming from fluid dynamics, solid mechanics and kinetic theory.

▶MS-Fr-D-21-1 13:30–14:00

Error Estimates on the Fully-discrtete Local Discontinuous Galerkin Method

Zhang, Qiang — Nanjing Univ.

Abstract: In this talk we give two error estimates on the local discontinuous Galerkin method. One is the local error estimate when the layer boundary exists, and the other is the implicit-explicit time-updating. For both cases, we obtained the optimal error estimates in a suitable domain.

▶MS-Fr-D-21-2 14:00–14:30

Error Analysis of Discontinuous Galerkin Schemes for Compressible Multiphase Flows

Giesselmann, Jan — Univ. of Stuttgart

Abstract: We consider semi-discrete local discontinuous Galerkin methods approximating a one-dimensional model for compressible multiphase flows of Korteweg type. We use the Korteweg (density gradient) terms in the energy to derive a modified relative entropy stability framework. We combine reconstruction techniques with the stability framework to derive a residual based a posteriori error estimate and we use a discrete version of the stability framework to prove an a priori error bound.

▶MS-Fr-D-21-3 14:30–15:00

Analysis of the Local Discontinuous Galerkin Method for the Drift-diffusion Model of Semiconductor Devices

Liu, Yunxian — Shandong Univ.
Shu, Chi-Wang — Brown Univ.

Abstract: In this talk we consider both the semi-discrete and fully discrete local discontinuous Galerkin (LDG) schemes for the drift-diffusion (DD) model of one dimensional semiconductor devices. In the fully discrete scheme, we couple the implicit-explicit (IMEX) time discretization with the LDG spatial discretization, in order to allow larger time steps and to save computational

cost. Optimal error estimates are obtained and a simulation is also performed to validate the analysis.

▶ MS-Fr-D-21-4 15:00–15:30

Optimal Error Estimates for Discontinuous Galerkin Methods Based on Upwind-biased Fluxes for Linear Hyperbolic Equations

Meng, Xiong Harbin Inst. of Tech. & Univ. of East Anglia
Shu, Chi-Wang Brown Univ.

Abstract: We analyze discontinuous Galerkin methods using upwind-biased numerical fluxes for time-dependent linear conservation laws. In one dimension, optimal a priori error estimates of order $k+1$ are obtained for the semidiscrete scheme. We extend the analysis to the multidimensional case on Cartesian meshes when piecewise tensor product polynomials are used, and to the fully discrete scheme with explicit Runge–Kutta time discretization. Numerical experiments are shown to demonstrate the theoretical results.

MS-Fr-D-22 13:30–15:30 206A

Recent development and applications of weighted essential non-oscillatory methods - Part IV of V

For Part 1, see MS-Th-BC-22
For Part 2, see MS-Th-D-22
For Part 3, see MS-Th-E-22
For Part 5, see MS-Fr-E-22

Organizer: Qiu, Jianxian Xiamen Univ.
Organizer: Shu, Chi-Wang Brown Univ.

Abstract: The spectrum covered by the minisymposium ranges from recent development, analysis, implementation and applications, for the weighted essential non-oscillatory (WENO) methods. The WENO methods provide a practical effective framework to solve out many nonlinear wave-dominated problems with discontinuities or sharp gradient regions, which play an important role arising in many applications of computational fluid dynamics, computational astrophysics, computational plasma physics, semiconductor device simulations, among others. Devising robust, accurate and efficient WENO methods for solving these problems is of considerable importance and, as expected, has attracted the interest of many researchers and practitioners. This minisymposium serves as a good forum for researchers to exchange ideas and to promote this active and important research direction.

▶ MS-Fr-D-22-1 13:30–14:00

A Sign Preserving Third-Order WENO Reconstruction

Ray, Deep TIFR-Cente for Applicable Mathematics

Abstract: We propose a third-order WENO reconstruction that satisfies the sign property i.e, the sign of the jump in the reconstructed states at an interface is the same as that of the original jump. It is introduced as an improvement over existing ENO schemes, which also satisfy this property. The proposed reconstruction gives satisfactory results when used with high-order entropy stable TeCNO schemes for conservation laws.

▶ MS-Fr-D-22-2 14:00–14:30

Recent Development and Applications of Weighted Essential Non-oscillatory Methods

Wang, Rong South Univ. of Sci. & Tech. of China

Abstract: We introduce a new mapped weighted essentially non-oscillatory method for hyperbolic conservation laws by proposing a new family of mapping functions. When it is applied to classic WENO methods, it can achieve the optimal order of accuracy near critical points in smooth regions. We also consider the potential loss of accuracy when using the classic forms of smoothness indicators for WENO of order ¿= 7 due to roundoff errors.

▶ MS-Fr-D-22-3 14:30–15:00

Boundary Extrapolation Techniques for Finite Difference WENO Schemes on Complex Geometries

Donat, Rosa Universitat de Valencia
Mulet, Pep Univ. of Valencia

Abstract: In the context of finite difference WENO schemes on structured Cartesian meshes, we propose an extrapolation technique of the information in the interior of the computational domain to ghost cells that can handle domains with complex geometries. This technique is based on the application of Lagrange interpolation with a filter for the detection of discontinuities that permits a data dependent extrapolation, with higher order at smooth regions and essentially non oscillatory properties near discontinuities.

▶ MS-Fr-D-22-4 15:00–15:30

High-order Finite Difference WENO Methods for Plasma Applications

Christlieb, Andrew Michigan State Univ.

Abstract: We construct single-stage, single-step finite difference weighted essentially non-oscillatory (WENO) methods for hyperbolic plasma models. Our methods are constructed from the Picard integral formulation (PIF) of the PDE. We begin with time averaged fluxes, and then discretize the temporal integral with a Taylor series. Our focus is on the magnetohydrodynamics equations. To obtain divergence free magnetic fields at the discrete level, we construct a high-order single-stage unstaggered constrained transport method using a Hamilton Jacobi formulation.

MS-Fr-D-23 13:30–15:30 208A

Computational Methods of PDE-based Eigenvalue Problems and Applications in Nanostructure Simulations - Part III of IV

For Part 1, see MS-Th-D-23
For Part 2, see MS-Th-E-23
For Part 4, see MS-Fr-E-23

Organizer: Bai, Zhaojun Univ. of California, Davis
Organizer: Yang, Chao Lawrence Berkeley National Laboratory
Organizer: Zhou, Aihui Acad. of Mathematics & Sys. Sci., Chinese Acad. of Sci.

Abstract: PDE based eigenvalue problems arise from electronic structure calculations, band structure calculations in photonic crystals and dynamics of electromagnetic fields. This minisymposium brings together researchers working on PDE-based eigenvalue problems from areas of mathematical modeling and analysis, numerical analysis, high-performance computing and applications. This minisymposium features the latest progress on developing adaptive discretizations, stable nonlinear iterations and fast algebraic solvers, code designing and high performance computing on modern computer systems.

▶ MS-Fr-D-23-1 13:30–14:00

Accurate Computations of Eigenvalues of Differential Operators

Ye, Qiang Univ of Kentucky

Abstract: In this talk, we present an algorithm that computes all eigenvalues of a symmetric diagonally dominant matrix to high relative accuracy. We further consider using the algorithm in an iterative method for a large scale eigenvalue problem and we show how smaller eigenvalues of finite difference discretizations of differential operators can be computed accurately. Numerical examples are demonstrate the high accuracy achieved by the new algorithm.

▶ MS-Fr-D-23-2 14:00–14:30

Variational Characterization of Eigenvalues of A Non–symmetric Eigenvalue Problem Governing Elastoacoustic Vibrations

Voss, Heinrich Hamburg Univ. of Tech.

Abstract: Vibration of an elastic structure coupled with an internal inviscid, homogeneous, compressible fluid are governed by a non self–adjoint eigenvalue problem, which shares many important properties with self–adjoint models: Its countable set of real eigenvalues allow for a variational characterizations known from symmetric theory. They can be characterized by Rayleigh's principle, and are minmax and maxmin values of a Rayleigh functional. Its FE discretization can solved efficiently by structure preserving iterative projection methods or AMLS.

▶ MS-Fr-D-23-3 14:30–15:00

Large Scale Eigenvalue Computation Using Tensor-Train Format

Wen, Zaiwen Peking Univ.

Abstract: In this talk, we present an efficient approach for finding the p smallest eigenvalues and their associated eigenvectors represented in a prescribed tensor-train (TT) format by solving the trace-minimization problem for a given a huge symmetric matrix A.

▶ MS-Fr-D-23-4 15:00–15:30

Applications of A Contour Integral Based Eigenvalue Solver to Large-scale Nanostructure Simulations with Density Functional Theory

Sakurai, Tetsuya Univ. of Tsukuba
Futamura, Yasunori Univ. of Tsukuba

Abstract: Contour integral based type methods are suitable for solving interior sparse eigenvalue problems that are the central problem arises in many kinds of density functional theory (DFT) based nanostructure simulations. We present some efficient implementations of a contour integral-based eigensolver that are each developed for different DFT-based nanostructure simulation codes built on different theories of approximation and types of discretization. We show performance evaluations on state-of-art supercomputers with large-scale nano-systems.

MS-Fr-D-24 13:30–15:30 211
Computational Electromagnetism and Its Engineering Applications - Part III of IV
For Part 1, see MS-Th-D-24
For Part 2, see MS-Th-E-24
For Part 4, see MS-Fr-E-24

Organizer: Duan, Huoyuan Collaborative Innovation Centre of Mathematics, School of Mathematics & Statistics, Wuhan Univ., Wuhan 430072, China
Organizer: Zheng, Weiying Chinese Acad. of Sci.

Abstract: In recent years, there arises a surge of numerical studies for electromagnetic problems in complex engineering systems, such as large power transformers, electrical machinery, magnetic fusion, etc. The mathematical models turn out to be nonlinear, multiscale, strongly singular, and coupled with multiple physical fields. It brings new challenges to researchers from both mathematical and engineering communities in developing practical mathematical models and effective and efficient numerical methods and solvers. This mini-symposium seeks to bring together researchers in both computational mathematics and electromagnetic engineering that involve the mathematical modeling, analysis, computation, and experimental validation for electromagnetic problems. The main theme will be focused on new efficient numerical methods and fast solvers for Maxwell's equations and magnetohydrodynamic equations and will address their extensive applications to engineering problems. It will promote exchange of ideas and recent developments on mathematical modeling, numerical discretization, solvers and engineering practices of computational electromagnetism.

▶ MS-Fr-D-24-1 13:30–14:00
Material Property Modeling under Extreme Excitations and Validation of Large-Scale Numerical Computation in Industry Applications
Cheng, Zhiguang R & D Center, Baoding Tianwei Group

Abstract: The working property modeling of electrical material under extreme excitations, probably involving DC-biasing and/or multi-harmonics source, and the validations of large-scale modeling and numerical computation are investigated based on engineering-oriented models, which are becoming increasingly challenging and important in industry applications.

▶ MS-Fr-D-24-2 14:00–14:30
Analysis for An Exactly Divergence-Free Method for the Magnetic Induction Equations
Li, Fengyan Rensselaer Polytechnic Inst.

Abstract: Motivated by the developments of the numerical divergence-free treatments for ideal magnetohydrodynamics (MHD) equations, we analyze an exactly divergence-free method based on central discontinuous Galerkin methods for the magnetic induction equations. von Neumann analysis is carried out for numerical stability when the meshes are uniform and the velocity field is constant. In order to be able to handle more general cases, we also establish stability and error estimates through energy methods.

▶ MS-Fr-D-24-3 14:30–15:00
Two-level Additive Preconditioners for Edge Element Discretizations of Time-harmonic Maxwell Equations
Zhong, Liuqiang South China Normal Univ.
Shu, Shi Xiangtan Univ.

Abstract: Two-level additive preconditioners are presented for edge element discretizations of time-harmonic Maxwell equations. It is shown that the generalized minimal residual (GMRES) method ap- plied to the preconditioned system converges uniformly provided that the coarsest mesh size is reasonably small (but independent of the fine mesh size) and the parameter for the “coarse mesh” space solver is sufficiently large. Numerical experiments show the efficiency of the proposed approach.

▶ MS-Fr-D-24-4 15:00–15:30
Fully discrete A-Φ finite element method for Maxwell's equations with nonlinear conductivity
Tong, Kang Communication Univ. of China

Abstract: This talk is referred to the study of a fully discrete A-Φfinite element scheme to solve nonlinear Maxwell's equations. The nonlinearity is due to a field-dependent conductivity with the power-law form $|E|^{\alpha-1}, 0 < \alpha < 1.$ We design a nonlinear time-discrete scheme for approximation in suitable function spaces. We show the well-posedness of the problem, prove convergence for our semidiscrete scheme based on boundedness of the second derivative in the dual space. The convergence of the nonlinear term is based on the Minty-Browder technique. We also discuss the error estimate for the fully discretized problem and support the theoretical result by some numerical experiments.

MS-Fr-D-25 13:30–15:30 210A
Emerging PDEs: Analysis and Computation - Part III of IV
For Part 1, see MS-Th-D-25
For Part 2, see MS-Th-E-25
For Part 4, see MS-Fr-E-25

Organizer: Chen, Zhiming AMSS, Chinese Acad. of Sci.
Organizer: Nochetto, Ricardo Univ. of Maryland
Organizer: Zhang, Chensong Acad. of mathematics & Sys. Sci.

Abstract: Novel models in science and engineering are governed by nonlinear integro-differential equations with increasing complexity which demand innovative techniques in both analysis and computation, such as adaptivity, fast methods and preconditioning, and structure preserving algorithms. Areas of special interest include complex fluids and new materials, electromagnetism and wave propagation, uncertainty quantification, and fractional PDEs, among others.
This minisymposium intends to gather about 16 world experts and young researchers in analysis and computation of PDE to discuss the most recent progress in this exciting field as well as future directions for research.

▶ MS-Fr-D-25-1 13:30–14:00
Preasymptotic Error Analysis of Higher Order FEM and CIP-FEM for Helmholtz Equation with High Wave Number
Wu, Haijun Nanjing Univ.

Abstract: H^1- and L^2- error estimates with explicit dependence on the wave number k are derived for the FEM and CIP-FEM. In particular, it is shown that if $k^{2p+1}h^{2p}$ is sufficiently small, then the pollution errors of both methods in H^1-norm are bounded by $O(k^{2p+1}h^{2p})$, which coincides with the phase error of the FEM obtained by existent dispersion analyses on Cartesian grids.

▶ MS-Fr-D-25-2 14:00–14:30
Semiclassical Computational Methods for Quantum Dynamics with Band-crossings
Jin, Shi Univ. of Wisconsin-Madison & Shanghai Jiao Tong Univ.

Abstract: We develop semiclassical models and multiscale computational methods for quantum dynamics with non-adiabatic effects. Applications of such methods include surface hopping, Schrodinger equation with periodic potentials, elastic and electromagnetic waves with polarizations, and graphene. We use the Wigner transform to derive these models. The key idea is to evolve the dynamics of the entire Wigner matrices, which contain important non-adiabatic terms, not just the diagonal projections corresponding to the eigenstates of the Hamiltonians. We also develop multiscale computational methods based on these models and numerical examples will be used to show the validity of these models in captuing the qunatum transitions at the crossing-points.

▶ MS-Fr-D-25-3 14:30–15:00
A rate of convergence for Monge-Ampére equation
Zhang, Wujun Univ. of Maryland, College Park
Nochetto, Ricardo Univ. of Maryland

Abstract: Monge-Ampére equation arises naturally from differential geometry, optimal transportation and other fields of science and engineering.
In this talk, we shall review the viscosity solution of Monge-Ampére equation. We design a numerical approximation of Monge-Ampére equation by using its geometric interpretation. Applying this geometric interpretation and discrete Alexandroff estimate, we derive a rate of convergence to the viscosity solution for Monge-Ampére equations.

▶ MS-Fr-D-25-4 15:00–15:30
Analysis and Computation of Discretized Coupled PDEs
Xu, Jinchao PKU,and The Pennsylvania State Univ.

Abstract: I will report some recent works on structure-preserving and stable discretization of some multi-physics models and robust preconditioning methods for the resulting algebraic systems. In particular, judging from theoretical and/or numerical analysis of several mathematical models for magnetohydrodynamics (MHD) which involve the coupling of Navier-Stokes or Euler equations with Maxwell equations, I will argue that some more complicated models may be easier to simulate than some simplified models that have been often used in practice.

MS-Fr-D-26 13:30–15:30 110
Disturbance rejection control: problems, principles and methodologies
Organizer: Gao, Zhiqiang Department of electrical & computer engineering, Cleveland State Univ.

Abstract: This mini-symposium gives a fresh perspective of the science of

automatic control through the exposition of the root problems, the fundamental principles and the useful methodologies of disturbance rejection. The first speaker will take us back to the original challenge posed by J. Han on the model-based modern control paradigm, and demonstrate the significance and consequence of such challenge. This is followed by three speakers, each will address a unique aspect of disturbance rejection control, including the mathematical analysis, the design philosophy, and methodologies. We look to the past to understand where we come from, to grasp the fundamental problems, and we contemplate the future of control theory and applied mathematics with inspiration and anticipation.

▶ MS-Fr-D-26-1 13:30–14:00

Disturbance Observation Based Control Theory with Applications to Mechatronic Systems

Shihua, Li Southeast Univ.

Abstract: Disturbances always bring adverse effects on control systems. Compared with high gain control and integral control methods, disturbance estimation based control provides a different way to handle disturbances. Some new research developments are introduced. Nonlinearities, frictions, internal dynamics, time-varying parameters and external disturbances make control design of mechatronic systems challenging. By theoritical analysis and experimental results, it is shown that disturbance observation based control methods can efficiently improve precision and robustness for such systems.

▶ MS-Fr-D-26-2 14:00–14:30

The Active Disturbance Rejection Control to Stabilization for Multi-Dimensional Wave Equation with Boundary Control Matched Disturbance

Bao-Zhu, Guo Acad. of Mathematics & Sys. Sci.,Academia Sinica

Abstract: In this paper we consider boundary stabilization for a multi-dimensional wave equation with boundary control matched disturbance that depends on both time and spatial variables. The active disturbance rejection control (ADRC) approach is adopted in investigation. All subsystems in the closed-loop are shown to be asymptotically stable. In particular, the time varying high gain is first time applied to a system described by the partial differential equation.

▶ MS-Fr-D-26-3 14:30–15:00

On the Conception of Disturbance as Bedrock in Engineering Cybernetics

Gao, Zhiqiang Department of electrical & computer engineering, Cleveland State Univ.

Abstract: Rather than external and state independent, disturbance is conceived by Qian Xuesen as uncertainties both internal and external to the plant. Disturbance rejection is thus central to Engineering Cybernetics, founded by Qian Xuesen in 1954. This distinct conception forces us to see differently the fundamental problems, basic premises, and foundational frameworks in control theory; it has also changed how control is practiced, evident in the latest product announcements of several industry giants in the West.

▶ MS-Fr-D-26-4 15:00–15:30

Composite Hierarchical Anti-Disturbance Control: from Single to Multiple Disturbances

Guo, Lei Beihang Univ.

Abstract: To sufficiently reduce conservatism and utilize the characteristics of disturbances themselves, we address the Composite Hierarchical Anti-Disturbance Control (CHADC) approach for multiple disturbance systems. CHADC is a “refined” anti-disturbance control including disturbance modelling and description, disturbance estimation and rejection in inner loop, and disturbance attenuation or other performance control in outer loop. Aerospace control examples are given to shown the significance of CHADC.

MS-Fr-D-27 13:30–15:30 407

Decoupling methods for multi-physics and multi-scale problems - Part VII of VIII

For Part 1, see MS-Tu-E-27
For Part 2, see MS-We-D-27
For Part 3, see MS-We-E-27
For Part 4, see MS-Th-BC-27
For Part 5, see MS-Th-D-27
For Part 6, see MS-Th-E-27
For Part 8, see MS-Fr-E-27

Organizer: He, Xiaoming Missouri Univ. of Sci. & Tech.
Organizer: Xu, Xuejun Inst. of Computational Mathematics, AMSS, CAS

Abstract: The inherent multi-physics and multi-scale features of many real world problems accentuate the importance to develop efficient and stable numerical methods for the relevant PDEs, especially the decoupling methods. Although great efforts have been made for solving these problems, many practical and analytical challenges remain to be solved. This mini-symposium intends to create a forum for junior and senior researchers from different fields to discuss recent advances on the decoupling methods for multi-physics and multi-scale problems with their applications.

▶ MS-Fr-D-27-1 13:30–14:00

A Cartesian Grid Method for the Nonlinear Poisson-Boltzmann Equations of Biophysics

Ying, Wenjun Shanghai Jiao Tong Univ.

Abstract: The nonlinear Poisson-Boltzmann equations of biophysics arise from multiphysics modelling of electrostatic potential in a solvated bimolecular system. The problem is a heterogeneous interface problem around complex geometry. This talk presents a Cartesian grid based boundary integral method to solve the problem. The method avoids generation of any unstructured body-fitted grids and uses fast elliptic solvers to solve discrete equations on the Cartesian grid.

▶ MS-Fr-D-27-2 14:00–14:30

Efficient Space Charge Solver in Particle Tracking Method for Beam Dynamics Simulations

Kaman, Tulin ETH Zurich

Abstract: The quantitative and efficient evaluation of space charge effects in existing and future high intensity hadron accelerators are essential. For this purpose, we create an interface between the block-structured adaptive mesh refinement framework and preconditioned iterative solvers to solve Poisson’s equation for the electrostatic potential on bounded three-dimensional domains. We introduce a new adaptive multigrid technique for 3D space charge calculation on the multilevel grid hierarchy.

▶ MS-Fr-D-27-3 14:30–15:00

Multiscale Multiphysics Simulation Tool for Dusty Proto-planetary Disks

Li, Shengtai Los Alamos National Laboratory

Abstract: We present a numerical method and simulation tool for interaction between dusty disk and embedded proto-planets. The dusty disk is subject to bi-fluid hydrodynamics equations and is solved via high-order high-resolution Godunov methods. The planet motions are solved as an N-body problem. The interaction between the disk and planets is carefully considered using an operator-split method. Several methods are proposed to bridge different time and length scales in this multi-physics problem.

MS-Fr-D-28 13:30–15:30 109

Models and Statistical analysis of bio-medical big data

Organizer: Li, Lei Chinese Acad. of Sci.

Abstract: The modeling, computation and inference of biological and medical big data is a promise of making new discoveries in life sciences, and finding treatment and cure of complex diseases. Meanwhile the sophisticated structures and large scale of these big data also challenge the intelligence of human beings of this time. Applied mathematicians and statisticians’ expertise are valuable in this research area. In this session, four distinguished applied mathematicians and statisticians will present their research and views toward the bio-medical big data.

▶ MS-Fr-D-28-1 13:30–14:00

Big Data and Brain Science: Stepping into Patients’ World

Feng, Jianfeng Fudan Univ.

Abstract: Multi-modality image data has played a critical role in studying mental disorders in recent years: it can be used as a biomarker or serve as an endophnotype data to link genetic and environmental data. Using the largest image data set in schizophrenia, we explored the roots of the disorders with a novel approach BWAS (brain-wide association study) and nonlinear associations. The approach allowed us to identify the roots of the disorders at different stages.

▶ MS-Fr-D-28-2 14:00–14:30

Inference of Markovian Properties of Molecular Sequences from NGS Data and Applications to Comparative Genomics

Sun, Fengzhu Univ. of Southern California, Fudan Univ.

Abstract: Markov chains (MC) have been widely used to model molecular sequences. We develop approximation theory for two widely used statistics related to MCs based on next generation sequence (NGS) reads. Surprisingly the traditional chi-square statistic does not follow chi-square distribution anymore, instead it has an approximate gamma distribution. We develop methods to estimate the order of the MC based on NGS reads. These results are used for alignment-free genome comparison and interesting results are obtained.

▶ MS-Fr-D-28-3 14:30–15:00

CCLasso: Correlation Inference for Compositional Data Through Lasso
Deng, Minghua Peking Univ.

Abstract: Inferring the correlation relationship among members of microbial communities is of fundamental importance for genomic survey study. We propose a novel method called CCLasso based on least squares with L1 penalty to infer the correlation network for latent variables of compositional data from metagenomics data. An effective alternating direction algorithm from augmented Lagrangian method is used to solve the optimization problem. The new method outperforms existing methods, e.g. SparCC, in edge recovery for compositional data.

▶MS-Fr-D-28-4 15:00–15:30
BASE – A Statistical Inference of transcription factors' effective regulation: notion and examples
Li, Lei Chinese Acad. of Sci.

Abstract: A typical problem in functional genomics is the identification of transcription factors (TFs) accounted for the profile of expression differences between two samples. We propose a statistical method, referred to as BASE (binding association with sorted expression), to infer transcription factors' effective regulation from expression profiles with the help of TFs' binding affinity data. It searches the maximum association between binding affinity profile of a TF and expression profile along the direction of sorted differentiation.

MS-Fr-D-29 13:30–15:30 305
Numerical Homogenization and Multiscale Model Reduction Methods - Part IV of V

For Part 1, see MS-Th-BC-29
For Part 2, see MS-Th-D-29
For Part 3, see MS-Th-E-29
For Part 5, see MS-Fr-E-29

Organizer: Zhang, Lei Shanghai Jiao Tong Univ.
Organizer: Peterseim, Daniel Universität Bonn
Organizer: Jiang, Lijian Hunan Univ.
Organizer: Chung, Eric The Chinese Univ. of Hong Kong

Abstract: Problems that transcend a variety of strongly coupled time and length scales are ubiquitous in modern science and engineering such as physics, biology, and materials. Those multiscale problems pose major mathematical challenges in terms of analysis, modeling and simulation. At the same time, advances in the development of multiscale mathematical methods coupled with continually increasing computing power have provided scientists with the unprecedented opportunity to study complex behavior and model systems over a wide range of scales.
This minisymposium is aimed at presenting the state-of-the-art in multiscale modeling, simulation and analysis for the applications in science and engineering. It will focus on the developments and challenges in numerical multiscale methods and multiscale model reduction methods. The lectures will cover the following subjects: - Numerical homogenization methods, e.g. Generalized FEM, MsFEM, FEM-HMM, DG methods, Partition of Unity methods, multiscale domain decomposition etc. - Multiscale model reduction methods for stochastic systems, such as stochastic PDEs and random materials. - Multiscale methods for problems arising in composite materials and heterogeneous porous media. - Multiscale methods for eigenvalue problems, high frequency waves, and multiscale hyperbolic PDEs. - Multiscale modeling in various applications such as reservoir performance prediction, bio-motility, chemical vapor infiltration, etc.

▶MS-Fr-D-29-1 13:30–14:00
Multiscale Modeling on Chemical Vapor Infiltration Process
Zhang, Changjuan Soochow Univ.
Yue, Xingye Soochow Univ.

Abstract: Mulitscale model was developed and analyzed to describe the isothermal chemical vapor infiltration (CVI) process in fabrication of the carbon fiber reinforced silicon carbide (C/SiC) composites by Yun Bai et al. Homogenization theory for the two stages of CVI process is established, which is the foundation of the multiscale algorithm. Some three dimensional simulations for the CVI process are presented.

▶MS-Fr-D-29-2 14:00–14:30
Domain Decomposition and Preconditioners for Heterogeneous Media Using Optimal Local Basis Functions
Lipton, Robert LSU
Sinz, Paul Louisiana State Univ.

Abstract: We introduce a new multiscale preconditioner derived from optimal local approximation spaces [1,2]. The domain decomposition is given by a partition of unity. We provide convergence rates for the iterative method.
[1]. Babuska, I. and Lipton, R. "Optimal local approximation spaces for generalized finite element methods with application to multiscale problems," MMS 2011 DOI:10.1137/100791051.
[2.] Babuska, I., Huang, X., and Lipton, R., "Machine computation using the exponentially convergent multiscale spectral generalized finite element method," http://dx.doi.org/10.1051/m2an/2013117

▶MS-Fr-D-29-3 14:30–15:00
On the Application of Generalized Multiscale Finite Element Method in Multiphase Flow Models
Ginting, Victor Univ. of Wyoming

Abstract: Subsurface flow and transport are described by partial differential equations whose parameters vary over many length scales. We employ a recent work on the generalized multiscale finite element (GMsFEM) method for solving these models. The lack of local conservation of the Darcy's flux is overcome by an element-based postprocessing which only requires solving inexpensive set of linear systems that are an independent of each other. Numerical examples are presented.

MS-Fr-D-30 13:30–15:30 VIP2-2
Numerical approaches in optimization with PDE constraints: recent progress and future challenges - Part VI of VII

For Part 1, see MS-We-D-30
For Part 2, see MS-We-E-30
For Part 3, see MS-Th-BC-30
For Part 4, see MS-Th-D-30
For Part 5, see MS-Th-E-30
For Part 7, see MS-Fr-E-30

Organizer: Yan, Ningning Chinese Acad. of Sci.
Organizer: Hinze, Michael Universität Hamburg

Abstract: The numerical treatment of optimization problems with PDE constraints is a very active field of mathematical research with great importance for many practical applications. To achieve further progress in this field of research, the development of tailored discretization techniques, adaptive approaches, and model order reduction methods has to be intertwined with the design of structure exploiting optimization algorithms in function space.
This minisymposium covers mathematical research in PDE constrained optimization ranging from numerical analysis and adaptive concepts over algorithm design to the tailored treatment of optimization applications with PDE constraints. It thereby forms a platform and fair for the exchange of ideas among young researchers and leading experts in the field, and for fostering and extending international collaborations between research groups in the field.

▶MS-Fr-D-30-1 13:30–14:00
Sustainable Fishing Strategy as An Optimal Control Problem
Tews, Benjamin Univ. of Kiel

Abstract: This talk is motivated by the global overfishing problem. What is the optimal design of marine protect areas regarding reproduction of fish stocks and amount of fisheries yield. We formulate the fishing strategy as an optimal control problem with control constraints. The fish stock dynamics are modeled by a time-dependent, non-linear PDE. The distributed control describes the fishing intensity and is assumed to be bilinear with the biomass. We present theoretical and numerical results.

▶MS-Fr-D-30-2 14:00–14:30
Optimal Control of Phase-field Models for Multiphase Flow.
Banas, Lubomir Bielefeld Univ.

Abstract: We consider a distributed optimal control problem for incompressible multiphase flow. The flow is modeled by a system of Cahn-Hilliard-Navier-Stokes equations with non-smooth free energy. We propose and analyze a fully-discrete finite element based numerical approximation of the problem. The discrete problem corresponds to a system of variational inequalities and is solved by an active-set type iterative algorithm. We present a number of computational experiments to demonstrate the performance the presented solution approach.

▶MS-Fr-D-30-3 14:30–15:00
Distributed and Boundary Control Problems for the Semidiscrete Cahn-Hilliard/Navier-Stokes System with Nonsmooth Ginzburg-Landau Energies
Hintermueller, Michael Humboldt-Univ. of Berlin

Abstract: Optimal control problems for the coupled Cahn- Hilliard/Navier-Stokes system with a non-smooth homogeneous free energy density are considered. Based on a suitable stationarity concept, a solver using the adaptive finite element method is discussed.

▶MS-Fr-D-30-4 15:00–15:30

Stochastic FE for Optimal Control Governed by Elliptic PDE with Random Coefficients

LIU, Wenbin — Univ. of Kent

Abstract: Stochastic optimal control problems has been one of the new hot research topics in the recent years. In this talk we apply stochastic Galerkin finite element methods to the optimal control problems governed by some PDEs with some random coefficients. We firstly establish stochastic Galerkin finite element approximation scheme for them and derive the optimality conditions. We then derive the priori error estimates with optimal order. We then extend our study to state constrainted cases.

MS-Fr-D-31 13:30–15:30 405

Advances on Mixed Finite Element Methods for Linear Elasticity - Part III of IV

For Part 1, see MS-Th-D-31
For Part 2, see MS-Th-E-31
For Part 4, see MS-Fr-E-31

Organizer: Hu, Jun — Peking Univ.
Organizer: Zhang, Shangyou — Univ. of Delaware

Abstract: The elasticity equations are solved in many scientific and engineering problems where the stress is often more important than the displacement. In this sense, the classical Hellinger–Reissner mixed formulation of the elasticity equations, where the stress tensor is sought in a symmetric H-div space and the displacement in an L2 space, is a natural and important variational formulation for this problem. The approximation of displacement can be taken in the space of discontinuous piecewise polynomials of some degree— but the approximation of the symmetric stress tensor is a long-standing, challenging, and surprisingly hard problem. As a matter of fact, "four decades of searching for mixed finite elements for elasticity beginning in the 1960s did not yield any stable elements with polynomial shape functions" [D. N. Arnold, Proceedings of the International Congress of Mathematicians, Vol. I: Plenary Lectures and Ceremonies (2002), 137-157].
This minisymposium will gather about 16 world experts and young researchers to discuss the most recent advances in this challenging field as well as future directions for research.

▶ MS-Fr-D-31-1 13:30–14:00

Multigrid Methods for Saddle Point Problems

Brenner, Susanne — Louisiana State Univ.

Abstract: In this talk we will present a general framework for the design and analysis of multigrid methods for saddle point problems arising from mixed finite element discretizations of elliptic boundary value problems. These multigrid methods are uniformly convergent in the energy norm on general polyhedral domains where the elliptic boundary value problems in general do not have full elliptic regularity. Applications to Stokes, Lame, Darcy and related nonsymmetric systems will be discussed. This is joint work with Hengguang Li, Duk-Soon Oh and Li-Yeng Sung.

▶ MS-Fr-D-31-2 14:00–14:30

A Reduced Local C^0 Discontinuous Galerkin Method for Kirchhoff Plates

Huang, Jianguo — Shanghai Jiao Tong Univ.

Abstract: We propose and analyze a reduced local C^0 discontinuous Galerkin method for Kirchhoff plate bending problems. The method can be viewed as the localization of Hellan-Herrmann-Johnson method, so we derive the well-posedness and a priori error estimates of the method. With the help of Zienkiewicz-Guzman-Neilan element space, the a posteriori error analysis is also developed. Numerical results are also provided. This is a joint work with Xuehai Huang from Wenzhou University.

▶ MS-Fr-D-31-3 14:30–15:00

A Non-conforming Finite Element Discretization for Linear Biot's Model in Poroelasticity: Convergence and Monotonicity

Gaspar, Francisco — Univ. of Zaragoza
Hu, Xiaozhe — Tufts Univ.
Rodrigo, Carmen — Univ. of Zaragoza
Zikatanov, Ludmil — The Pennsylvania State Univ.

Abstract: We consider the linear Biot's model in poroelasticity discretized with nonconforming linear elements for the displacement field and piece-wise constant elements for the pressure field. We show convergence of a fully discrete scheme using implicit Euler method in time. We also discuss the issues related to the monotonicity of the discrete schemes, i.e. the presence of non-physical oscillations in the pressure approximations for low permeabilities and/or small time steps.

MS-Fr-D-32 13:30–15:30 307A

Structured-mesh methods for interface problems. - Part VII of VIII

For Part 1, see MS-Tu-E-32
For Part 2, see MS-We-D-32
For Part 3, see MS-We-E-32
For Part 4, see MS-Th-BC-32
For Part 5, see MS-Th-D-32
For Part 6, see MS-Th-E-32
For Part 8, see MS-Fr-E-32

Organizer: Chen, Huanzhen — College of Mathematical Sci. Shandong Normal Univ.
Organizer: He, Xiaoming — Missouri Univ. of Sci. & Tech.
Organizer: KWAK, Do Young — Korea Advanced Inst. of Sci. & Tech.
Organizer: Zhang, Xu — Purdue Univ.

Abstract: In many real world applications it is more convenient or efficient to utilize structured meshes for solving different types of interface problems. Since the structured meshes may not fit the non-trivial interfaces, special methods need to be developed to deal with the difficulties arising from the interface problems in order to solve them on these meshes. Therefore, great efforts have been made for solving interface problems and tracing the moving interfaces based on structured meshes in the past decades. This mini-symposium intends to create a forum for researchers from different fields to discuss recent advances on the structured-mesh numerical methods for interface problems and their applications.

▶ MS-Fr-D-32-1 13:30–14:00

INTERFACE PROBLEMS: FROM ISOTROPY TO ANISOTROPY

Chen, Huanzhen — College of Mathematical Sci. Shandong Normal Univ.

Abstract: In this talk we discuss the numerical simulation for the second-order interface elliptic problems with tensor diffusion coefficient(anistropic flow case). By enforcing the jump condition into the finite element space involved the interface element, we construct the piecewise linear finite element space and capability of approximation. We develop the corresponding partially penalty immersed interface finite element method and prove its optimal order convergence.

▶ MS-Fr-D-32-2 14:00–14:30

A Partially Penalty Immersed Interface Finite Element Method for Elliptic Interface Problems with Nonhomogeneous Jump Conditions

Liu, Zhongyan — School of Mathematical Sci. Shandong Normal Univ.

Abstract: In this report, we proposed a partially penalty immersed interface finite element(PIFE) method for second order elliptic interface problem with non-homogeneous interface jump conditions. We add penalty terms to the general immersed interface formulation along the sides intersected with the interface. Then we prove the consistency and the solvability of the procedure. Theoretical analysis and numerical experiments show that PIFE method solution possesses optimal-order error estimates in the energy norm and L2 norm.

▶ MS-Fr-D-32-3 14:30–15:00

An Iterative Immersed Finite Element Method for An Electric Potential Interface Problem Based on Given Surface Electric Quantity

He, Xiaoming — Missouri Univ. of Sci. & Tech.

Abstract: In plasma simulation, we often only know the total electric quantity on the surface of the object, not the charge density distribution on the surface which appears as the non-homogeneous flux jump condition in the usual interface problems. We propose an iterative method that employs the immersed finite element (IFE) method to solve the 2D interface problem for the potential field according to the given total electric quantity on the surface of the object.

▶ MS-Fr-D-32-4 15:00–15:30

Second-order Partitioned Time Stepping Method for Fluid-fluid Interaction

Zheng, Haibiao — East China Normal Univ.

Abstract: We study a second-order partitioned time stepping method(BDF2-GA(AB2)) for fluid-fluid interaction. This is accomplished through explicit treating the jump in velocities across the fluid-fluid interface by a geometric averaging of this data over the Adams-Bashforth formulation with the previous two time levels.

MS-Fr-D-33 13:30–15:30 406

Mathematical and computational methods for coupling local and nonlocal models - Part III of IV

For Part 1, see MS-Th-D-33
For Part 2, see MS-Th-E-33
For Part 4, see MS-Fr-E-33

Organizer: D'Elia, Marta — Sandia National Laboratories
Organizer: Seleson, Pablo — Oak Ridge National Laboratory
Organizer: Bochev, Pavel — Sandia Labs

Abstract: Nonlocal continuum and atomistic models are used in many scientific and engineering applications, where material dynamics depends on microstructure. The numerical solution of nonlocal models might be prohibitively expensive; therefore, concurrent multiscale methods have been proposed for efficient and accurate solutions of such systems. These methods employ nonlocal models in parts of the domain and use local, macroscopic, models elsewhere. A major challenge is to couple these models at interfaces or in overlapping regions. This minisymposium invites contributions on coupling local and nonlocal continuum models and concurrent multiscale methods for atomistic-to-continuum coupling. Related domain decomposition methods are also considered.

▶ MS-Fr-D-33-1 13:30–14:00

Identify the Effect of the Ghost Forces in Multiscale Coupling Methods

Ming, Pingbing — Chinese Acad. of Sci.,AMSS

Abstract: Ghost forces is the inconsistence issue arising from improper interface conditions in multiscale coupling methods. We shall demonstrate the effect of ghost forces through a series of examples, which vary rom 1d to 3d, from static to dynamics, and from perfect crystals to systems with defects.

▶ MS-Fr-D-33-2 14:00–14:30

Concurent Atomistic-continuum Simulation of Mechanical and Thermal Transport Behavior of Materials

Chen, Youping — Univ. of Florida

Abstract: A concurrent atomistic-continuum methodology will be presented. The statistical mechanics foundation and the coarse graining strategy of the method will be introduced. Simulation results of dislocation dynamics and phonon thermal transport will be presented.

▶ MS-Fr-D-33-3 14:30–15:00

A Posteriori Error Estimates for Quasicontinuum Methods

Lin, Ping — Univ. of Dundee

Abstract: In the talk we will show a posteriori $W^{1,\infty}$ error estimate for a 1D complex-lattice quasicontinuum method. Numerical experiments will be presented to support the result of the analysis. We may also present a posteriori error estimate for a 2D atomistic-to-continuum coupling method at the end. The most part of the talk is based on a joint work with A. Abdulle and A.V. Shapeev.

▶ MS-Fr-D-33-4 15:00–15:30

Modeling Electrokinetic Flow by Lagrangian Particle-based Method

Pan, Wenxiao — Pacific Northwest National Laboratory

Abstract: Recent applications in micro-/nano-transport and technology demand efficient and accurate computational modeling of multiphysical processes at the mesoscale. This work focuses on mathematical models and numerical schemes based on Lagrangian particle-based method that can effectively capture mesoscale multiphysics (hydrodynamics, electrostatics, and advection-diffusion) as well as the effect of thermal fluctuations. Specifically, we show simulation results on separation and mixing processes in micro-/nano-channel, electrokinetic flow through semi-permeable membranes, and diffusive reaction on biomolecules.

MS-Fr-D-34 13:30–15:30 112

Modeling and Simulation of Complex Fluids and Biological Systems - Part III of IV

For Part 1, see MS-Th-D-34
For Part 2, see MS-Th-E-34
For Part 4, see MS-Fr-E-34

Organizer: Zhang, Hui — Beijing Normal Unversity
Organizer: Forest, M. Gregory — Univ. of North Carolina at Chapel Hill
Organizer: Wang, Qi — Univ. of South Carolina & Beijing Computational Sci. Research Center

Abstract: This mini symposium will bring together researchers in complex fluids and biological systems to exchange ideas and perspectives as well as to share their most recent findings. The goal is to integrate advances in mathematics (theory, modeling, data analytics, algorithms, simulations, high performance computing techniques) with new experimental data from complex fluids and biological systems, and targeted applications. The specific systems represented include single living cells, biofilms, active molecular fluids, and transport properties of biological fluids such as lung mucus.
We would like to invite you to give a talk on your current research at the proposed mini-symposium. The talks are scheduled to be 25 minutes each + 5 minutes for discussion.

▶ MS-Fr-D-34-1 13:30–14:00

Some Polymeric Fluid Flow Models: Steady States & Large-time Convergence

Arnold, Anton — Vienna Univ. of Tech.

Abstract: We consider a dumbbell model (Hookean and FENE) for a dilute polymeric solution in a homogeneous fluid. In a micro-macro model, the incompressible Navier-Stokes equation for the fluid flow is coupled to a Fokker-Planck equation for the (microscopic) distribution of the polymeric chains.
We analyze the linear Fokker-Planck equation (steady states, large-time convergence using entropy methods). In the coupled Hookean case we also show exponential convergence to a homogeneous stationary flow.

▶ MS-Fr-D-34-2 14:00–14:30

Structure Patterns of Active Nematic Polymers

Zhou, Ruhai — Old Dominion Univ.

Abstract: Based on the kinetic model proposed for active nematic polymers, we developed numeical simulation methods and performed various simulations with a variety of parameter values. Several dynamic structure formation patterns of active suspensions are observed and carefully studied. Examples of 1D stationary, periodic and aperiodic attractors, as well as 2D strongly fluctuating periodic and stationary attractors will be examined.

▶ MS-Fr-D-34-3 14:30–15:00

Analysis of An Active Liquid Crystal Model

Wang, Qi — Univ. of South Carolina & Beijing Computational Sci. Research Center
Yang, Xiaogang — Beijing Computational Sci. Research Center

Abstract: We will present a continuum model for flows of active polar liquid crystals. Thermodynamical consistency will be discussed. With this model, we will systematically investigate the flow driven dynamics and the flow-coupled dynamics in 1D and 2D, respectively. The effect of the active viscosity and self-propelled velocity to spontaneous motion will be studied in detail.

▶ MS-Fr-D-34-4 15:00–15:30

Thermodynamically Consistent Phase Field Models for Two-phase Flows with Thermocapillary Effects

Lin, Ping — Univ. of Dundee
Guo, Zhenlin — Univ. of California Irvine

Abstract: We develop a phase-field model for binary incompressible (quasi-incompressible) fluid with thermocapillary effects, which allows for the different properties (densities, viscosities and heat conductivities) of each component while maintaining thermodynamic consistency. The governing equations of the model including the Navier-Stokes equations with additional stress term, Cahn-Hilliard equations and energy balance equation are derived within a thermodynamic framework based on entropy generation, which guarantees thermodynamic consistency. A sharp-interface limit analysis is carried out as well.

MS-Fr-D-35 13:30–15:30 408

Analysis, Modeling, and Numerical Methods for High Frequency Waves - Part III of IV

For Part 1, see MS-Th-D-35
For Part 2, see MS-Th-E-35
For Part 4, see MS-Fr-E-35

Organizer: YANG, XU — Univ. of California, Santa Barbara
Organizer: YING, LEXING — Stanford Univ.
Organizer: HUANG, ZHONGYI — Tsinghua Univ.
Organizer: RUNBORG, OLOF — Department of Mathematics, KTH

Abstract: The development of modern techniques has been able to provide accurate studies on the micro- and nano-scale physics. Under this small scale, the objects often appear as a form of waves, and present quantum properties. On the other hand, the observation is often made at macroscopic scale which is closely related to small-scale details, therefore it is necessary to consider problems at multiple scales. Propagation of high frequency waves is one such topic. The major challenge is that one usually needs to handle the disparity between the two length scales: the large domain size and the small wavelength. This means one has to work on a large computational domain that contains thousands to millions of wavelengths, and each of them needs to be resolved if direct numerical methods are applied. Therefore the total number of grid points is huge, which usually leads to unaffordable computational cost. This minisymposium will focus on high-frequency waves and their applications in quantum mechanics and seismology. Topics on analysis, modeling and numerical methods will be discussed.

▶ MS-Fr-D-35-1 13:30–14:00

GAUSSIAN BEAM METHODS FOR THE HELMHOLTZ EQUATION

Liu, Hailiang — Iowa State Univ.
RUNBORG, OLOF — Department of Mathematics, KTH

Abstract: We construct Gaussian beam approximations to solutions of the high frequency Helmholtz equation with a localized source. Under the assumption of nontrapping rays we show error estimates between the exact outgoing solution and Gaussian beams in terms of the wave number k, both for single beams and superposition of beams. The main result is that the relative local L2 error in the beam approximations decay as $k^{-N/2}$ independent of dimension and presence of caustics.

▶ MS-Fr-D-35-2 14:00–14:30

The Hierarchical Poincaré - Steklov scheme: An accurate and efficient technique for variable media scattering and more

Gillman, Adrianna — Rice Univ.

Abstract: This talk presents a recently developed discretization technique that naturally comes with an efficient direct solver for time-harmonic scattering problems where there is a bounded region in which the wave speed varies smoothly in space. The method can solve problems 100 wavelengths in size to 9 digits of accuracy in a few minutes on a workstation. For each new incident wave the solution can be found in 3 seconds.

▶ MS-Fr-D-35-3 14:30–15:00

Scalability Up to P $N^{1/5}$ Nodes for the 2D Helmholtz Equation

Demanet, Laurent — MIT

Abstract: We present a solver for the 2D high-frequency Helmholtz equation in heterogeneous acoustic media, with online parallel complexity that scales optimally as O(N/P), where N is the number of volume unknowns, and P is the number of processors, as long as $P = O(N^{1/5})$. The solver combines two ideas: polarized traces, and nested sweeps. It works well on standard geophysics community models. Joint work with Leo Zepeda.

▶ MS-Fr-D-35-4 15:00–15:30

Uncertainty Quantification for High Frequency Waves

Motamed, Mohammad — Univ. of New Mexico
RUNBORG, OLOF — Department of Mathematics, KTH
TEMPONE, RAUL — KING ABDULLAH Univ. OF Sci. & Tech.
Malenova, Gabriela — Royal Inst. of Tech.

Abstract: We will analyze and compute high frequency wave propagation problems subject to stochastic uncertainty. We construct an optimal stochastic spectral algorithm, by employing Gaussian beam superposition in the deterministic space and collocation on sparse grids in the stochastic space. The developed algorithm will significantly accelerate the convergence of current Monte Carlo sampling methods for high frequency wave propagation problems. We present a stochastic regularity analysis and obtain uniform convergence rates.

MS-Fr-D-36 13:30–15:30 409

Advances in MCMC and related sampling methods for large-scale inverse problems - Part III of IV

For Part 1, see MS-Th-D-36
For Part 2, see MS-Th-E-36
For Part 4, see MS-Fr-E-36

Organizer: Bui-Thanh, Tan — The Univ. of Texas at Austin
Organizer: Cui, Tiangang — MIT
Organizer: Marzouk, Youssef — Massachusetts Inst. of Tech.

Abstract: Inverse problems convert indirect measurements into useful characterizations of the parameters of a physical system. Parameters are typically related to indirect measurements by a system of partial differential equations (PDEs), which are complicated and expensive to evaluate. Available indirect data are often limited, noisy, and subject to natural variation, while the unknown parameters of interest are often high dimensional, or infinite dimensional in principle. Solution of the inverse problem, along with prediction and uncertainty assessment, can be cast in a Bayesian setting and thus naturally tackled with Markov chain Monte Carlo (MCMC) and other posterior sampling methods. However, designing scalable and efficient sampling methods for high dimensional inverse problems that involve expensive PDE evaluations poses a significant challenge. This mini-symposium presents recent advances in sampling approaches for large scale inverse problems.

▶ MS-Fr-D-36-1 13:30–14:00

Affine Invariante MCMC's, the Way Forward or the Least We Should Ask For?

Christen, Andres — CIMAT

Abstract: Affine invariant MCMC methods (eg. the 't-walk' or the 'emcee hammer') are regularly used in some areas of Bayesian inference, although still not used extensively. We will mention a large number of multiscale nonlinear Inverse Problems examples in which these methods work as automatic, out of the box, MCMC samplers. We will explain what affine invariant MCMC is and why we believe are a very relevant alternative in designing working MCMC samplers.

▶ MS-Fr-D-36-2 14:00–14:30

A Randomized Likelihood Method for Data Reduction in Large-scale Inverse Problems

Bui-Thanh, Tan — The Univ. of Texas at Austin

Abstract: We develop innovative approach to address the big data challenge in large-scale inverse problems and UQ governed by expensive PDEs. We analyze our approach from both statistical theory and machine learning point of view. Theoretical and various numerical results will be presented to demonstrate the effectiveness of our approach

▶ MS-Fr-D-36-3 14:30–15:00

Ensemble-based MCMC Methods for Exploring Large-scale High Dimensional Bayesian Inverse Problems

WANG, KAINAN — HALLIBURTON LANDMARK GRAPHICS
Bui-Thanh, Tan — The Univ. of Texas at Austin

Abstract: Sampling techniques are important for large-scale high dimensional Bayesian inferences. However, general-purpose technique such as Markov chain Monte Carlo is intractable. We present an ensemble transform algorithm that is rooted from the optimal transportation theory. The method transforms the prior ensemble to posterior one via a sparse optimization. We develop methods to accelerate the computation of the transformation. Numerical results for large-scale Bayesian inverse problems governed by PDEs will be presented.

▶ MS-Fr-D-36-4 15:00–15:30

Sampling High-dimensional Distributions Using Linear Iterations

Fox, Colin — Univ. of Otago

Abstract: Sampling from a Gaussian distribution is essentially the same task as solving a linear system in the precision matrix, plus drawing normal random variables. In high-dimensional settings the iterative solvers are attractive, and correspond exactly to Gibbs samplers. It follows that polynomial acceleration may be applied to Gibbs sampling from Gaussians. For non-Gaussian distributions the linear iterations can provide proposal distributions for Metropolis-Hastings MCMC, with MALA and HMC algorithms being special cases.

MS-Fr-D-37 13:30–15:30 301B

Mathematics for Industry 2: Methods from number theory, geometry, computer algebra, and integer programming for cryptography and optimization

Organizer: Morozov, Kirill — Kyushu Univ.

Abstract: Rapid development of information technologies poses various challenges in the areas of information security and performance optimization. Cryptographic systems based on factoring (RSA) and discrete logarithms are widely used for protection of the Internet transactions and cloud security. We will present recent results on cryptanalysis of RSA using lattices, construction of new elliptic curves suitable for cryptography and secure solutions for cloud storage. Parametric integer programming (PIP) is an integer programming such that the right-hand-side vector contains parameters. It is an important tool for compiler optimization. We will present an algorithm for solving PIP based on toric ideals.

▶ MS-Fr-D-37-1 13:30–14:00

Secret Sharing Secure Against Active Adversaries with Applications to Cloud Security and Long-term Storage

Morozov, Kirill — Kyushu Univ.

Abstract: Secret sharing realizes splitting of the data into pieces (called "shares") among a set of parties such that only designated subsets of them can reconstruct it. For cloud storage, this approach allows us to combine security and reliability. We present cheater-identifiable schemes and robust schemes with minimum share sizes (up to date) in different settings. Security is guaranteed even against an adversary with unlimited computing power making these schemes particularly attractive for long-term security applications.

▶ MS-Fr-D-37-2 14:00–14:30

Developments in Computer Algebra Research and Collaboration with Industry

Yokoyama, Shun'ichi Kyushu Univ.

Abstract: Recently, development in computer algebra research becomes important and several applications of number theory in cryptography are found. In this talk, we give a brief introduction to computational number theory for cryptography. Especially, we introduce a collaborative research in cryptography with industry. Some ideas in number theory and symbolic computation are used.

▶ MS-Fr-D-37-3 14:30–15:00

An Algorithm for Parametric Integer Programming

Takafumi, Shibuta Kyushu Univ.

Abstract: Parametric integer programming (PIP) is an integer programming such that the right-hand-side vector contains parameters. PIP is important for compiler optimization problems. In this talk, we give a parametric version of algorithm for solving PIP based on Groebnor bases of toric ideals. This is joint work with Norie Fu.

MS-Fr-D-38 13:30–15:30 302A

Control of partial differential equations - Part I of II

For Part 2, see MS-Fr-E-38

Organizer: Coron, Jean-Michel Univ. Pierre et Marie Curie

Organizer: Alabau-Boussouira, Fatiha Universite de Lorraine, IECL UMR 7502

Abstract: This mini-symposium will present an overview of recent advances on the control of PDE's and stochastic PDE's, as well as their challenging applicative issues for the control of complex models in quantum mechanics, fluid mechanics, climatology, conservation laws... The first session will focus on the control of quantum systems, stochastic PDE's, hyperbolic systems and applied control problems. The second session will present different mathematical methods to solve control issues for degenerate parabolic or hypoelliptic PDE's, bang-bang control of parabolic questions, under-observed coupled hyperbolic systems and hierarchic control for coupled parabolic systems.

▶ MS-Fr-D-38-1 13:30–14:00

Boundary Control of Open Channels : Application to the Meuse River

Bastin, Georges Louvain Univ.

Coron, Jean-Michel Univ. Pierre et Marie Curie

Abstract: In this communication we emphasize the main features that may occur in real live applications of boundary feedback control of systems represented by 1-D hyperbolic partial differential equations. The issue is presented through the specific case study of the control of navigable rivers with a particular focus on the Meuse river in Wallonia (south of Belgium) where the system is described by Saint-Venant equations and an important challenge is to regulate the water level.

▶ MS-Fr-D-38-2 14:00–14:30

Control and Observation for Stochastic Hyperbolic Equations

Zhang, Xu Sichuan Univ.

Abstract: In this talk, I will explain the main difficulty for the controllability of stochastic hyperbolic equations. I will also introduce some observability estimates for the same equations and applications.

▶ MS-Fr-D-38-3 14:30–15:00

A Constructive Method to the Exact Boundary Controllability for 1-D Quasilinear Hyperbolic Systems

LI, Tatsien Fudan Univ.

Abstract: In this talk we will present a simple and efficient constructive method with modular structure to the exact boundary controllability and the exact boundary controllability of nadal profile for general 1-D quasilinear hyperbolic systems with general nonlinear boundary conditions.

▶ MS-Fr-D-38-4 15:00–15:30

Some Results on Boundary Control of 1-D Hyperbolic Systems with A Vanishing Characteristic Speed

Wang, Zhiqiang Fudan Univ.

Abstract: In this talk, we will show some results on boundary control of 1-D hyperbolic systems with a vanishing characteristic speed. Different from the case without vanishing characteristic speeds, we prove non-controllability in finite time for a class of linear hyperbolic system. However, boundary controllability can be obtained for some kind of quasilinear hyperbolic systems thanks to the nonlinearity.

MS-Fr-D-39 13:30–15:30 302B

New methods and trend in the field of nonlinear filtering - Part I of II

For Part 2, see MS-Fr-E-39

Organizer: Luo, Xue School of Mathematics & Sys. Sci., Beihang Univ., Beijing, P. R. China, 100191

Organizer: Yau, Stephen Department of Mathematical Sci., Tsinghua Univ., Beijing, P. R. China, 100084

Abstract: We shall focus on various aspects of the nonlinear filtering(NLF), including the new methods and related fields. The general idea of NLF is to form some kind of "best estimate" for the true state of some system, given only some potentially noisy observations, and either the system or the observation (or both) is nonlinear. The NLF has been widely used in many science and engineering disciplines, such as radar tracking problems, signal processing etc. There have been intensive research on new methods recently, including the particle filters, methods based on Duncan-Mortensen-Zakai equation, cubature Kalman filter and their variants. The scope of this mini symposium is to discuss all sorts of newly developed methods and the potential trend in the field of NLF.

▶ MS-Fr-D-39-1 13:30–14:00

Particle Flow for Nonlinear Filters Inspired by Physics

Daum, Fred Raytheon

Abstract: Our new nonlinear filter theory is many orders of magnitude faster than standard particle filters for the same accuracy, and it beats the extended Kalman filter accuracy by several orders of magnitude for difficult nonlinear problems. Our theory uses particle flow (like physics) to compute Bayes' rule, rather than a pointwise multiply. We design the particle flow with the solution of a linear first order highly underdetermined PDE, like the Gauss law in electromagnetics.

▶ MS-Fr-D-39-2 14:00–14:30

The Suboptimal Method for Nonlinear Filterings via Carleman Approach Using Hermite Polynomials

Luo, Xue School of Mathematics & Sys. Sci., Beihang Univ., Beijing, P. R. China, 100191

Yau, Stephen Department of Mathematical Sci., Tsinghua Univ., Beijing, P. R. China, 100084

Abstract: In this talk we will investigate a novel suboptimal method for nonlinear filtering by augmenting the original states with its probabilists' Hermite polynomials. It is shown that the augmented states satisfy a bilinear system, of which a suboptimal filtering has been derived by Carravetta et. al. (SIAM J. Control Optim., 2000). The accuracy of our method has been compared with the one via Carleman approach, developed in Germani, et. al. (IEEE Trans. Automat. Control, 2007).

▶ MS-Fr-D-39-3 14:30–15:00

Continuous-Time Nonlinear Filtering, Feynman Path Integrals and Supersymmetry

Balaji, Bhashyam Defence R&D Canada

Abstract: In this talk, it is shown that Feynman path integrals provide an elegant formulation and solution of the continuous-discrete and continuous-continuous nonlinear filtering problems. The major role played by the path integral techniques in modern theoretical physics and pure mathematics is reviewed, and the connection to Euclidean quantum mechanics identified. Some novel algorithms and illustrated with highly nontrivial problems. A new precise connection with supersymmetry is also identified and illustrated, and new research directions proposed.

▶ MS-Fr-D-39-4 15:00–15:30

Sparse Grid Filtering of Nonlinear Dynamical Systems

Cheng, Yang Mississippi State Univ.

John, Crassidis Univ. at Buffalo, State Univ. of New York

Moriba, Jah Air Force Research Laboratory

Abstract: The sparse grid filter is a nonlinear filter in which sparse grid quadratures are used to represent and compute the moments of random vectors. Many Gaussian filters, including the unscented Kalman filter and the cubature Kalman filter and their variants, are special cases of the sparse grid filter. Recent development of the sparse grid filter based on direct update of the quadrature points as well as a space object tracking application will be presented.

MS-Fr-D-40 13:30–15:30 303A

Stretching of slender viscous fibres

Organizer: Stokes, Yvonne The Univ. of Adelaide

Abstract: The stretching (or drawing or spinning) of fluid threads has wide-ranging application including in the manufacture of optical fibres and optical

fibre preforms, capillary tubes, micro-electrodes, and textile fibres. In recent times, much research has been motivated by microstructured optical fibres (MOFs), having one through to many internal air channels running along the length of the fibre, and which promise a virtually limitless range of fibre designs. Realization of their true potential is, however, hampered by a lack of understanding of the parameters that control the practical achievability of a desired geometrical structure. This mini-symposium is focused on mathematical modelling to yield understanding of the important physics that governs fibre drawing, including initial geometry, draw ratio, temperature, pressurization of any internal air channels, gravity and rotation of the fibre. Mathematical modelling is crucial to solving the practically important inverse problem of determining the initial conditions and draw parameters to achieve a desired geometry for a given application. We will consider recent progress and future requirements.

▶ MS-Fr-D-40-1 13:30–14:00

Forward and Inverse Modelling to Aid Fabrication of Fibres with Complex Geometry.

Stokes, Yvonne — The Univ. of Adelaide
Crowdy, Darren — Imperial College London
Ebendorff-Heidepriem, Heike — Univ. of Adelaide
Tronnolone, Hayden — The Univ. of Adelaide
Chen, Michael — Univ. of Adelaide
Buchak, Peter — Imperial College London

Abstract: Slenderness of fibres has long been exploited to derive 1D models of extensional flows such as fibre drawing. Where modification of structure in the cross-section, e.g. by surface tension or pressure, is important, these must be coupled to 2D cross-plane models. We present recent progress that has been made in the context of fibre drawing and the extrusion of fibre preforms, and discuss challenges that remain. Temperature is an important aspect that will be discussed.

▶ MS-Fr-D-40-2 14:00–14:30

Geometrical Pore Models for Regularizing the Inverse Problem in Microstructured Optical Fibre Fabrication

Crowdy, Darren — Imperial College London
Buchak, Peter — Imperial College London
Stokes, Yvonne — The Univ. of Adelaide
Ebendorff-Heidepriem, Heike — Univ. of Adelaide
Chen, Michael — Univ. of Adelaide

Abstract: In the fabrication process for microstructured optical fibres an important inverse problem is relevant: what is the preform shape that, after deformations due to surface tension, pressure effects and draw tension, will produce the desired fibre geometry. Here we present a hierarchy of “geometrical pore models” we have devised to describe multi-channel interactions during the fabrication process. Significantly, the same reduced models provide a regularization of the ill-posed inverse problem.

▶ MS-Fr-D-40-3 14:30–15:00

Asymptotic Analysis of A Viscous Thread Extending under Gravity

Wylie, Jonathan — City Univ. of Hong Kong
Huang, Huaxiong — York Univ.
Miura, Robert — New Jersey Inst. of Tech.

Abstract: We investigate the motion of a slender axisymmetric highly viscous thread that is supported at its top by a fixed horizontal surface and extends downward under gravity. Using matched asymptotic expansions, we obtain solutions for the full initial-boundary-value problem and show how inertia ultimately must become important. The solution allows us to understand the mechanisms that underlie highly persistent filaments.

▶ MS-Fr-D-40-4 15:00–15:30

Magnetospinning of Nano and Microfibres

O’Kiely, Doireann — Univ. of Oxford
Griffiths, Ian — Univ. of Oxford

Abstract: We consider a novel method for the fabrication of nanofibres and microfibres called magnetospinning, where a magnetic-nanoparticle-laden viscous fluid is drawn using an external magnet. We derive a mathematical model that exploits the geometrical features of the system. This is validated with experiments and used to make predictions on the appropriate operating regimes for fibre manufacture.

MS-Fr-D-41 13:30–15:30 303B

Variational image analysis and applications - Part I of II

For Part 2, see MS-Fr-E-41

Organizer: Guo, Weihong — Case Western Reserve Univ.
Organizer: Qin, Jing — Univ. of California, Los Angeles

Abstract: Variational/PDE is a powerful tool in image processing and analysis. After decades of intensive research, it is still a challenge to recover high quality images from their noisy, blurry, low-resolution counterparts and/or incomplete measurements. It is especially difficult for images containing important details of various scales. Effective regularity schemes and efficient algorithms play important roles in these problems. This mini-symposium brings together leading researchers to discuss the state-of-the-art theoretical developments in variational image reconstruction, image segmentation, image super-resolution and their applications in medicine biology, etc.

▶ MS-Fr-D-41-1 13:30–14:00

A Two-stage Image Segmentation Method Using A Convex Variant of the Mumford-Shah Model

Chan, Raymond — The Chinese Univ. of Hong Kong

Abstract: We propose a two-stage segmentation method based on the Mumford-Shah model. In the first stage, we find a smooth solution to a convex variant of the Mumford-Shah model and in the second stage, the segmentation is done by thresholding the solution into different phases. Our method works for very general images, including noisy and blurry images and for very general noise models such as Gaussian, Poisson and multiplicative Gamma noise.

▶ MS-Fr-D-41-2 14:00–14:30

Global Optimization Based on Continuous Max-flow on Graphs for Classification of High Dimensional Data

Tai, Xue-Cheng — Department of Mathematics, Univ. of Bergen

Abstract: This work develops a global minimization framework for segmentation of high dimensional data into two classes. It combines recent convex optimization methods from imaging with recent graph based variational models for data segmentation. Two convex splitting algorithms are proposed, where graph-based PDE techniques are used to solve some of the subproblems. It is shown that global minimizers can be guaranteed for semisupervised segmentation with two regions. Joint with Egil Bae, Andrea Bertozzi and E Merkurje.

▶ MS-Fr-D-41-3 14:30–15:00

An Approximated PDHG Method for Total Variation Wavelet Inpainting

Zhou, Haomin — Georgia Inst. of Tech.
Ye, Xiaojing — Georgia State Univ.

Abstract: The primal-dual hybrid gradient (PDHG) algorithm has been successfully applied to a number of total variation (TV) based image reconstruction problems for fast numerical solutions. We show that PDHG can also effectively solve the computational problem of image inpainting in wavelet domain, where high quality images are to be recovered from incomplete wavelet coefficients due to lossy data transmission. In particular, we propose an approximated PDHG algorithm to tackle the non-orthogonality of Daubechies 7-9 wavelet which is widely used in practice. We show that this approximated version essentially alters the gradient descent direction in the original PDHG algorithm, but eliminates its orthogonality restriction and retains low computation complexity. This work is jointly with Xiaojing Ye (Georgia State).

▶ MS-Fr-D-41-4 15:00–15:30

Single Image Super-resolution via An Iterative Reproducing Kernel Hilbert Space Method

Guo, Weihong — Case Western Reserve Univ.
Deng, Liangjian — Univ. of Electronic Sci. & Tech. of China
Huang, Ting-Zhu — School of Mathematics Sci., Univ. of Electronic Scicence & Tech. of China

Abstract: Image super-resolution is usually done on multiple inputs. We present an iterative scheme to recover a high-resolution image from solely one low-resolution image. We solve the problem from image intensity function estimation perspective. We assume an image contains both smooth components and edges which we model using a thin-plate reproducing kernel Hilbert space (RKHS) and approximated Heaviside functions respectively. Visual and quantitative comparisons with some competitive approaches show the effectiveness of the proposed method.

MS-Fr-D-42 13:30–15:30 301A

Agent-based Scheduling

Organizer: Wang, Junqiang — Northwestern Polytechnical Univ.

Abstract: The minisymposium is orgnized by the Scheduling Society of Operations Research Society of China (ORSC-SS).

Scheduling was originated 60 years ago, starting with solving n/2/F/Cmax problems by S. M. Johnson in 1954. Considering jobs or orders that might come from several customers who have different objectives or priority requests, a two-agent scheduling problem was introduced 14 years ago by A. Agnetis et al in 2000. The two-agent scheduling problem breaks the limitation that all jobs must meet same criteria, instead, in a two-agent case, jobs coming from different agents may have different criterion. Scheduling with multiple agents has already received considerable attention in the literature. Various results on complexity analysis and algorithms have been developed with different objective functions and different machine settings for two agent settings.
However, the existing researches do not give full play to agent's initiative. All proposed heuristic algorithms are exquisitely designed and fine tuned to satisfy each agent's constraints and goal. These are done by managers rather than agents. Agents are merely representing different job sets. However, in the literature of multi-agent systems (MAS), an agent is considered as an autonomous entity who can observe and act upon its environment, and direct its activity towards its goals. Agents can develop schedules using negotiation, competitive or other mechanisms rather than simple dispatching rule in heuristic and generate-and-test search strategy in meta-heuristic. Unfortunately, the two-agent scheduling research has largely ignored this autonomy property of agents focusing instead on optimizing schedules or analyzing complexity.
In the past 25 years, multi-agent system (MAS) is introduced into production scheduling to direct towards the support for scheduling agility rather than scheduling optimality and scheduling flexibility in the earlier research. However, the gap between current agent-based scheduling and initiative scheduling mainly reflects in these aspects: 1) independent agent for individual machine or job instead of a kind of machines or jobs according to the functional or physical decomposition approach; 2) open architecture to access to cloud manufacturing instead of closed architecture motivated by the manufacturing mode of real factory; 3) heterogeneous agents instead of homogeneous agents; and 4) agent-centered scheduling mode instead of manager-centered scheduling mode. In addition, there lacks richer literature discussing how to realize the autonomous ability in the context of production scheduling.
With the high technology development of internet of things, cyber-physical system, and cloud computing, a flatform is being realized where autonomous agents interact with each other to reach common objectives in the presence of real-time information, while simultaneously each agent pursues individual goals. Hence, how to autonomously perform reactive, proactive, and social actions in its execution environment and act upon each other to generate schedule is a worthy question to explore, especially in a dynamic manufacturing environment. For example, in job shops, inevitable and unpredictable disturbances necessitate the revision of established schedules during manufacturing processes.
In this symposium, we discuss some evolving scenarios, models, solution techniques and future research of agent-based scheduling.

▶MS-Fr-D-42-1 13:30–14:00

Synchronization in Manufacturing Planning and Scheduling with Physical Internet

Huang, George Q. The Univ. of Hong Kong

Abstract: This paper discusses a model for synchronizing manufacturing shopfloor and finished product dispatching logistics. We examine a number of measures for punctuality and simultaneity. We discuss how these two measures can be used in production scheduling and dispatching planning.

▶MS-Fr-D-42-2 14:00–14:30

Coordinating Agents in Multi-agent Planning Problems

Zhang, Yingqian Erasmus Univ. Rotterdam

Abstract: Coordination plays an important role in multi-agent planning (MAP) as the independently generated plans by agents can lead to an infeasible joint solution. We study a class of MAP problems in supply-chain applications, and introduce coordination-by-design to ensure the feasibility of the joint plan. We show deciding a minimum coordination set is NP-complete. A polynomial-time algorithm is then proposed to compute a sufficient coordination set. Joint work with Chetan Yadati and Cees Witteveen.

▶MS-Fr-D-42-3 14:30–15:00

Multi-agent Scheduling Cooperative Game on A Single Parallel-batching Machine

Zhao, Xiaoli Inst. of Industrial Engineering & Logistics Optimization, Northeastern Univ., Shenyang
Tang, Lixin Inst. of Industrial Engineering & Logistics Optimization, Northeastern Univ.

Abstract: This paper considers a multi-agent scheduling cooperative game problem in which each agent has more than one job and all the jobs are processed on a common single parallel-batching machine. We show that the agent game and the job game are neither σ 0-component additive games nor convex games with respect to the initial order. We prove the existence of core for the corresponding cooperative games by devising a reasonable cost savings allocation scheme.

▶MS-Fr-D-42-4 15:00–15:30

Job Shop Scheduling Considering Flexible Routings Based on Analytical Target Cascading Method

Guanghui, Zhou School of Mechanical Engineering, Xian Jiaotong Univ.
Li, Yanguang School of Mechanical Engineering, Xi'an Jiaotong Univ.

Abstract: For solving the large-scale job shop scheduling problems considering flexible routings, a hierarchical coordination optimization model is proposed based on ATC which is divided into two sub-levels. The top level is for optimal processing routes of all jobs while the low-level is for optimal scheduling solutions of jobs in each manufacturing cell. The two levels collaborate to obtain the final optimal solution. Computational experiments demonstrate the validity of presented model and its resloving algorithm.

MS-Fr-D-43 13:30–15:30 VIP4-1

Optimization algorithms and application - Part IV of V

For Part 1, see MS-Th-BC-43
For Part 2, see MS-Th-D-43
For Part 3, see MS-Th-E-43
For Part 5, see MS-Fr-E-43

Organizer: Wen, Zaiwen Peking Univ.
Organizer: Yuan, Ya-xiang Inst. of Computational Mathematics & Scientific/Engineering Computing
Organizer: Xia, Yong Beihang Univ.

Abstract: This minisymposium consists 5 sessions. It highlights recent advances in theory, algorithms and applications of mathematical optimization on solving huge problems that are intractable for current methods.

▶MS-Fr-D-43-1 13:30–14:00

Some New Results on the Convergence of Multi-Block ADMM

Ma, Shiqian The Chinese Univ. of Hong Kong

Abstract: The alternating direction method of multipliers (ADMM) has been widely used for solving structured convex optimization problems that minimize the sum of N convex functions. While the convergence of the ADMM for N=2 was well established, it remained an open problem for a long time whether the ADMM for N¿=3 is still convergent until very recently. In this talk, we discuss some new results on the convergence of multi-block ADMM for N¿=3.

▶MS-Fr-D-43-2 14:00–14:30

The Teaching-Learning-Based Optimization Metaheuristic for Discrete Combinatorial Optimization Problems

Lu, Yun Kutztown Univ. of PA

Abstract: The Teaching-Learning-Based Optimization (TLBO) metaheuristic requires no parameter fine-tuning other than determining the population size and convergence criteria. In this paper, we enhance the performance of the TLBO method by introducing "a local neighborhood search on the best solution" before the teaching phase of TLBO. We use it to solve the problems from the literature for multiple-choice multidimensional knapsack problem (MMKP), and demonstrate that TLBO outperforms the best published solution approaches for the MMKP.

▶MS-Fr-D-43-3 14:30–15:00

Interiors of Completely Positive Cones

Fan, Jinyan Shanghai Jiao Tong Univ.

Abstract: In this talk, we characterize the interior of the completely positive (CP) cone. A semidefinite algorithm is proposed for checking whether a matrix is in the interior of the CP cone, and its properties are studied. A CP-decomposition of a matrix in Dur and Still or Dickinson's form can be obtained if it is an interior of the CP cone. Some computational experiments are also presented.
This is a joint work with Anwa Zhou.

▶MS-Fr-D-43-4 15:00–15:30

Quasi-Newton Methods for the Kohn-Sham Equation

Wang, Xiao Univ. of Chinese Acad. of Sci.
Wen, Zaiwen Peking Univ.
LIU, XIN AMSS

Abstract: This paper considers the Kohn-Sham (KS) equation in discretized

Kohn-Sham density functional theory. As the exact Jacobian of the KS equation could not be easily obtained, the application of classic Newton method is impractical. In this paper we propose several types of quasi-Newton methods for solving the KS equation by making use of the structure of the Jacobian. Theoretical convergence analysis of the proposed quasi-Newton method is given. Some numerical experiments results are also reported.

MS-Fr-D-44 13:30–15:30 VIP2-1
Pseudo-Differential Operators in Industries and Technologies - Part III of IV

For Part 1, see MS-Th-D-44
For Part 2, see MS-Th-E-44
For Part 4, see MS-Fr-E-44

Organizer: Wong, M.W. York Univ.

Abstract: Pseudo-differential operators, first appeared in 1960s in the paper by Joseph J. Kohn and Louis Nirenberg in the Communications on Pure and Applied Mathematics, have been used in the explicit descriptions of solutions of Partial Differential Equations. Since wavelet transform and related transforms came to the fore and became understood by scientists and engineers in the physical sciences, biomedical sciences, atmospherical sciences and geological sciences in the context of time/space -frequency representations, pseudo-differential operators and their variants such as Weyl transforms and noncommutative quantization with operator-valued symbols have become instrumental in signal and image analysis in the role of filters. Extensions of classical pseudo-differential operators to Weyl transforms and pseudo-differential operators to H-type groups can be thought of as noncommutative quantization. The aim of this minisymposium is to provide a platform for dialogs on several developments of pseudo-differential operators in some areas of industries and technologies such as information, communication and signals.

▶ MS-Fr-D-44-1 13:30–14:00
Advances in Queueing Models' Research
Gupur, Geni Xinjiang Univ.

Abstract: On the basis of our research work, we introduce the dynamics for queueing models formulated by the supplementary variable technique. Firstly, we state our motivation, next we provide the main tools in functional analysis, then we state the idea to obtain the well-posedness of queueing models. After that, we introduce the asymptotic behavior of time-dependent solutions of queueing models. In addition, we discuss structure of time-dependent solutions of queueing models. We conclude this talk with some open problems.

▶ MS-Fr-D-44-2 14:00–14:30
Visualization of Complex-Valued Time-frequency Representations
Yan, Yusong Beijing Inst. of Tech.
Zhu, Hongmei York Univ.

Abstract: Time-frequency analysis techniques are effective in detecting local signal structure and have been applied successfully in a wide range of fields. Different time-frequency analysis transforms yield different time-frequency spectra. However, visualizing a four-dimensional complex-valued time-frequency spectrum is not a trivial task. Here, we propose a new way to visualize such a complex-valued time-frequency spectrum in one graph. We show that the proposed visualization tool may facilitate better understanding of local signal behavior.

▶ MS-Fr-D-44-3 14:30–15:00
Pseudo-Differential Operators on Finite Abelian Groups
Wong, K. L. York Univ.
Molahajloo, Shahla Inst. for Advanced Studies in Basic Sci.

Abstract: We give the basic theory of pseudo-differential operators on finite abelian groups. In the case of a group with two elements, we give a criterion for invertibility of these operators and we also give a solution of the spectral invariance problem for these operators.

▶ MS-Fr-D-44-4 15:00–15:30
Phases of Modified Stockwell Transforms and Instantaneous Frequencies
Wong, M.W. York Univ.
Molahajloo, Shahla Inst. for Advanced Studies in Basic Sci.

Abstract: The phase of a signal is analyzed using the Stockwell transform. In particular, the relationships between the instantaneous frequencies of a signal in polar form and the phase of the corresponding Stockwell transform are given. The corresponding results using a reciprocal Morlet wavelet transform are given for comparisons.

MS-Fr-D-45 13:30–15:30 213A
Optimization Methods for Inverse Problems - Part IV of V

For Part 1, see MS-Th-BC-45
For Part 2, see MS-Th-D-45
For Part 3, see MS-Th-E-45
For Part 5, see MS-Fr-E-45

Organizer: LIU, XIN AMSS
Organizer: WANG, YANFEI The Inst. of Geology & Geophysics, CAS

Abstract: In this minisymposium, inverse problems arisen from various areas such as geoscience and petroleum engineering, related optimization models like L1 norm regularization, and advanced optimization methods for solving these models such as first order methods, subspace methods, alternating direction method of multipliers and distributed optimization approaches are discussed.

▶ MS-Fr-D-45-1 13:30–14:00
A Matrix Framework Approach to Solve A High-Deminsional Inverse Problem
Wu, Leqin Jinan Univ.

Abstract: In this talk, we will introduce a method, which is based on a new matrix framework, to solve a high-dimensional inverse problem, or more specifically, the parameter estimation problem raised in the field of Gene Regulatory Networks(GRNs). Our method not only gives more fascinating theoretical properties, but also dramatically improves the numerical performance.

▶ MS-Fr-D-45-2 14:00–14:30
New Regularization Algorithm with Due Account Taken of Round-off Errors for Solving Multidimensional Ill-posed Problems
Lukyanenko, Dmitry Lomonosov Moscow State Univ.

Abstract: One of the most efficient way of solving multidimensional ill-posed problems is using of parallel computing that helps us to process a huge amount of data. But the round-off errors that grow with increasing amount of computations can significantly affect the final result of calculations. Several recent results will be presented on the study of this problem.
This work was supported by RFBR, project No. 14-01-31201, and by the Supercomputing Center of Lomonosov Moscow State University.

▶ MS-Fr-D-45-3 14:30–15:00
Regularized Optimization Method for Some Inverse Problems of Linear Diffusion Equations and Its Application in Numerical Differentiation
Wang, Zewen East China Inst. of Tech.
Ruan, Zhousheng School of Sci., East China Inst. of Tech.

Abstract: In this talk, we firstly present a regularized optimization method without iteration for some inverse problems of linear diffusion equation, such as inverse source problem of parabolic equation, the inverse problem of simultaneously determining both a space-dependent source and an initial value in the linear parabolic equations, etc. Then, we propose a PDEs-based numerical differentiation method based on the inverse source problems of diffusion equations.

▶ MS-Fr-D-45-4 15:00–15:30
Parameter Inversions for the Fractional Diffusion Equation Using the Optimal Perturbation Algorithm
Li, Gongsheng Shandong Univ. of Tech.

Abstract: In this talk, we consider parameters inversion problems in the time/space fractional diffusion equation using the optimal perturbation regularization algorithm with discrete additional data. We give three kinds of numerical inversions for the space-dependent diffusion coefficient, the fractional orders and/or the diffusion coefficient, and the linear source term respectively. Numerical simulations are presented, and discussions on the inversion algorithm are given too, including the finite-dimensional approximation, the regularization parameter, and data noises, etc.

IM-Fr-D-46 13:30–15:30 306B
Recent mathematical advances in seismic modeling, imaging and inversion - Part I of II

For Part 2, see IM-Fr-E-46

Organizer: Yarman, Evren Schlumberger
Organizer: Flagg, Garret Schlumberger

Abstract: Confidence in recovering earth's properties requires good understanding of the underlying physics of wave propagation to synthetically generate data matching the measurements. This data matching problem, also known as full waveform inversion, requires three steps: (1) modeling: simulation of seismic wave propagation; (2) imaging (linearized inversion): reconstruction of the medium's singularities by linearization of the forward modeling with respect to a known background; (3) inversion (non-linear inversion): updating the background model to match the measurements. This mini sym-

posium scopes recent methods that are being developed in industry and academia addressing various aspects of these three steps.

▶ IM-Fr-D-46-1 13:30–14:00

Mathematics of Time-domain Seismic Imaging

Fomel, Sergey — The Univ. of Texas at Austin

Abstract: Time-domain imaging, which includes prestack time migration, as well as normal moveout, dip moveout, and stacking, is a workhorse of seismic data processing. Many of the transformations involved in time-domain imaging can be described as "images waves" with the help of specially constructed linear PDEs. Image wave PDEs include offset continuation, velocity continuation, and Gardner continuation. Gardner continuation transforms seismic reflection data to remove the dependence of moveouts on dip and curvature of reflectors.

▶ IM-Fr-D-46-2 14:00–14:30

Phase and Amplitude Tracking for Seismic Event Separation

Li, Yunyue Elita — Massachusetts Inst. of Tech.
Demanet, Laurent — MIT

Abstract: We propose a method for decomposing a seismic record into atomic events defined by a smooth phase and a smooth amplitude. The method uses an iterative refinement-expansion tracking scheme to minimize the highly nonconvex objective function. We demonstrate the proposed method on two synthetic records. An application of our method to frequency extrapolation is shown for the synthetic shot record from the shallow Marmousi model.

▶ IM-Fr-D-46-3 14:30–15:00

Cheverda Vladimir, Chavent Guy, Gadylshin Kirill Full Waveform Inversion in Migration Based Travel Time Formulation: SVD Analysis and Numerical Implementation

Tcheverda, Vladimir — Inst. of Petroleum Geology & Geophysics

Abstract: We present Reflection FWI algorithm in Migration Based Travel Time (MBTT). This approach is based on decomposition of the velocity model for two constituents: smooth propagator and rough depth reflector. Subsequent reformulation of the data misfit function leads to a new FWI statement. Numerical experiments prove the feasibility of reflection FWI in MBTT formulation for macro velocity model reconstruction in case of absence low frequencies in the input data.

▶ IM-Fr-D-46-4 15:00–15:30

Model Reduction Approaches for Solution of Wave Equations for Multiple Frequencies

Zaslavsky, Mikhail — Schlumberger-Doll Research
Druskin, Vladimir — Schlumberger-Doll Research
Remis, Rob — delft Univ. of Tech.

Abstract: We have developed a novel algorithm to solving Helmholtz equation for multiple frequencies. Our approach is based on model reduction techniques using Krylov and extended Krylov subspaces (EKS) . Numerical examples on SEG/EAGE Salt model indicate that Krylov model reduction allows to obtain the solution for multiple frequencies at the cost of the BiCGStab iterative solver for a single frequency. The EKS improves the convergence by providing more uniform error distribution for the entire range.

MS-Fr-D-48 13:30–15:30 212B

Image restoration: new algorithms and new applications - Part II of III

For Part 1, see MS-Th-E-48
For Part 3, see MS-Fr-E-48

Organizer: Sgallari, Fiorella — Univ. of Bologna
Organizer: Chan, Raymond — The Chinese Univ. of Hong Kong

Abstract: The field of digital image restoration is concerned with the reconstruction or estimation of uncorrupted images from noisy, blurred ones. This blurring may be caused by optical distortions, object motion during imaging, or atmospheric turbulence. There are existing or potential applications of image restoration in many scientific and engineering fields, e.g. aerial imaging, remote sensing electron microscopy, and medical imaging. From these arise some real challenging problems related to image reconstruction/restoration that open the way to some new fundamental scientific questions closely related with the world we interact with and Mathematics has become one of the main driving forces of the modern development of image restoration.
The purpose of this mini-symposium is to gather the leading researchers in the areas of image restoration/reconstruction to present a series of talks that will expose the current state of knowledge in the algorithmic and application field. Our goal is also to establish connections between different techniques, talk about important issues in the emerging application fields and generate novel ideas for future development.

▶ MS-Fr-D-48-1 13:30–14:00

Krylov Subspace Methods for Constrained Image Restoration

James, Nagy — Emory Univ.

Abstract: Iterative Krylov subspace methods play a central role in the regularization of image restoration problems. In this talk we consider hybrid schemes that can be used to effectively implement regularization, including determining regularization parameters. We also consider approaches to enforce sparsity and nonnegativite constraints, as well as approaches that can compensate for outliers, such as missing pixels.

▶ MS-Fr-D-48-2 14:00–14:30

Restoration of Manifold-Valued Images by Half-Quadratic Minimization

Persch, Johannes — TU Kaiserslautern

Abstract: The talk addresses the generalization of the half-quadratic minimization method for the restoration of images having values in a complete Riemannian manifold. We recall the half-quadratic minimization method and adapt the algorithm to our special variational setting. We prove the convergence of the method for Hadamard spaces. Numerical examples for images with values on spheres, in the rotation group SO(3), and in the manifold of positive definite matrices demonstrate the algorithm.

▶ MS-Fr-D-48-3 14:30–15:00

Image Reconstruction and Interpretation in Positron Emission Tomography for Small Animals (micro-PET)

Garbarino, Sara — Department of Mathematics, Univ. of Genoa

Abstract: FDG-PET experiments involve two kinds of problems: the first one is the reconstruction of tracer distribution (a classical imaging inverse problem), and we focus on a Maximum Likelihood Estimation Maximization GATE-based algorithm for its implementation; the second problem is the quantification of descriptors of tracer kinetics (a compartmental inverse problem), and we present a novel approach for its resolution. We describe different applications utilizing nuclear data measured by a PET device for small animal models.

▶ MS-Fr-D-48-4 15:00–15:30

Edge Recovery in Images from Linear Attenuating Operators

Nikolova, Mila — CMLA, CNRS - ENS Cachan

Abstract: We consider applications like eddy current (EC) of metallic parts where the quality of the representation of the layers in the material degrades with the deepness of the layer. The goal is to recover anomalies (cracks) in the metal. Contemporary methods provide resolution that rapidly decay with the depth. Our method improves this decay by adapting the regularization parameters to the attenuation. The improvement is limited by the noise.

MS-Fr-D-49 13:30–15:30 107

Mathematical modeling of infectious diseases - Part II of II

For Part 1, see MS-Th-E-49

Organizer: Wang, Xueying — Washington State Univ.

Abstract: Mathematical modeling plays an important role in understanding the spread and control of infectious diseases in populations. Mathematical models have been increasingly used to guide public health policy decisions and explore questions in infectious disease control. This minisymposium will bring together researchers employing a variety of mathematical techniques to study relevant phenomena of infectious diseases.

▶ MS-Fr-D-49-1 13:30–14:00

A PDE System Modeling the Dengue Transmission with Nonlocal Infections and Crowding Effects

Feng-Bin, Wang — Chang Gung Univ.

Abstract: In this talk, I consider the influences of the spatial heterogeneity, crowding effect and non-local infection caused by the movements of the latent mosquitoes on the dynamics of dengue transmission. For this purpose, we modify an existing model to obtain a nonlocal and time-delayed reaction-diffusion system with the Neumann condition on the boundary. Then the basic reproduction number R_0 is defined for the model system, and it can be obtained explicitly when all model parameters are constants. Finally, we show that the global threshold dynamics of the model system can be determined by R_0.

▶ MS-Fr-D-49-2 14:00–14:30

Interacting Scales in Modeling HPV and Oropharyngeal Cancer

Eisenberg, Marisa — Univ. of Michigan, Ann Arbor

Abstract: Human papillomavirus (HPV) is a sexually transmitted infection which is associated with several forms of cancer, including cervical and oropharyngeal cancer. Interactions between infectious diseases and cancer form an inherently multi-scale problem, with population-level disease transmission driving within-host carcinogenesis, yielding overall population-level

cancer trends. In this talk, I will discuss recent work examining the dynamics of HPV and oropharyngeal cancer, which has recently overtaken cervical as the most common HPV-related cancer in the US.

▶ MS-Fr-D-49-3 14:30–15:00
Investigation of Doubling-Time Probability Densities for Growth Processes
Allen, Edward — Texas Tech Univ.

Abstract: The doubling-time probability density for a growth process is the probability density of times for the initial magnitude to double. Doubling-time probability densities are useful in studying growth rates, for example, of organisms, populations, financial products, or chemical reactions. Three stochastic models of growth are investigated for their doubling-time probability densities. Two of the stochastic models have doubling-time probability densities which are inverse Gaussian. The third stochastic model' s doubling-time density has no simple analytical

▶ MS-Fr-D-49-4 15:00–15:30
Influence of Heterogeneity in Model Predictions for Public Health Policymaking
Feng, Zhilan — Purdue Univ.

Abstract: Mathematical modeling of infectious diseases has affected disease control policy throughout the developed world. Policy goals vary with disease and setting, but preventing outbreaks is common. We use epidemiological models that incorporate various spatial and temporal heterogeneities to demonstrate how these heterogeneities may influence model predictions, particularly their implications for public health policymaking.

MS-Fr-D-50 13:30–15:30 207
Mathematical and Numerical Aspects of Electronic Structure Theory - Part IV of V
For Part 1, see MS-Th-BC-50
For Part 2, see MS-Th-D-50
For Part 3, see MS-Th-E-50
For Part 5, see MS-Fr-E-50
Organizer: Lin, Lin — Univ. of California at Berkeley
Organizer: Lu, Jianfeng — Duke Univ.
Abstract: Electronic structure theory and first principle calculations are among the most challenging and computationally demanding science and engineering problems. This minisymposium aims at presenting and discussing new developments of mathematical analysis, and numerical methods for achieving ever higher level of accuracy and efficiency in electronic structure theory. This includes ground state and excited state density functional theory calculations, wavefunction methods, together with some of their applications in computational materials science and quantum chemistry. We propose to bring together experts on electronic structure theory, which include not only mathematicians, but also physicists working actively in the field.

▶ MS-Fr-D-50-1 13:30–14:00
Nonlinear Spinor Field: Multi-hump Waves and the Stability
Shao, Sihong — Peking Univ.

Abstract: We first present a brief introduction to nonlinear spinor field, emphasizing on the motivation, the solitary wave solutions as well as the multi-hump structure. The upper bounds of the hump number in the charge, energy and momentum densities for the solitary waves are proved in theory. We then explore the relation between the multi-hump profile and the stability theoretically and numerically.

▶ MS-Fr-D-50-2 14:00–14:30
An Adaptive Finite Element Framework for Kohn-Sham/time-dependent Kohn-Sham Equation
Bao, Gang — Zhejiang Univ.
Hu, Guanghui — Univ. of Macau
Liu, Di — Michigan State Univ.

Abstract: A general numerical framework of using adaptive finite element methods to solve Kohn-Sham and time-dependent Kohn-Sham equations is presented in this talk. The Kohn-Sham equation is linearized with the SCF iteration, and the derived eigenvalue system is solved with LOBPCG. With the Crank-Nicolson method, the numerical method can be used to solve TDKS in the time domain. To improve the efficiency, the mesh adaptive methods are introduced. Numerical examples show the effectiveness of our method.

▶ MS-Fr-D-50-3 14:30–15:00
Rapid Iterative Diagonalization of Ill-conditioned Eigenvalue Problems in Electronic Structure Calculations
CAI, YUNFENG — Peking Univ
Bai, Zhaojun — Univ. of California, Davis
Pask, John — LLNL
Sukumar, N — UC Davis

Abstract: There has been substantial effort to develop ab initio electronic structure calculations that use localized basis functions for much fewer degrees of freedom. However, the iterative diagonalization of the sequence of underlying eigenproblems is particularly challenging due to highly ill-conditioning. We present a hybrid preconditioning scheme with the steepest descent-type algorithms for rapid iterative diagonalization of ill-conditioned eigenproblems, and present new theoretical convergence results.

▶ MS-Fr-D-50-4 15:00–15:30
An Intrinsically Parallel Algorithm for Large-scale Eigenvalue Problems
Zhou, Yunkai — Southern Methodist Univ.

Abstract: We present a novel spectrum decomposition algorithm for solving large-scale eigenvalue problems. The algorithm is intrinsically parallel. The design of the algorithm addresses several challenging difficulties encountered in existing parallel eigenvalue algorithms. Our algorithm has less global re-orthogonalization cost and less Rayleigh-Ritz refinement cost. Effectiveness of our algorithm will be shown via numerical experiments on matrices from DFT calculations.

MS-Fr-D-51 13:30–15:30 209A
Recent Developments in the Modeling, Simulation and Analysis of Mathematical Models Arising from Biology - Part II of III
For Part 1, see MS-Th-E-51
For Part 3, see MS-Fr-E-51
Organizer: Jain, Harsh — Florida State Univ.
Organizer: Zhao, Kun — Tulane Univ.
Abstract: Mathematical modeling is an effective and powerful tool in understanding complex biological phenomena. These models, using tools from diverse areas of mathematics ranging from partial and ordinary differential equations to group theory and topology, provide deep insights into the complex nature of biology that would otherwise be difficult to capture experimentally or in a clinical setting. Active research areas in mathematical biology include modeling of human vascular system, chemotaxis, wound healing, population dynamics, angiogenesis, cancer, morphogenesis and epidemiology. Speakers in this mini-symposium will discuss current research progress on the modeling, analysis and numerical simulation of models in these areas.

▶ MS-Fr-D-51-1 13:30–14:00
Dual Gradient System Modeling the Aggregation of Microglia in Alzheimer's Disease
Wang, Zhian — Hong Kong Polytechnic Univ.

Abstract: In the talk, we shall discuss a dual gradient system of chemotaxis modeling aggregation of microglia in Alzheimer's disease. Recent mathematical progresses with numerical simulations will be reported and open questions will be presented.

▶ MS-Fr-D-51-2 14:00–14:30
Oncolytic Virus Spread and CSPG-driven Tumor Cell Infiltration in Glioblastoma
Kim, Yangjin — Konkuk Univ.

Abstract: Oncolytic viruses are genetically engineered viruses that are designed to kill cancer cells while doing minimal damage to normal healthy tissue. Glioblastoma is the most aggressive type of brain cancer with the median survival time of one year. We show how a mathematical model can be used to generate useful predictions on therapy.

▶ MS-Fr-D-51-3 14:30–15:00
On Eigenvalue Problems Arising from Nonlocal Diffusion Models
Wang, Xuefeng — tulane Univ.

Abstract: We consider three classes of nonlocal diffusion operators that are not necessarily symmetric, and characterize their principal eigenvalues in a uniform, min-max fashion. For each class of these operators, we prove the positivity of a principal eigenfunction, the algebraic simplicity and the isolatedness of the principal eigenvalue. We also try to say as much as possible about the other part of the spectrum of the operator.

▶ MS-Fr-D-51-4 15:00–15:30
Multiscale Stochastic Reaction-diffusion Algorithms Combining Markov Chain Models with SPDEs
Kang, Hye Won — Univ. of Maryland, Baltimore County

Abstract: This talk introduces a multiscale algorithm for stochastic simulation of reaction-diffusion processes. The algorithm is applicable to systems which include regions with a few molecules and regions with a large number of molecules. A domain of interest is divided into two subsets where continuous-time Markov chain models and stochastic partial differential equations (SPDEs) can be respectively used. Several examples will be presented. This is a joint work with Radek Erban at the University of Oxford.

MS-Fr-D-52 13:30–15:30 212A

Recent Development of Mathematical Models in Computational Biology - Part IV of V

For Part 1, see MS-Th-BC-52
For Part 2, see MS-Th-D-52
For Part 3, see MS-Th-E-52
For Part 5, see MS-Fr-E-52

Organizer: Zhang, Lei Peking Univ.
Organizer: Ge, Hao Peking Univ.
Organizer: Lei, Jinzhi Tsinghua Univ.

Abstract: One of the central problems in biology is to understand the design principles of complex biological systems. Mathematical and computational models of biological processes can be characterized both by their level of biological detail and by their mathematical complexity. In this minisymposium, we focus on recent findings of computational models and methods to gain insights of the complexity of cellular life and efficiently analyze the experimental observations. Topics of interests include stem cells, developmental patterning, gene regulatory networks, neuron networks, uncertainty quantification of biological data, etc.

▶ MS-Fr-D-52-1 13:30–14:00
Energy Landscape Theory for the Biological System
Li, Tiejun Peking Univ.

Abstract: The construction of the energy landscape for the biological system attracts much attention recent years. There are different proposals for this construction. We will try to give a detailed comparison for these different approaches from an applied mathematics point of view.

▶ MS-Fr-D-52-2 14:00–14:30
Clustering Analysis for Coarse Grain Models of Biomolecules
Zhou, Xiang City Univ. of Hong Kong

Abstract: Coarse grained (CG) model of large biomolecule is important for the study of functional dynamics. Building CG model is to cluster full atoms into several sites in rational way. We define the dissimilarity between atoms from their MD simulated trajectories which includes both spatial structure and motion dynamics. K-means clustering method is applied and the selection of number of sites is based on minimizing clustering instability. Example of ATP-bound G-action is presented.

▶ MS-Fr-D-52-3 14:30–15:00
Reliability of Noise-Induced Spikes for Two Types of Threshold Dynamics
Kuske, Rachel Univ. of British Columbia

Abstract: We study spike time reliability (STR) in neurons, driven by frozen copies of a stochastic, rather than constant, signal. For quiescence in unstimulated neurons, we compare smooth vs. discontinuous dependence of frequency on the applied current. Computational and geometrical approaches show how favorable time profiles combined with specific current increases improve STR. Analytical approximations for the phase difference density of two coupled stochastically forced oscillators complement our understanding of intrinsic vs. extrinsic noises in STR.

▶ MS-Fr-D-52-4 15:00–15:30
Multimodal Feedback in Lineage Control and Morphogenesis
Lowengrub, John UC Irvine

Abstract: Feedback regulation of cell lineage progression plays an important role in tissue size control, but a role for such feedback in tissue morphogenesis is unexplored. Here we use mathematical modeling to show that positive and negative diffusible signals acting on stem and/or progenitor cells, leads to the appearance of bi-stable or bi-modal growth behaviors, ultrasensitivity to external growth cues, and the spontaneous emergence of self-organized budding and branching reminiscent of in vivo morphogenesis.

MS-Fr-D-53 13:30–15:30 311B

Stochastic Analysis in Insurance

Organizer: Ludkovski, Mike UC Santa Barbara
Organizer: Leung, Tim Columbia Univ.
Organizer: Cui, Zhenyu City Univ. of New York
Organizer: Li, Bin Univ. of Waterloo

Abstract: This minisymposium addresses applications of stochastic modeling in insurance and actuarial mathematics, including optimal dividend payouts, variable annuities, solvency requirements and claim evaluation

▶ MS-Fr-D-53-1 13:30–14:00
Optimal Dividend, Capital Injection and Bankruptcy for An Insurer with Solvency Requirement
Zhou, Ming Central Univ. of Finance & Economics

Abstract: We consider the optimal dividend problem in a Cramér-Lundberg model with capital injections, and a potential bankruptcy is allowed in this model. By maximizing the firm's market value, we find that the optimal policy is to pay all surplus exceeding d^* as dividends, and do capital injections when the surplus falls down solvency requirement, but declare bankruptcy when the surplus further drops down $-b^*0$, at which the market value of the firm equals zero.

▶ MS-Fr-D-53-2 14:00–14:30
Composite Bernstein Copulas
Yang, Jingping Peking Univ.

Abstract: Copula function has been widely used in insurance and finance for modeling inter-dependency between risks. Inspired by the Bernstein copula (BC) put forward by Sancetta and Satchell (2004), we introduce a new class of multivariate copulas, the composite Bernstein copula (CBC), generated from a composition of two copulas. This new class of copula functions is able to capture the tail dependence, and it has a reproduction property for the three important dependency structures: comonotoniciy, countermonotoniciy and independence. We introduce an estimation procedure based on the empirical composite Bernstein copula (ECBC) which incorporates both prior information and data into the estimation. A simulation study and an empirical study on financial data illustrate the advantages of the ECBC estimation method, especially in capturing the tail dependence. It is a joint work with Zhijin Chen, Fang Wang and Ruodu Wang.
Reference:
[1] A. Sancetta and S. Satchell (2004). The Bernstein copula and its applications to modeling and approximations of multivariate distributions. Ecomometric Theory, Vol.20, 535-562.

▶ MS-Fr-D-53-3 14:30–15:00
The Optimal Stopping Time of A Merger for Two Insurance Companies
Lihua, Bai Nankai Univ.

Abstract: This paper is concerned with the optimal stopping time of a merger for two insurance companies under the condition that the merger will generate some synergy and create some costs. theobjection is to maximize the sum of the two companies' expected discounted value.Under different initial conditions, we split up the problem into three cases. Then, by using the optimal stopping theorem, we solve the the problem separately and the value function and the optimal policy

▶ MS-Fr-D-53-4 15:00–15:30
Investment and Claim Evaluation: A Hedged Monte-Carlo Approach.
Zubelli, Jorge IMPA

Abstract: Claim evaluation and risk management decisions require taking into account a large number of uncertain variables and volatile scenarios. They may include financial market investments as well as unhedgeable risks. Thus, risk neutral techniques are not suitable to this context. In this talk, we propose and discuss a variant of the hedged Monte-Carlo method of Potters et al. to tackle strategic and risk management decisions. This leads to interesting statistical and numerical analysis questions.

MS-Fr-D-54 13:30–15:30 VIP1-2

Modeling and Simulations of Complex Biological Systems - Part III of IV

For Part 1, see MS-Th-D-54
For Part 2, see MS-Th-E-54
For Part 4, see MS-Fr-E-54

Organizer: Liu, Xinfeng Univ. of South Carolina
Organizer: Ju, Lili Univ. of South Carolina

Abstract: This mini-symposium aims to bring together researchers focusing on using modeling and numerical approach to study complex biological systems including (but not limited to) cell signaling pathways, complex bio-fluids, biofilms, cell polarization, developmental and cell biology, and stem cells, and etc. Such complex biological systems in general consist of multiple interacting components that exhibit complicated temporal and spatial dynamics. Furthermore, feedback, nonlinearities and multiple time and length scales often make such systems extremely difficult to describe, model or predict. The invited speakers will discuss the challenges of modeling such complex systems, introduce new computational techniques to simulate them and, where possible, present novel analytical techniques to extract meaningful information.

▶ MS-Fr-D-54-1 13:30–14:00
Single-step Implicit Integration Factor Methods for Advection-diffusion-reaction Equations

Zhang, Yong-Tao — Univ. of Notre Dame

Abstract: In this paper, I shall present our work on developing single-step implicit integration factor (IIF) methods for solving stiff advection-diffusion-reaction equations. WENO schemes are applied to the nonlinear advection terms. Krylov subspace approximations are used for dealing with the computational challenge arising from the matrix exponentials in high dimensions. Both linear analysis and numerical experiments for the new method will be shown. This is a joint work with Tian Jiang at U. of Notre Dame.

▶ MS-Fr-D-54-2 — 14:00–14:30

Nonlinear Growth Kinetics of Breast Cancer Stem Cells: Implications for Cancer Stem Cell Targeted Therapy

Liu, Xinfeng — Univ. of South Carolina

Abstract: We will introduce mathematical modeling for the dynamical interaction between cancer stem cells (CSCs) and non-stem cancer cells, and our findings reveal that two negative feedback loops are critical in controlling the balance between the population of CSCs and that of non-stem cancer cells. Furthermore, the model with negative feedback suggests that over-expression of the oncogene HER2 leads to an increase of CSCs by regulating the division mode or proliferation rate of CSCs.

▶ MS-Fr-D-54-3 — 14:30–15:00

Periodic Migration in A Physical Model of Cells on Micropatterns

Zhao, Yanxiang — The George Washington Univ.

Abstract: We extend a model for the morphology and dynamics of a crawling eukaryotic cell to describe cells on micropatterned substrates. This model couples cell morphology, adhesion, and cytoskeletal flow in response to active stresses induced by actin and myosin. Consistent with experimental results, simulated cells exhibit a broad range of behaviors, including steady motion, turning, bipedal motion, and periodic migration, in which the cell crawls persistently in one direction before reversing periodically.

▶ MS-Fr-D-54-4 — 15:00–15:30

An Energetic Variational Approach to Model Interaction of Multicomponent Biofilms with Fluid Flows

Xu, Zhiliang — Univ. of Notre Dame

Abstract: A novel biofilm model is described which systemically couples bacterial, extracellular polymeric substances (EPS) and solvent phases in biofilm. This allows for studying contributions of rheology of individual phases to deformation of biofilm in response to fluid flow as well as interactions between different phases. The model is derived using energetic variational approach and phase-field method. Phase-field coupling is used to model structural changes of a biofilm. Model simulations are shown to be in qualitative

MS-Fr-D-55 — 13:30–15:30 — 106

Wavelet Methods for Inverse Problems Modelling Real World Systems - Part III of IV

For Part 1, see MS-Th-D-55
For Part 2, see MS-Th-E-55
For Part 4, see MS-Fr-E-55

Organizer: Siddiqi,Prof., Abul — Sharda Univ.,NCR
Organizer: Al-Lawati, M.A. — Sultan Qaboos Univ.

Abstract: In a direct problem an effect is determined by a cause while in an inverse problem cause is determined from an effect. In an image processing the direct problem is to find out how a given sharp photograph would look like while camera is incorrectly focused.A related inverse problem is to find sharp photograph from a given blurry image.Inventors of CAT and MRI were awarded Nobel Prize of Medicine and Physiology respectively in 1979 and 2003.Inverse problems typically involve certain quantities based on indirect measurements of these quantities.Seismic exploration,CAT,MRI,X-ray are examples of inverse problems. Bio metric identifiers are measurements from human body;examples are ear,face,facial thermogram,hand thermogram,hand vein,hand geometry,finger print,iris,retina,signature and voice..The direct and indirect problems of biometrics correspond to the analysis and synthesis of biometric information,respectively.Recognition of face is a direct problem while face reconstruction is an an inverse problem.Refinement of Fourier methods,called wavelet methods including curve lets,shear lets play important role for study of inverse problems occurring in above themes. The symposium is devoted to updated research on applications of wavelets to the above problems.

▶ MS-Fr-D-55-1 — 13:30–14:00

Teaching of Inverse Problems

Zahra, Noore — Sharda Univ.
Kaur, Jagjeet — Khalsa College,Delhi Univ.
Rajoriya, Manisha — SET,SHARDA Univ.

Abstract: Inverse problems have been enormously influential in the development of natural sciences .Inverse problems related to Radon transform have immense practical importance .During the talk I would like to discuss importance of teaching inverse problems, whether it should be a compulsory course at graduate or undergraduate level and should be taught as an optional interdisciplinary subject .Ratio between analytic and numerical methods in a model course of inverse problems could be examined..

▶ MS-Fr-D-55-2 — 14:00–14:30

THE COMPARISON OF ANN ALGORITHMS-II FOR THE DIAGNOSIS OF MULTIPLE SCLEROSIS SUBGROUPS

Karaca, Yeliz — suleman Shah Univ.

Abstract: Including 120 MS patients (RRMS, SPMS, PPMS) and 19 healthy individuals for the control group, this study aims at diagnosing MS subgroups through Magnetic Resonance Imaging and Expanded Status Disability Scale applied onto the input of Artificial Neural Networks Algorithms (ANN), namely Cascade Forward Back Propagation and Nonlinear Autoregressive (NARX). The significance of these variables for the diagnosis of MS subgroups has been revealed as a result of this study where algorithm has been utilized.

▶ MS-Fr-D-55-3 — 14:30–15:00

DIGITAL CARICATURES AS A MODEL FOR INDUSTRIAL COMPANIES: TECHNOLOGY TRANSFER OFFICE SAMPLE

UCAN, Bahadir — Yildiz Technical Univ.

Abstract: Years of 2000’s can be defined as “the IT century”. In this IT century, it is seen that digitalization creates new concepts and approaches and it even affects our daily lifes. Changes have seen on different areas of art both on style and contentment with digitalization. In this study, the purpose is to underline digitalization, to investigate its effects on caricature. Digital caricatures applied on Yildiz Techinical University Technology Transfer Office.

▶ MS-Fr-D-55-4 — 15:00–15:30

Dynamic Charging Algorithms and Quota Transfer Systems

Ucan, Osman Nuri — Istanbul Aydin Univ.
Celik, Duygu — Istanbul Aydin Univ.
Zontul, Metin — Istanbul Aydin Univ.
Celenk, Ulas — Innova

Abstract: In this article, a novel Dynamic Quota Calculation System (DQCS) is proposed for dynamic quota allocations and charging in GSM systems by using two cascaded blocks. The first block is Self-Organizing Maps (SOM) clustering based on Sliding Window followed by the second block Markov Chain (MC) and overall system is denoted as (SOM/SW) &MC. MC block is applied for the future prediction of quota values.

MS-Fr-D-56 — 13:30–15:30 — 403

Mathematical trends, challenges and future applications for liquid crystal theories - Part III of IV

For Part 1, see MS-Th-D-56
For Part 2, see MS-Th-E-56
For Part 4, see MS-Fr-E-56

Organizer: Majumdar, Apala — Univ. of Bath
Organizer: Wang, Changyou — Purdue Univ.
Organizer: Zhang, Pingwen — Peking Univ.

Abstract: Liquid crystals are mesogenic phases of matter intermediate between the solid and liquid phases of matter. Liquid crystals typically exhibit partial ordering and are consequently, highly sensitive to light, electric fields, mechanical and rheological effects. The proposed minisymposium focuses on key questions in liquid crystal research, based on defects, atomistic to continuum modelling, phase transitions, pattern formation and hydrodynamics. The minisymposum will comprise four themed sessions on (i) analysis, (ii) modelling, (iii) simulations and (iv) related areas, with invited talks from physicists, mathematicians and materials scientists, thus providing an ideal platform for the cross-fertilization of expertise from around the globe.

▶ MS-Fr-D-56-1 — 13:30–14:00

Surveying the Free Energy Landscape of A Multistable Liquid Crystal Device

Kusumaatmaja, Halim — Durham Univ.
Majumdar, Apala — Univ. of Bath

Abstract: Using the planar bistable device as an example, we present new methodologies to compute not only relevant minimum energy configurations, but also transition pathways between any two minima, their corresponding energy barriers and the transition state configurations. Depending on the surface anchoring strengths, the transition pathway can be defect-free or mediated by topological defects. We also demonstrate cusp catastrophes, where some minima become unstable and instead act as transition states at very weak

anchoring.

▶ MS-Fr-D-56-2 14:00–14:30

Sawtooth Profile in Smectic A Liquid Crystals

Joo, Sookyung Old Dominion Univ.

Abstract: We study de Gennes free energy for smectic A liquid crystals to understand the chevron (zigzag) pattern formed in the presence of an applied magnetic field. Well above the instability threshold, we show via Gamma-convergence that a chevron structure where the director connects two minimum states of the sphere is favored. Numerical simulations illustrating the chevron structures for the de Gennes energy will be presented. This is a joint work with T. Giorgi and C.Garcia-Cervera.

▶ MS-Fr-D-56-3 14:30–15:00

Analysis on the Isotropic-nematic Interface Problem

Wang, Wei Zhejiang Univ.

Abstract: In this talk, we will discuss the isotropic-nematic problem in the framework of Landau-de Gennes theory. Specifically, we will discuss the stability of uniaxial interface profile, the sharp interface limit for the hydrodynamics of isotropic-nematic two-phase flow, and the effect of anisotropic elastic coefficient . Moreover, we will talk about the asymptotic behavior of minimizers for the isotropic-nematic interface problem.

▶ MS-Fr-D-56-4 15:00–15:30

Capilary Instability of An Active Liquid Crystal Filament

Wang, Qi Univ. of South Carolina & Beijing Computational Sci. Research Center

Yang, Xiaogang Beijing Computational Sci. Research Center

Abstract: In this talk, we will first present a thermodynamically consistent active liquid crystal model and discuss the appropriate boundary conditions for free surface flows. then, we will study the Capillary instability of an infinitely long active liquid crystal filament. We will show three types of instability associated with this filament at different regimes of model parameters. Some numerical simulation of nonlinear instability will be briefly discussed as well.

MS-Fr-D-57 13:30–15:30 402A

Modeling, Applications, Numerical Methods, and Mathematical Analysis of Fractional Partial Differential Equations I - Part IV of V

For Part 1, see MS-Th-BC-57
For Part 2, see MS-Th-D-57
For Part 3, see MS-Th-E-57
For Part 5, see MS-Fr-E-57

Organizer: Wang, Hong Univ. of South Carolina

Organizer: Karniadakis, George Brown Univ.

Abstract: Fractional Partial Differential Equations (FPDEs) are emerging as a new powerful tool for modeling many difficult complex systems, i.e., systems with overlapping microscopic and macroscopic scales or systems with long-range time memory and long-range spatial interactions. They offer a new way of accessing the mesoscale using the continuum formulation and hence extending the continuum description for multiscale modeling of viscoelastic materials, control of autonomous vehicles, transitional and turbulent flows, wave propagation in porous media, electric transmission lines, and speech signals. FPDEs raise modeling, computational, mathematical, and numerical difficulties that have not been encountered in the context of integer-order partial differential equations. The aim of this minisymposium is to cover the recent development in mathematical and numerical analysis, computational algorithms, and applications in the context of FPDEs and related nonlocal problems.

▶ MS-Fr-D-57-1 13:30–14:00

The Exit-time Problem for A Markov Jump Process

Lehoucq, Richard Sandia National Labs

Abstract: The purpose of my presentation is to consider the exit-time problem for a finite-range Markov jump process, i.e, the distance the particle can jump is bounded independent of its location. Such jump diffusions are expedient models for anomalous transport exhibiting superdiffusion or nonstandard normal diffusion. We refer to the associated deterministic equation as a volume-constrained nonlocal diffusion equation. This is joint work with Nate Burch and Marta D'Elia.

▶ MS-Fr-D-57-2 14:00–14:30

Nonlocal Diffusion and Fractional Diffusion Models and Their Approximations

Du, Qiang Columbia Univ.

Tian, Xiaochuan Columbia Univ.

Abstract: We discuss some nonlocal diffusion models define on a bounded domain and their limiting fractional diffusion models as well as their numerical approximations. The key ingredients of our study involve a combination of the mathematical theory of nonlocal calculus of variations for nonlocal variational problems and the recently developed abstract framework of asymptotically compatible (AC) schemes for robust discretizations of a family of parametrized problems.

▶ MS-Fr-D-57-3 14:30–15:00

Stochastic Solutions for Fractional Wave Equations

Sikorskii, Alla Michigan State Univ.

Abstract: A fractional wave equation replaces the second time derivative by a fractional derivative of order between one and two. In this paper, we show that the fractional wave equation governs a stochastic model for wave propagation, with deterministic time replaced by the inverse of a stable subordinator whose index is one half the order of the fractional time derivative.

MS-Fr-D-58 13:30–15:30 401

Theoretical and numerical studies of phase field model - Part III of IV

For Part 1, see MS-Th-D-58
For Part 2, see MS-Th-E-58
For Part 4, see MS-Fr-E-58

Organizer: Wang, Cheng Univ. of Massachusetts Dartmouth

Organizer: Qiao, Zhonghua The Hong Kong Polytechnic Univ.

Organizer: Wang, Xiaoping Hong Kong Univ. of Sci. & Tech.

Abstract: Phase field equations, which treat the phase variable as a continuous function instead of a sharp interface, model a great number of physical and biological phenomena, such as phase transformations of materials at different scales, the process in biological growth and development, and the topological change involved in multi-phase flows. This mini symposium is focused on the developments of the phase field models. Both the theoretical analysis for these highly nonlinear PDEs and the numerical approximations are of great interests.

▶ MS-Fr-D-58-1 13:30–14:00

An Efficient ADI Approach for Augmented Immersed Interface Methods

Zhang, Zhengru Beijing Normal Univ.

Abstract: We combine the conventional ADI method and the augmented immersed interface method for solving the parabolic partial differential equations with discontinuous coefficients. The proposed method owns the significant advantages of the both methods. The augmented variables can be obtained by solving a much smaller linear system because they are only defined along the interface, and the matrix of the system can be obtained by solving a series of the original parabolic equations using ADI method.

▶ MS-Fr-D-58-2 14:00–14:30

Modeling and Simulation of Three-component Flows on Solid Surface

Wang, Xiaoping Hong Kong Univ. of Sci. & Tech.

Abstract: We propose a phase field model for the study of three-component immiscible flows with boundary. The model is a generalization of the two-component model. We first study certain consistency conditions for the forms of the bulk free energy and surface energy. We then develop an adaptive mesh refinement(AMR) technique to solve the system in order to improve the efficiency of the problem. Several numerical results are also given.

▶ MS-Fr-D-58-3 14:30–15:00

Phase Field Methods with Energetic Variational Approaches

Liu, Chun Penn State Univ.

Abstract: In this talk, I will discuss various phase field models with the general variational approaches. The focus is to relate these approaches to the existing results/theories for viscoelasticity.

▶ MS-Fr-D-58-4 15:00–15:30

3D Numerical Simulation of Biofilm Hydrodynamics

Wang, Qi Univ. of South Carolina & Beijing Computational Sci. Research Center

Zhao, Jia Univ. of South Carolina

Abstract: In this presentation, we will present a systemaic study of biofilm hydrodynamics using a multiphase complex fluid model that accounts for quorum sensing, bacterial phenotypes and antimicrobial treatment. The model is essentially a phase field model with the phase boundary naturally defined by the concentration of biomass. 2nd order numerical methods are developed to simulate the hydrodynamics of biofilm system. 3D numerical results will be discussed.

MS-Fr-D-59 13:30–15:30 402B
Energy-Driven Pattern Formation - Part III of IV
For Part 1, see MS-Th-D-59
For Part 2, see MS-Th-E-59
For Part 4, see MS-Fr-E-59
Organizer: Kohn, Robert New York Univ.

Abstract: Energy-driven pattern formation examines how energy minimization leads to the formation of defects and microstructure in a variety of physical systems. Examples include the wrinkling of a stretched elastic membrane, the twinning produced by martensitic phase transformation, and the defects seen in liquid crystals. In these and many other examples, the physics is modelled by a nonconvex variational problem regularized by a higher-order term with a small coefficient, and energy-driven pattern formation can be studied by considering the limiting behavior of minimizers as the small parameter tends to zero. Another recurrent theme is the use of ansatz-free bounds to identify and explore the features of energy-minimizing configurations. A third recurrent theme is dynamics, since the patterns of interest are sometimes transient states of steepest-descent processes.

▶ MS-Fr-D-59-1 13:30–14:00
A Variational Perspective on the Blistering of A Compressed Thin Film on A Compliant Substrate
Kohn, Robert New York Univ.

Abstract: Complex blister patterns occur in elastic films as a consequence of compressive misfit. Blistering permits the film to expand locally, reducing the elastic energy. It is therefore natural to ask: what is the minimum energy achievable by blistering on a fixed area fraction of the substrate? I' ll discuss this variational problem, which involves both the elastic deformation of the film and substrate and the geometry of the blistered region. (Joint work with Jacob Bedrossian.)

▶ MS-Fr-D-59-2 14:00–14:30
Nonexistence of Minimizers to Some Variational Principles with Nonlocal Repulsive Interactions
Lu, Jianfeng Duke Univ.

Abstract: Variational principles with competing attractive and repulsive interactions often arise from physical applications. In this talk, we will consider variational models with Coulomb repulsion coming from the theory of phase transition and electronic structure theory. We will present some recent progress on understanding the nonexistence of minimizers to these variational problems. (joint work with Felix Otto)

▶ MS-Fr-D-59-3 14:30–15:00
Coarsening Mechanism for Cahn-Hilliard Equation with Degenerate Diffusion Mobility
Du, Qiang Columbia Univ.
Dai, Shibin NMSU

Abstract: We present in this talk some recent analytical and computational studies of the coarsening dynamics of a Cahn-Hilliard equation which is specified with a double-well potential and a degenerate mobility. Combining careful asymptotic analysis with effective computational schemes, we demonstrate that there is a strong dependence of the coarsening mechanism on specific forms of the potential and mobility functions.

▶ MS-Fr-D-59-4 15:00–15:30
Variational Modeling of Microstructure in Shape-memory Alloys
Conti, Sergio IAM, Univ. of Bonn

Abstract: Shape-memory alloys are a classical problem in the variational study of pattern formation in solids, both in the context of the theory of relaxation and in the study of singularly perturbed problems. I shall discuss recent progress on the singularly-perturbed two-well problem, including in particular the vectorial, geometrically nonlinear situation and the limit of low volume fraction.

MS-Fr-D-60 13:30–15:30 310
Mathematical methods in biomedical applications - Part II of III
For Part 1, see MS-Th-E-60
For Part 3, see MS-Fr-E-60
Organizer: Amigo, Jose Universidad Miguel Hernandez
Organizer: Liang, X. San Nanjing Inst. of Meteorology
Organizer: Small, Michael Univ. of Western Australia

Abstract: Mathematics is being successfully applied to a number of important topics in biology and medicine like biofluids, data analysis, drug design and discovery, epidemiology, evolution, genetics, image processing, immunology, medical instrumentation, neuroscience, plant growth, population dynamics (including ecology and microbiology), tumor propagation, virus dynamics, etc. The list of tools include virtually the whole applied mathematics. To cite just the most familiar ones: discrete dynamical systems, ordinary and time-delay differential equations, graph and network theory, integral transforms, numerical and computational mathematics, partial and stochastic differential equations, statistics, probability, and time series analysis. All this research has contributed and is increasingly contributing both to a better understanding of complex biological phenomena and to find practical ways of action. On the wake, new branches of applied mathematics have emerged, e.g., mathematical biology, theoretical biology, and computational neuroscience. But the most important consequence is the improvement in health care and life quality that results from, say, early and better diagnoses, more efficient drugs, plague control, or biotechnological know-how, all of which owe much to the mathematical research.
This being the case, the scope of the minisymposium hereby proposed is to give researchers the opportunity to share their latest applications of mathematical methods to biology and medicine in a multi- and interdisciplinary environment. The topics addressed have been intentionally left open with the objective of having a broader participation. Thus, researchers in computational neuroscience can benefit very much from a network-based approach or time series analysis. Researchers in deterministic models can get further inspiration from stochastic methods or fractional analysis. Moreover, specialists in one particular field can learn new, possibly unexpected applications of their technical skills or hear about other approaches.
With this scope in mind, the organizers of this minisymposium have invited a reduced number of experts who work on applications of mathematics to medicine and biology. Their theoretical backgrounds cover mainly nonlinear dynamics, computational neuroscience, time series analysis, network theory, and partial differential equations, thus a representative blend of current research. Specially important are the actual and potential applications to the biomedical industry of topics such as complex fluids, drug discovery, computational methods and information analysis, all of them included in the minisymposium. For instance, the parametric study of the flow in ventricular catheters for the treatment of hydrocephalus presented in one of the communications, has led new designs which are patent pending.
If approved, this minisymposium will be certainly a great place to create synergies in an area of mathematics which has scientific interest, applications to the biomedical industry, and social impact.

▶ MS-Fr-D-60-1 13:30–14:00
Neuron Models: the Role of Homoclinic and Heteroclinic Phenomena
Rodriguez, Marcos Centro Universitario de la Defensa
Barrio, Roberto Univ. of Zaragoza
Serrano, Sergio Univ. of Zaragoza
Martinez, Maria Angeles Univ. of Zaragoza
Shilnikov, Andrey Georgia State Univ.

Abstract: We study a 3 cell network of leach heart neurons, where the bursting of the cells evolve to patterns (equilibria) when time increases. We present the parametric evolution of the equilibrium states in the phase space of the neuron network. Along the values parameter we can accurately detect a Hopf-Andronov bifurcation and a Heteroclinic bifurcation that give rise to robust slow switching patterns.

▶ MS-Fr-D-60-2 14:00–14:30
Reservoir Computing of Spiking Neural Network Based on Self-organized Learning Rules
LI, Xiumin Chongqing Univ.

Abstract: Reservoir computing of Spiking Neural Network (SNN) has attracted much attention, which is a recently developed cortical model shown to be beneficial for performing computational tasks. Here we propose a novel reservoir network which is self-organized by Spike-Timing-Dependent Plasticity or/and Intrinsic Plasticity. Results show that SNN with both learning rules has a better performance than SNN with random reservoir. Also, this structure obviously enhances the neuronal activity entropy, indicating its high efficiency in information processing.

▶ MS-Fr-D-60-3 14:30–15:00
Model-based Approach to Drug Discovery
Small, Michael Univ. of Western Australia

Abstract: Mass spectrometry methodologies provide a massive amount of noisy data - within that mass of noisy data, biochemist wish to discover certain signatures corresponding to particular drug metabolites. These signatures can be characterised as a particular parameterised template within the data. Using minimum-description-length modelling methods we describe a new approach to identify potential drug locations and hence areas for further biochemical investigation. This method offers a new approach to the identifi-

cation of such deterministic signatures.

▶ MS-Fr-D-60-4 15:00–15:30

Memory and Bifurcations in Nonlinear Biological Systems

Edelman, Mark — Stern College at Yeshiva Univ. & Courant Inst. at NYU

Abstract: Fractional analysis shows that changes in the memory of a nonlinear dynamical system lead to bifurcations. Biological systems with memory include the brain and also all organs' tissues which are viscoelastic and may be described by equations with time fractional derivative of order between zero and one. In this talk we make a review of possible applications of fractional calculus to biology and medicine based on recent publications.

CP-Fr-D-61 13:30–15:30 101

Medical science

Chair: Tridane, Abdessamad — United Arab Emirates Univ.

Abstract:

▶ CP-Fr-D-61-1 13:30–13:50

Targeting the Quiescent Cells in Cancer Chemotherapy Treatment: is Enough ?

Tridane, Abdessamad — United Arab Emirates Univ.

Abstract: In this work, we develop a mathematical model to study the effect of drug on the development of cancer including the quiescent compartment. The model is governed by a system of delay differential equations where the delay represents the time that the cancer cell takes to proliferate. Our analytical study of the stability shows that by considering the time delay as a parameter of bifurcation, it is possible to have stability switch and oscillations.

▶ CP-Fr-D-61-2 13:50–14:10

Nonlinear Dynamics in Fractional-Order Mathematical Model of Autoimmune Disease Psoriasis

Roy, Priti Kumar — Jadavpur Univ.

Abstract: Psoriasis is one type of autoimmune chronic skin. We consider a mathematical model of Psoriasis involving T-Cells, Dendritic Cells, CD8+ T-Cells and Keratinocyte cell populations based on a set of FODEs. Our focus is how we can reduce the excess Keratinocytes, which is the causal effect of Psoriasis. From mathematical findings, we try to activate the suppressed memory, the inherited property of the cell-biological system, to decrease the surplus production of Keratinocyte cell population.

▶ CP-Fr-D-61-3 14:10–14:30

Forecasting the Incidence of Cancer

Mills, Terence — Loddon Mallee Integrated Cancer Service

Abstract: Approximately 30% of deaths in Australia are caused by malignant cancers. How do we deal with this group of diseases? There is widespread interest in this question in Australia. Planning for cancer services involves forecasting the incidence of cancer. These forecasts are based on mathematical models. My aim is to review the research literature on forecasting the incidence of cancer with a view to comparing models.

▶ CP-Fr-D-61-4 14:30–14:50

Convection Enhanced Macromolecular Nutrient Transport Through A Tumor Interstitial Space with Quadratically Varying Permeability

Dey, Bibaswan — Indian Inst. of Tech. Kharagpur
Raja Sekhar, G P — Indian Inst. of Tech. Kharagpur

Abstract: Extra-vascular transport of solute macromolecular nutrients and trans-vascular exchange between blood vessel and tumor interstitium inside a tumor (in vitro) are addressed. It is considered that the permeability of the interstitial space decreases quadratically with the radial distance towards the core. A general framework for transvascular and interstitial solute nutrient transport is discussed in a macroscopic view, where the modified Sterling law is used in order to describe transvascular nutrient transport. The interstitial fluid transport is modeled in the light of the mixture theory. The present model describes one dimensional analytical solution of hydrodynamic equations and an approximate analytical solution of advection-diffusion-reaction equation for describing the overall solute nutrient concentration within the interstitial space. Some criteria of the formation of necrosis within the tumor interstitium are discussed, when the nutrient metabolism kinetics of the tumor cells is first order in nature.

▶ CP-Fr-D-61-5 14:50–15:10

Galerkin Finite Element Method for Chemotaxis-Haptotaxis Cancer Invasion Model

Shangerganesh, Lingeshwaran — Indian Inst. of Sci.

Abstract: Cancer invasion of tissues is explained as system of partial differential equations using a wide range of continuum mathematical models. These models are used to explain the diverse growth of cancer cell dynamics and their interactions with the host tissue like extra cellular matrix. In this work, we propose a model to describe the evolutions of cancer cells density, extra cellular matrix (ECM) density and matrix degrading enzymes (MDE) concentration produced by cancer cells. In order to examine the interactions of cancer cells with ECM and MDE, we consider the reaction-diffusion system with chemotaxis and haptotaxis effect. In this work, the Galerkin finite element method will be presented for the numerical simulations of the cancer invasion model and we investigate the effects of haptotactic and chemotactic coefficients, diffusion coefficients of cancer cell density and matrix degrading enzymes, proliferation rate of cancer cells, remodeling rate of ECM.

CP-Fr-D-62 13:30–15:30 102

Computational Science and Imaging Science

Chair: Chow, Shue-Sum — Brigham Young Univ.

Abstract:

▶ CP-Fr-D-62-1 13:30–13:50

A Reconstruction Algorithm for An Inverse Source Problem in Non-homogeneous Media

Chow, Shue-Sum — Brigham Young Univ.

Abstract: In many inverse source problems involving time harmonic wave propagation, the solution is improved if measurements based on many frequencies are used to recover the source. However, most of these results assumed the underlying medium is homogeneous. We propose an iterative reconstruction algorithm that allows one to recover the source term in non-homogeneous Helmholtz equation using boundary measurements for a range of frequencies, and discuss computational results in acoustic and elastic wave problems.

▶ CP-Fr-D-62-2 13:50–14:10

Infimal Convolution of Total Generalized Variation Functionals for Spatio-temporal Regularization of Image Sequences

Holler, Martin — Univ. of Graz
Bredies, Kristian — Univ. of Graz
Kunisch, Karl — Univ. of Graz

Abstract: Variational methods for image processing heavily rely on appropriate regularization functionals. While this topic is well investigated in the still image context, the question of suitable regularization for image sequences is still quite open, but not less important. In this talk, we present a new approach for spatio-temporal regularization of image sequences. When considering for instance the spatio-temporal Total Variation (TV) or Total Generalized Variation (TGV) functional, the scale of space with respect to time is not given a-priori and in fact defines a trade-off between spatial and temporal regularization. This can be exploited to further improve reconstruction quality by optimally balancing between two different scales via the infimal convolution of such functionals (ICTGV). We present the analysis of the resulting regularization term and its application for dynamic MRI reconstruction and the artifact-free decompression of MPEG compressed videos.

▶ CP-Fr-D-62-3 14:10–14:30

A Multiscale Butterfly Algorithm for Multidimensional Fourier Integral Operators

Li, Yingzhou — Stanford Univ.
YING, LEXING — Stanford Univ.

Abstract: This paper presents an efficient multiscale butterfly algorithm for computing Fourier integral operators (FIOs) of the form $(\mathcal{L}f)(x) = \int_{\mathbb{R}^d} a(x,\xi)e^{2\pi\imath\Phi(x,\xi)}\widehat{f}(\xi)d\xi$, where $\Phi(x,\xi)$ is a phase function, $a(x,\xi)$ is an amplitude function, and $f(x)$ is a given input. The frequency domain is hierarchically decomposed into a union of Cartesian coronas. The integral kernel $a(x,\xi)e^{2\pi\imath\Phi(x,\xi)}$ in each corona satisfies a special low-rank property that enables the application of a butterfly algorithm on the Cartesian phase-space grid. This leads to an algorithm with quasi-linear operation complexity and linear memory complexity. Different from previous butterfly methods for the FIOs, this new approach is simple and reduces the computational cost by avoiding extra coordinate transformations. Numerical examples in two and three dimensions are provided to demonstrate the practical advantages of the new algorithm.

▶ CP-Fr-D-62-4 14:30–14:50

Butterfly Factorization

Li, Yingzhou — Stanford Univ.
YING, LEXING — Stanford Univ.

Abstract: The butterfly algorithm has been applied to accelerate an important class of matrix-vector multiplications. A matrix in this class enjoys a special low-rank property that the rank of any contiguous submatrix is only determined by the size of the submatrix. We refer to these matrices as butterfly matrices and present an efficient butterfly factorization method to represent them as a multiplication of data-sparse matrices. This butterfly factorization admits efficient algebraic operations, e.g., matrix-vector multiplication, matrix compression, etc. The factorization can be constructed efficiently in two cases: if a pre-existing code for the butterfly algorithm is available, or if arbitrary entries of the butterfly matrix can be computed on-the-fly. The application of the factorization is significantly faster than that of the butterfly algorithm as

▶ CP-Fr-D-62-5 14:50–15:10

Single Image Super-resolution by Approximated Heaviside Functions

Deng, Liangjian — Univ. of Electronic Sci. & Tech. of China
Guo, Weihong — Case Western Reserve Univ.
Huang, Ting-Zhu — School of Mathematics Sci., Univ. of Electronic Scicence & Tech. of China

Abstract: Image super-resolution is a process to enhance image resolution. It is widely used in medical imaging, satellite imaging, target recognition, etc. In this paper, we conduct continuous modeling and assume that the unknown image intensity function is defined on a continuous domain and belongs to a space with a redundant basis. We propose a new iterative model for single image super-resolution based on an observation: an image is consisted of smooth components and non-smooth components, and we use two classes of approximated Heaviside functions (AHFs) to represent them respectively. Due to sparsity of the non-smooth components, a L1 model is employed. In addition, we apply the proposed iterative model to image patches to reduce computation and storage. Comparisons with some existing competitive methods show the effectiveness of the proposed method.

▶ CP-Fr-D-62-6 15:10–15:30

Fast GPU Implementation of Active Contours for High-throughput Medical Imagery

Prasath, Surya — Univ. of Missouri-Columbia

Abstract: Active contour method is based on a nonlinear minimization model and widely used for digital image segmentation. Nonlinear optimization combined with segmenting huge size of the images have hindered the progress of these algorithms for real time usage in medical diagnostics. Recently, globally convex version of traditional active contour models has paved the way for fast and efficient optimization procedures. Following the dual minimization of the total variation regularization, we derive efficient discretization schemes for active contour without edges model. By utilizing graphical processing unit (GPU) based implementation we obtained 20x faster results than using traditional computational methods. This enables us to utilize these algorithms for practical use in computationally demanding applications.

CP-Fr-D-63 13:30–15:30 103

Thermal system

Chair: CERETANI, Andrea — CONICET & Univ. Austral

Abstract:

▶ CP-Fr-D-63-1 13:30–13:50

Determination of One and Two Unknown Thermal Coefficients Through A Mushy Zone Model with A Convective Overspecified Boundary Condition

CERETANI, Andrea — CONICET & Univ. Austral
Tarzia, Domingo Alberto — CONICET & Univ. Austral

Abstract: We consider a semi-infinite material that is initially liquid at its melting temperature. At time t=0, a heat flux (characterized by constant q¿0) and an overspecified Robin condition (characterized by constant h¿0) are imposed at x=0 and then solidification ensues, where three distinct regions can be distinguished: 1) Solid, at temperature T(x,t)¡0, occupying the region 0¡x¡s(t); 2) Liquid, at T=0, occupying the region x¿r(t); 3) Mushy zone, at T=0, occupying the region s(t)¡x¡r(t), with two assumptions on this structure which depends on two parameters The goal is the simultaneous determination of one (6 cases) and two (15 cases) thermal coefficients among (conductivity, specific heat, mass density, latent heat, and two parameters of the mushy region) when the constants q and h are determined experimentally. We obtain explicit formulas for the unknown coefficients, and we also give necessary and sufficient conditions on data for the existence of a solution.

▶ CP-Fr-D-63-2 13:50–14:10

PARTIAL DIFFERENTIAL EQUATIONS APPLIED TO THE ANALYSIS OF THERMAL STRESSES AND THERMAL DEFORMATIONS OF A SHALLOW SKEW Shell PANEL

Biswas, Paritosh — Von Karman Society for Advanced Study & Research in Mathematical & Social Sci.

Abstract: In solid and structural mechanics, numerous problems arise where thermal stresses, thermal deformations and vibrations play an important role. In this paper non-linear coupled partial differential equations derived in the von Karman sense and extended to thermal loading with the inclusion of curvature for a skew rectangular panel have been employed to analyze thermal stresses and thermal deformations for movable edge boundary conditions. Numerical results have been presented for cross-variation of parameters involved herein.

▶ CP-Fr-D-63-3 14:10–14:30

Some Applications of Lomen' s Functions and Confluent Hyper-geometric Functions in Solving Thermo-Elastic Plate Problems.

Biswas, Paritosh — Von Karman Society for Advanced Study & Research in Mathematical & Social Sci.

Abstract:
Non-homogeneous Bessel' s Differential Equations in which Lomen' s Functions occur to get the particular integrals for the case of a semi-circular plate and for the case of a circular plate of variable thickness under thermal stresses, the governing equations can be reduced to a confluent hyper-geometric equation. Solutions for Semi-Circular plates and circular plates of variable thickness under thermal loading can be obtained using the above two equations.

▶ CP-Fr-D-63-4 14:30–14:50

Unsteady Boundary Layer Heat and Mass Transfer Flow of A Casson Fluid Past An Oscillating Vertical Plate with Newtonian Heating

Hussanan, Abid — Universiti Malaysia Pahang, Malaysia
Salleh, Mohd Zuki — Universiti Malaysia Pahang, Malaysia
Tahar, Razman Mat — Universiti Malaysia Pahang, Malaysia
Khan, Ilyas — College of Engineering Majmaah Univ., Saudi Arabia

Abstract: This paper deals with exact solutions for unsteady heat and mass transfer flow of a Casson fluid over an infinite vertical plate with Newtonian heating. The analysis of heat transfer in the presence of radiation effects are also considered. Some suitable non-dimensional variables are introduced. The governing equations together with imposed conditions are transformed into dimensionless forms. Expressions for the velocity, temperature and concentration fields are obtained using the Laplace transform.

▶ CP-Fr-D-63-5 14:50–15:10

Electrothermal Convection of A Rotating Dielectric Micropolar Fluid Layer

Pawar, Neela — MCM DAV College,Chandigarh

Abstract: The effect of uniform rotation on the onset of instability in a horizontal layer of dielectric micropolar fluid under the simultaneous action of a vertical AC electric field and a vertical temperature gradient has been considered. Applying linear stability theory and Boussinesq approximation on the model under consideration, the dispersion relation and the relevant boundary conditions are derived. This dispersion relation is solved exactly to determine the required critical values to study the instability of the fluid layer. The influence of various micropolar fluid parameters, rotation and electric Rayleigh number on the onset of convection has been analyzed. Some previous results have been derived and discussed as special cases. Critical Rayleigh electric numbers, wave numbers and frequencies for the onset of instability are plotted graphically as function of Rayleigh heat number for various values of other parameters involved in the system. The stabilizing and destabilizing effect of temperature, AC electric field, rotation etc. have also been discussed.

▶ CP-Fr-D-63-6 15:10–15:30

Effect of Diffusion on Plane Waves in Micropolar Theromoelastic Medium

Yadav, Anand Kumar — M.M. Univ., Mullana, Ambala, Haryana, India
Singh, Baljeet — Department of Mathematics, Post Graduate Government College, Sector 11, Chandigarh-160011, India

Abstract: Effect of Diffusion on Plane waves in Micropolar Theromoelastic Medium
Baljeet Singh1 and Anand Kumar Yadav2
1Department of Mathematics, Post Graduate Government College, Sector 11, Chandigarh, India, E-mail: bsinghgc11@gmail.com 2Department of Mathematics, M. M. University Mullana Ambala, India, E-mail:yadavanand977@gmail.com
Abstract: In this paper, the governing equations of micropolar thermoelasticity with diffusion are formulated in context, Lord-Shulman theory of generalized thermoelasticity. The plane wave solutions of these equations indicate the existence of six plane waves. The speed of these plane waves are computed for a particular material, and plotted against the angle of propagation. Effect of diffusion, thermal and mocropolarity is observed on these plane waves.

MS-Fr-D-67 13:30–16:00 Function Hall C
Minisymposium on Mathematical Modeling Education for High School Students - Part I of II
For Part 2, see MS-Fr-E-67

Organizer: Cheung, Alfred — NeoUnion ESC Organization
Organizer: Bai, Fengshan — Tsinghua Univ.
Organizer: Qiao, Zhonghua — The Hong Kong Polytechnic Univ.

Abstract: This minisymposium will introduce the newly instituted international contest in modeling for high school students - International Mathematical Modeling Challenge (IM2C or IMMC) whose co-founders and co-organizers are Consortium for Mathematics and its Application (COMAP) and NeoUnion ESC Organization. The meaning and significance of mathematical modeling education for fostering students innovation competencies will be addressed in response to the global trend in STEM education. Award presentation to local teams will be held during the minisymposium. A team of students and their teacher advisor who won the Outstanding Prize in the first Annual IM2C 2015 will make presentation. Review in depth of the contest problem Movie Scheduling and commentary on solution papers by awarded teams will be lectured. Hands-on workshop on mathematical modeling teaching and learning will be offered in the minisymposium.

▶ MS-Fr-D-67-1 13:30–14:00
Introduction to the International Mathematical Modeling Challenge (IM2C or IMMC)
Cheung, Alfred — NeoUnion ESC Organization

Abstract: Introduction to the International Mathematical Modeling Challenge (IM2C or IMMC)

▶ MS-Fr-D-67-2 14:00–14:30
Award Presentation to Local Winning Teams.

Abstract: Award presentation to local winning teams

▶ MS-Fr-D-67-3 14:30–15:00
Modeling of Movie Scheduling - Outstanding Team's Solution Paper
Wang, Yaoyang — Affiliated High School of Peking Univ.

Abstract: Modeling of Movie Scheduling - Outstanding Team Solution Paper

▶ MS-Fr-D-67-4 15:00–15:30
Review of IM2C Participating Teams and Their Papers from Beijing and Shanghai
Bai, Fengshan — Tsinghua Univ.

Abstract: Review of IM2C Participating Teams and their Papers from Beijing and Shanghai

▶ MS-Fr-D-67-5 15:30–16:00
Review of IM2C Outstanding Papers
Qiao, Zhonghua — The Hong Kong Polytechnic Univ.

Abstract: Review of IM2C Outstanding Papers

MS-Fr-E-01 16:00–18:10 311A
The mathematical problems in information technology - Part II of II
For Part 1, see MS-Fr-D-01

Organizer: Chen, Xiuqing — Beijing Univ. of Posts & Telecommunications

Abstract: The aim of this mini-symposium is to bring together specialists in the fields of mathematical problems in information technology, to intensify the mathematical research on three important research fields as follows. 1. Differential equations in telecommunications, such as, solitary wave. 2. Probability and Statistics in information technology. 3. Optimization and Scientific Computation in telecommunications.

▶ MS-Fr-E-01-1 16:00–16:30
Analytic Study on Optical Solitons in Nonlinear Schrödinger Equation
Liu, Wenjun — Beijing Univ. of Posts & Telecommunications

Abstract: The propagation of optical solitons in optical fibers can be modeled by nonlinear Schrödinger equation (NLSE). The properties of solitons are presented, and the Hirota method is introduced. With the Hirota method, the bilinear forms for the NLSE are obtained, and the analytic one-soliton solution is derived.

▶ MS-Fr-E-01-2 16:30–17:00
Research on Network Coding Optimization Using Differential Evolution
Zhang, Liying — Beijing Univ. of Posts & Telecommunications

Abstract: Network coding can reduce the data transmission time and improves the throughput and transmission efficiency. However, network coding technique increases the complexity and overhead of network because of extra coding operation for information from different links. Therefore, network coding optimization problem becomes more and more important. In this paper, a new differential evolution variant is proposed to solve the network coding optimization problem based on simulated annealing and elitist parameter preserving strategy. Simulation experiments indicate its competitive performance based on various butterfly diagram network instances.

▶ MS-Fr-E-01-3 17:00–17:30
Preemptive Online Scheduling with Lp Norm on Three Identical Machines
Shuai, Tianping — Beijing Univ. of Posts & Telecommunications

Abstract: One of the basic and fundamental scheduling problems is to minimize the machine completion time vector in the lp norm. We concentrate on the on-line and preemptive version of this problem where jobs arrive one by one over a list to be allocated to three identical machines with job preemption permitted. We present an on-line scheduling algorithm for this problem. The competitive ratio is close to a lower bound derive from a MP formulation.

▶ CP-Fr-E-01-4 17:30–17:50
On A Mode-matching Analysis of 2D Flexible Waveguide Problems: Applications in Sound-structure Interaction
Nawaz, Rab — COMSATS Inst. of Information Tech. Islamabad

Abstract: The article concerned with a flexible duct scattering problem arising in structural acoustics. The structure is particularly used as a component in a hybrid silencer for heating ventilation and air-conditioning HVAC ducting systems. The material properties of duct sections are considered as the rigid and flexible. The application of the orthogonality relation is established whereas the mode-matching technique with the help of separation of variables enables the solution to the underlying structural problems. Finally the expressions for energy fl‡ux are investigated numerically.

▶ CP-Fr-E-01-5 17:50–18:10
Chain Blockers and Convoluted Catalan Numbers
Ahmad, Sarfraz — COMSATS Inst. of Information Tech., Lahore Campus

Abstract: For a poset P we say that a subset A in P is a chain blocker if any maximal chain in P contains exactly one element of A. We study the set of chain blockers for the class of posets $P = C_a X C_b$ where C_i is the chain 1 ¡ ... ¡ i. We identify some naturally defined classes of chain blockers that are enumerated by the k fold convolution of Catalan numbers. Thereby we give a new combinatorial interpretation of convoluted Catalan numbers.

EM-Fr-E-02 16:00–18:00 309A
Differential Algebra and Related Topics - Part VIII of VIII
For Part 1, see EM-Mo-D-02
For Part 2, see EM-Mo-E-02
For Part 3, see EM-Tu-D-02
For Part 4, see EM-Tu-E-02
For Part 5, see EM-We-D-02
For Part 6, see EM-We-E-02
For Part 7, see EM-Fr-D-02

Organizer: Feng, Ruyong — Acad. of Mathematics & Sys. Sci.,CAS
Organizer: Guo, Li — Rutgers Univ. at Newark, USA
Organizer: Gao, Xiao-Shan — Acad. of Mathematics & Sys. Sci., Chinese Acad. of Sci.

Abstract: This meeting is to offer an opportunity for participants to present original research , to learn of reserch progress and new developments on differential algebra and related topics, particularly, the applications of differential algebra to control theory, physics, chemistry, biology and so on.

▶ EM-Fr-E-02-1 16:00–16:30
Discrete Moving Frames
Mansfield, Elizabeth — Univ. of Kent

Abstract: I will outline a theory, developed with Gloria Mari Beffa, of discrete moving frames which has the same computational benefits for studying Lie group symmetric difference systems, as the smooth moving frame has for differential systems. This includes the use of generating sets of discrete invariants of Lie group actions with recurrence relations between them. Applications to the difference variational calculus will be indicated.

▶ EM-Fr-E-02-2 16:30–17:00
Binomial Difference Ideal and Toric Difference Variety
Chun-Ming, Yuan — AMSS, CAS
Gao, Xiao-Shan — Acad. of Mathematics & Sys. Sci., Chinese Acad. of Sci.

Abstract: In this talk, the concepts of binomial difference ideals and toric difference varieties are defined and their properties are proved. Four equivalent definitions for toric difference varieties are presented. Algorithms are given to check whether a given Laurent binomial difference ideal I is reflexive, prime, perfect, or toric, and in the negative case, to compute the reflexive and perfect

closures of I.

▶ EM-Fr-E-02-3 17:00–17:30

Differential Algebra and the Moduli Space of Products of Elliptic Curves

Freitag, James UC Berkeley

Abstract: It is a classically known fact the j-function satisfies a nonlinear third order differential equation. The structure of the solution set of this differential equation can be used to prove various arithmetic results about the moduli space, which we will discuss. The structure of the solution set also provided the answer to an old problem in the model theory of differential fields. This talk will emphasize the model theoretic tools used in our analysis. This

▶ EM-Fr-E-02-4 17:30–18:00

On the Existence of Differential Chow Varieties

Li, Wei Acad. of Mathematics & Sys. Sci., CAS

Abstract: Chow varieties are parameter spaces for algebraic cycles with given dimension and degree. We establish their differential analogs for differential algebraic cycles, answering a question proposed by Gao-Li-Yuan in their work on differential Chow form. The proof uses the construction of classical Chow varieties, the model theory of differential fields, characteristic set methods, the theory of prolongation spaces, and the theory of differential Chow forms. This is joint work with James Freitag and Tom Scanlon.

MS-Fr-E-03 16:00–18:00 306A

Propagation Phenomena of Reaction-Diffusion Models in Biology - Part IV of IV

For Part 1, see MS-Th-D-03
For Part 2, see MS-Th-E-03
For Part 3, see MS-Fr-D-03

Organizer: Li, Wan-Tong Lanzhou Univ.
Organizer: Ruan, Shigui Univ. of Miami

Abstract: With the tide of globalization, biological invasions and pathogen transmission, which in turn can affect ecosystem or threaten public health, become focal spots in literature. In mathematical biology, there are many reaction-diffusion models arising from various applications such as animal dispersal, geographic spread of epidemics. To model/illustrate these problems/phenomena and investigate/evaluate the corresponding control strategy, it has been proved that the corresponding propagation modes are very important and useful. This minisymposium focus on the recent advances of propagation phenomena of different reaction-diffusion models in biology. In particular, the traveling wave solutions, asymptotic spreading, entire solutions, generalized transmission and threshold dynamics with their applications of reaction-diffusion models will be discussed.

▶ MS-Fr-E-03-1 16:00–16:30

The Evolution of Traveling Waves in A Simple Isothermal Chemical System Modelling Quadratic Autocatalysis with Strong Decay

Tsai, Je-Chiang Chung-Cheng Univ. & Advanced Inst. of Manufacturing with High-tech Innovations

Abstract: We study a reaction-diffusion system for an isothermal chemical reaction scheme governed by a quadratic autocatalytic step A + B →2B and a decay step B →C, where A, B, and C are the reactant, the autocatalyst, and the inner product, respectively. We explore the traveling waves generated by this reaction.

▶ MS-Fr-E-03-2 16:30–17:00

The Stability of Higher Dimensional Traveling Waves for A Degenerate Fisher Equation

Wu, Yaping Capital Normal Univ.

Abstract: It's a joint work with Junfeng He. In this talk we shall talk abut our recent work on the local and global stability of cylinder waves with critical and noncritical speeds for the degenerate Fisher equation in some exponentially weighted spaces and the asymptotic behavior of solutions of with more general initial values.

▶ CP-Fr-E-03-3 17:00–17:20

Numerical Methods of Rational Form for for Solving PDEs

Algarni, Said King Fahd Univ. of Petroleum & Minerals

Abstract: The purpose of this study was to investigate select numerical methods that demonstrate good performance in solving PDEs that couple diffusion and reaction terms. These types of equations have numerous fields of application such as environmental studies, biology, chemistry, medicine, and ecology. Our aim was to investigate and develop accurate and efficient approaches which compare favourably to other applicable methods. In particular, we investigated and adapted a relatively new class of methods based on rational polynomials. Namely, Pad′ e time stepping (PTS), which is highly stable for the purposes of the present application and is associated with lower computational costs. Furthermore, PTS was optimized for our study to focus on reaction diffusion equations. Due to the rational form of PTS method, a local error control threshold (LECT) was proposed. Numerical runs were conducted to obtain the optimal LECT.

▶ CP-Fr-E-03-4 17:20–17:40

An Optimal Adaptive Mesh Strategy for Convection Dominant Diffusion Problems

Aggarwal, Vivek Delhi Technological Univ.
Srinivasan, Balaji Indian Inst. of Tech.

Abstract: In this paper, a new adaptive mesh strategy has been developed for solving SPP with higher order central schemes. Our strategy uses a novel, entropy-like variable as the adaptation parameter for convection diffusion SPP. Further, unlike the popular Bakhvalov and Shishkin type meshes, no pre-knowledge of the location and width of the layers (boundary as well as interior) is needed. The method is completely free of arbitrary perturbation parameters.

MS-Fr-E-04 16:00–18:00 308

Topological Data Analysis and Dynamics II

Organizer: Hiraoka, Yasuaki Tohoku Univ.
Organizer: Mischaikow, Konstantin Rutgers Univ.
Organizer: Kokubu, Hiroshi Kyoto Univ.
Organizer: Nishiura, Yasumasa Tohoku Univ., WPI-AIMR

Abstract: This is the second half of the multiple minisymposiums "Topological Data Analysis and Dynamics I & II". The purpose of this multiple minisymposiums is to collect researchers studying theory, computations, and applications of topological data analysis (TDA). TDA is a rapidly growing research field, and offers powerful geometric and topological tools to understand complicated data sets, time series, dynamics, and so on. In this second half of the multiple minisymposiums, we aim to apply methods of TDA into physical sciences such as glasses, grains, and fluids in order to understand complicated dynamics behind them.

This minisymposium is organized as follows. The first speaker Takenobu Nakamura (Tohoku University) will give a talk about applications of TDA into amorphous silica. His recent research shows two important new discoveries: (1) The dimensions of supports of persistence diagrams computed on alpha filtrations of atomic arrangements clearly distinguish crystal (0 dim), glass (1 dim), and liquid (2 dim) states, (2) The rings in the atomic arrangement of glass states possess a hierarchical structure. The second speaker Miro Kramar (Rutgers University) will give a talk about applications of TDA to fluid dynamics and pattern formations appearing in Rayleigh-Benard convection. In this research, he transforms experimental or numerical data into a point cloud in the space of persistence diagrams. By choosing different metrics, one can interrogate the pattern locally or globally, which provides deeper insight into the dynamics of the process of pattern formation. The third speaker Mohammad Saadatfar (Australian National University) will give a talk about applications of TDA into granular dynamics. He is an experimentalist of 3 dimensional granular systems, and recent his researches show some of the key geometric configurations of grains such as 5-rings to understand amorphous and crystal packing states. He also starts to apply TDA to study his experimental results and makes clear phase transitions in grain packings. The fourth speaker Yuan YAO (Peking University) will talk about several methods for high dimensional data analysis. In particular, he will show some recent results on statistical ranking and combinatorial Hodge theory.

▶ MS-Fr-E-04-1 16:00–16:30

Persistent Homology and Many-Body Atomic Structure for Medium-Range Order in the Glass

NAKAMURA, TAKENOBU WPI-AIMR Tohoku Univ.
Hiraoka, Yasuaki Tohoku Univ.
Escolar, Emerson Kyushu Univ.
Nishiura, Yasumasa Tohoku Univ., WPI-AIMR

Abstract: We introduce a new topological tool, persist diagram (PD) to characterize medium-range order (MRO), which is difficult to describe because of its many-body atomic structure. The presented method can elucidate the hierarchical structure of MRO. We explain several concepts appeared in PD first by applying it to perfect crystalline and random structures. Based on these concepts, we describe the atomic structure of an amorphous silica.

▶ MS-Fr-E-04-2 16:30–17:00

Analyzing the Dynamics of Pattern Formation in the Space of Persistence Diagrams

Kramar, Miroslav — Ruters

Abstract: Persistence diagrams are a relatively new topological tool for describing and quantifying complicated patterns in a simple but meaningful way. We will demonstrate this technique on patterns appearing in Rayleigh-Benard convection. This procedure allows us to transform experimental or numerical data from experiment or simulation into a point cloud in the space of persistence diagrams. There are a variety of metrics that can be imposed on the space of persistence diagrams. By choosing different metrics

▶ MS-Fr-E-04-3 17:00–17:30

Social Choice Theory and Hodge Decomposition

Yao, Yuan — Peking Univ.

Abstract: Voting has been an important topic for human activities and a central theme in the social choice theory in Economics, featured with the celebrated Impossibility Theorems by Nobel Laureates Ken Arrow and Amartya Sen. Hodge decomposition, a bridge between algebraic topology and geometry, provides us some best possible out of impossibilities, balancing between the faithful representation of individuals and the desire for consistent social orders.

▶ MS-Fr-E-04-4 17:30–18:00

Mathematical and Physical Characterisation of Microstructured Materials Based on Their 3D Images.

Saadatfar, Mohammad — Australian National Univ. (ANU)
Takeuchi, Hiroshi — Tohoku Univ.
Hiraoka, Yasuaki — Tohoku Univ.

Abstract: Cellular solids and granular materials have some specific properties, which set them apart from conventional solids. Properties such as collapse bands in cellular materials under loading or shear banding and dilatancy in granular systems require detailed geometrical and topological knowledge of the materials structure combined with their physical properties. Utilising mathematical tools such as Minkowski functional and Persistent Homology, we show how such detailed information can be obtained from complex structures.

MS-Fr-E-05 16:00–18:00 215

Geometric Understanding of Data in 3D and Higher - Part III of III

For Part 1, see MS-Th-E-05
For Part 2, see MS-Fr-D-05

Organizer: Lai, Rongjie — Rensselaer Polytechnic Inst.
Organizer: Zhao, Hongkai — UC Irvine

Abstract: Rapid development of data acquisition technology stimulates research on developing new computational tools for analyzing and processing data to make more effective decisions. In many problems, coherent structures of data allows us to model data as a low dimension manifold in a high dimension space. More recently, there has been increasing interests in using geometric based method to analyze and infer underlying structures from the given data. This minisymposium aims to bring together people from different research groups with common interest. We hope that this symposium can propel further collaborations and developments in this field.

▶ MS-Fr-E-05-1 16:00–16:30

High-genus Surface Registration and Its Applications to Medical Imaging

LUI, Lok Ming Ronald — The Chinese Univ. of Hong Kong

Abstract: We present a method to obtain the registration between high-genus surfaces. The high-genus topology of the surfaces poses great challenges for surface registration. Conventional approaches partition surfaces into simply-connected patches and registration is done by a patch-by- patch manner. Consistent cuts are required, which are difficult to obtain and prone to error. This talk presents a method to handle the registration problem for high-genus surfaces without introducing consistent cuts.

▶ MS-Fr-E-05-2 16:30–17:00

A Discrete Uniformization Theorem for Polyhedral Surfaces

Gu, Xianfeng — Stony Brook Univ.

Abstract: A discrete conformality for polyhedral metrics on surfaces is introduced in this wprl which generalizes earlier work on discrete surface Ricci flow. It is shown that each polyhedral metric on a surface is discrete conformal to a constant curvature polyhedral metric which is unique up to scaling. Furthermore, the constant curvature metric can be found using a discrete Yamabe flow with surgery.

▶ MS-Fr-E-05-3 17:00–17:30

Geometric Methods for Graph Partitioning

Osting, Braxton — Univ. of Utah
Zosso, Dominique — UCLA Mathematics

Abstract: Several geometric methods for graph partitioning have been introduced in the past few years, with wide applications in clustering, community detection, and image analysis. In this talk, I'll discuss a new graph partitioning method where the optimality criterion is given by the sum of the Beltrami energies of the partition components, a quantity which appears in the study of minimal surfaces.

MS-Fr-E-06 16:00–18:00 201

Data-driven methods for quantifying uncertainty of multiscale dynamical systems - Part IV of IV

For Part 1, see MS-Th-D-06
For Part 2, see MS-Th-E-06
For Part 3, see MS-Fr-D-06

Organizer: Harlim, John — The Pennsylvania State Univ.
Organizer: Sapsis, Themistoklis — MIT
Organizer: Giannakis, Dimitrios — New York Univ.

Abstract: A major challenge in contemporary applied science is to design efficient models for predicting dynamical behavior resulting from complex interaction of multiple scale processes. This task, implicitly, requires one to account for uncertainties of the models due to initial conditions, boundary conditions, model errors, and observation errors. A promising interdisciplinary approach to address such issue is with a data-driven statistical methods that combine ideas from dynamical systems theory, stochastic processes, statistics, and data analysis. This special session aims to bring together researchers from across the spectrum of disciplines related to data-driven methods to discuss the development and application of emerging ideas and techniques for these important and difficult practical issues.

▶ MS-Fr-E-06-1 16:00–16:30

Predicting Chaotic Network Time Series with A Partial Model

Sauer, Timothy — George Mason Univ.

Abstract: Methods for forecasting time series are a critical aspect of the understanding and control of dynamical networks. When an explicit model of the system is unknown, nonparametric methods for prediction have been developed, based on concepts of attractor reconstruction pioneered by Takens and others. We consider how to make use of a subset of the system equations, if they are known, to improve the predictive capability of forecasting methods.

▶ MS-Fr-E-06-2 16:30–17:00

On Anomalous Diffusion in Weakly Chaotic Deterministic Systems

Gottwald, Georg — Univ. of Sydney

Abstract: We present a universal view on diffusive behaviour in spatially extended systems and establish links between weak chaos and Levy processes. Furthermore, we establish stochastic limit systems driven by Levy noise from deterministic multi-scale systems driven by weakly chaotic fast dynamics. We then use these results to devise a method to construct one- and two-sided alpha-stable processes with specified parameter values. This is joint work with Ian Melbourne.

▶ MS-Fr-E-06-3 17:00–17:30

Sampling Approaches to Non-Gaussian Data Assimilation

Sandu, Adrian — Virginia Tech

Abstract: Current operational ensemble-based filters like Ensemble Kalman Filter (EnKF), and Maximum Likelihood Ensemble Filter (MLEF), could fail in case of non-linear obser- vations or non-Gaussian distributions. We discuss general data assimilation methods that work by sampling directly from the posterior distribution using a Hybrid Monte Carlo (HMC) approach. Numerical tests show the promise of he proposed filter and smoother.

▶ MS-Fr-E-06-4 17:30–18:00

Quantification and Prediction of Rare Events in Nonlinear Water Waves

Sapsis, Themistoklis — MIT

Abstract: The scope of this work is the development, application, and demonstration of probabilistic methods for the quantification and prediction of extreme events occurring in complex nonlinear systems involving water waves. We are interested to address two specific topics related to rare events in complex dynamical systems, namely i) the Rare Event Prediction Problem and ii) the Rare Event Quantification Problem).

MS-Fr-E-07 16:00–18:00 202A

Recent Developments in Modeling and Numerical Simulations of Geophysical Flows - Part II of II

For Part 1, see MS-Fr-D-07

Organizer: Alina, Chertock North Carlina State Univ.
Organizer: Kurganov, Alexander Tulane Univ.
Organizer: Lukacova, Maria Univ. of Mainz, Inst. of Matehmatics

Abstract: This minisymposium focuses on complex problems arising from geophysical flows and their numerical simulations. The models are typically governed by hyperbolic systems of conservation and balance laws, which are difficult to be solved numerically due to the presence of (possibly singular) geometric source terms, nonconservative exchange terms as well as multiscale phenomena in singular limit cases. These may lead to the loss of hyperbolicity, nonlinear resonance, very complicated wave structures and, as a result, to appearance of spurious oscillations and slow convergence of numerical methods. Therefore accurate modeling and development of robust, highly accurate and efficient numerical methods for these systems is a very important and challenging task.
The organizers of the minisymposium are: Alina Chertock, Alex Kurganov and Maria Lukacova-Medvidova

▶ MS-Fr-E-07-1 16:00–16:30

Numerical Simulation of Shallow Water Equations on Sphere by the GRP Scheme

Li, Jiequan Beijing Normal Univ.

Abstract: We will talk about our recent contribution on the numerical simulation of atmospherical motion using the model of shallow water equations on the earth. The generalized Riemann problem (GRP) scheme is used to capture the effect of Criolis force and preserve the well-balanced property.

▶ MS-Fr-E-07-2 16:30–17:00

A Well-balanced Scheme for the Shallow-water Equations with Topography and Bottom Friction.

Michel-Dansac, Victor Universite de Nantes
Berthon, Christophe Universite de Nantes
Foucher, Françoise Ecole Centrale de Nantes
Clain, Stephane Universidade do Minho

Abstract: We consider the shallow-water equations with topography and Manning friction source terms. This system admits strongly nonlinear steady states, which present particular challenges from a numerical point of view. We derive a well-balanced Godunov-type scheme for this model, i.e. a scheme able to exactly capture the stationary solutions. In addition, we establish that this scheme has robustness properties. Moreover, the derived numerical method turns out to be relevant in the approximation of wet/dry transitions.

▶ MS-Fr-E-07-3 17:00–17:30

The New Semi-Implicit Runge-Kutta Methods and Their Applications in Shallow Water Equations with Friction Terms

Wu, Tong Tulane Univ.

Abstract: We develop a family of second-order semi-implicit time integration methods for systems of ordinary differential equations (ODEs) with stiff damping term, which is capable of exactly preserving the steady states and maintaining the sign of the computed solution. We implement the proposed SSP-RK based semi-implicit methods on a system of ODEs arising from the semi-discretization of the shallow water equations with friction terms and achieve a remarkable agreement between the numerical results and experimental data.

▶ MS-Fr-E-07-4 17:30–18:00

On Hydrostatic Reconstruction (HR) Schemes for the Shallow Water Equation

Noelle, Sebastian RWTH Aachen Univ.

Abstract: A key difficulty in the analysis and numerical approximation of the shallow water equations is the non-conservative product of measures. Solutions may be non-unique, and numerical schemes make an implicit decision how to model the physics. We present a systematic derivation of HR schemes, including a new scheme which borrows its structure from the wet-dry front, and compares well with previous schemes. This is joint work with Guoxian Chen, Wuhan University.

MS-Fr-E-08 16:00–18:00 202B

Success Stories of Spanish Industrial Mathematics with Industry

Organizer: Quintela, Peregrina Spanish Network for Mathematics & Industry; Univ. of Santiago de Compostela

Abstract: The minisymposium “Success Stories of Spanish Industrial Mathematics with Industry” will emphasize the importance of the mathematical methods and techniques in the resolution of industrial problems. To do that, it will be presented four success stories between Spanish research groups in Industrial Mathematics and companies. To show that Mathematical technology is present at all economic sectors, examples of collaborations has been selected in four different sectors which are: Environment, Space, Materials and Transport. Each speaker will explain the improvements to achieve a successful implementation in companies. The first project was conducted under contract with the Kaleido Ideas & Logistics Company. The objective was to determine a lashing solution for granite sheets during sea transport into containers complying with IMO standards for stowage and safety. The design is focused on the sheets packaging, the bundles location, and the slings necessary to tie them to the container, so that the cargo remains immobilized under adverse conditions of navigation. The second success case will present the strategy implemented in the Italian TEWS (Tsunami Early Warning System) concerning tsunami simulations using tsunami-HySEA model developed by EDANYA Group implemented on GPUs. This model takes into account the three phases of an earthquake generated tsunami: generation, propagation and coastal inundation, and combines finite difference and finite volume schemes, providing a complete simulation on the Mediterranean basin in less than five minutes of computational time. Most Earth satellites observation decouple the acquisition of a panchromatic (grayscale) image at high spatial resolution from the acquisition of a multispectral image at lower spatial resolution. The pansharpening problem refers to the fusion process of inferring a high-resolution multispectral image from a high-resolution panchromatic image and a low-resolution multispectral one. To solve it, in the third talk, a functional model that incorporates a nonlocal regularization term and two fidelity terms will be proposed. Finally, the goal of the fouth succes case will be to enable on-the-fly recommendations for technological conditions in polymerization processes. The focus is on algorithms for prediction of particle morphology development and polymer branching. The work has been done in collaboration with Basque Center for Macromolecular Design and Engineering (POLYMAT), a long term partner of the chemical companies Arkema, BASF and Solvay.

▶ MS-Fr-E-08-1 16:00–16:30

A New Mathematical Model for Pansharpening Satellite Images

Coll Vicens, Bartomeu Univ. of Balearic Islands
Buades, Antonio universitat illes balears
Duran, Joan Univ. of Balearic Islands
Sbert, Catalina Universitat de les Illes Balears

Abstract: Most Earth satellites observation decouple the acquisition of a panchromatic (grayscale) image at high spatial resolution from the acquisition of a multispectral image at lower spatial resolution. The pansharpening problem refers to the fusion process of inferring a high-resolution multispectral image from a high-resolution panchromatic image and a low-resolution multispectral one. To solve it, we propose a functional model that incorporates a nonlocal regularization term and two fidelity terms.

▶ MS-Fr-E-08-2 16:30–17:00

Numerical Simulation of Lashing Solutions for Containerized Transport of Granite Sheets

Quintela, Peregrina Spanish Network for Mathematics & Industry; Univ. of Santiago de Compostela
Barral, Patricia Univ. of Santiago de Compostela
Rial, Angel Univ. of Santiago de Compostela

Abstract: A project conducted under the contract with the Kaleido Ideas & Logistics Company will be presented. The objective was to determine a lashing solution for granite sheets during sea transport into containers complying with IMO standards for stowage and safety. The design is focused on the sheets packaging, the bundles location, and the slings necessary to tie them to the container, so that the cargo remains immobilized under adverse conditions of navigation.

▶ MS-Fr-E-08-3 17:00–17:30

Mathematical Modelling of Polymers Particles Production

Rusconi, Simone BCAM - Basque Center for Applied Mathematics
Akhmatskaya, Elena BCAM - Basque Center for Applied Mathematics
Dutykh, Denys CNRS
Sokolovski, Dmitri Univ. of Basque Country
Asua, Jose M POLYMAT, Univ. of the Basque Country UPV/EHU

Abstract: We present the novel stochastic approach for polymers particles production modelling and numerical simulations amenable to high performance computing. The goal is to enable on-the-fly recommendations for technological conditions in polymerization processes. The focus is on algorithms for prediction of particle morphology development. The work has been done in collaboration with Basque Center for Macromolecular Design and Engineering (POLYMAT), partner of a consortium of companies including some of the

major producers of dispersed polymers.

▶ MS-Fr-E-08-4 17:30–18:00

HySEA-tsunami, A Faster Than Real Time Tsunami Model and Its Implementation in the Italian Tsunami Early Warning System

Castro Diaz, Manuel J — Univ. of Malaga

Abstract: In this talk we present the strategy implemented in the Italian TEWS (Tsunami Early Warning System) concerning tsunami simulations using tsunami-HySEA model developed by EDANYA Group implemented on GPUs. This model takes into account the three phases of an earthquake generated tsunami: generation, propagation and coastal inundation, and combines finite difference and finite volume schemes, providing a complete simulation on the Mediterranean basin in less than five minutes of computational time.

MS-Fr-E-09 16:00–18:00 203A

Mathematical Modeling and the analysis in dissipative systems - Part II of II

For Part 1, see MS-Fr-D-09

Organizer: EI, SHIN-ICHIRO — Hokkaido Univ.
Organizer: Nagayama, Masaharu — Hokkaido Univ.

Abstract: In this minisymposium, we aim to merge mathematical modeling and the theoretical analysis for phenomena arising in dissipative systems including chemical reactions and biological systems by introducing from each field both of models for real phenomena and techniques for nonlinear differential equations. As mathematical models, we deal with nonlinear parabolic equations of reaction-diffusion types and higher dimensional ODEs. Through the interaction between modeling and mathematical techniques, many joint works with researchers from both fields are expected.

▶ MS-Fr-E-09-1 16:00–16:30

Conservation Breaking Dynamics in Reaction-diffusion Systems

Kuwamura, Masataka — Kobe Univ.

Abstract: In reaction-diffusion systems with a mass conservation property, a spatial pattern induced by the diffusion-driven (Turing type) instability can eventually approach a simple localized pattern after exhibiting long transient dynamics. This study investigated the perturbed reaction-diffusion systems of such conserved systems. The results provide interesting examples of spatio-temporal dynamics in reaction-diffusion systems. This work is based on a joint work with Prof. Yoshihisa Morita.

▶ MS-Fr-E-09-2 16:30–17:00

A Mathematical and Experimental Study on Jet Lag: Why is Eastbound Trip So Hard?

Kori, Hiroshi — Ochanomizu Univ.

Abstract: I will report on a mathematical and experimental study on jet lag. After giving a short review of our experimental study, mathematical interpretation will be provided. Here, the body clock is described as periodically forced phase oscillators. I found that, using perturbation theory, periodic forcing generally has an effect of slowing down relaxation time for the phase advance of external force. Effect of coupling between oscillators will also be discussed.

▶ MS-Fr-E-09-3 17:00–17:30

Mathematical Modeling and Genetic Analysis of the Wave of Differentiation

Sato, Makoto — Kanazawa Univ.
Miura, Takashi — Kyushu Univ. Graduate School of Medicine
Nagayama, Masaharu — Hokkaido Univ.

Abstract: Notch-mediated lateral inhibition is found in various developmental processes. However, how it behaves when combined with the other signaling systems is not understood in detail. By combining mathematical modeling and genetic analysis, we demonstrate that it plays an unexpected role in combination with EGF signaling in the course of proneural wave progression during development of the Drosophila visual center.

▶ MS-Fr-E-09-4 17:30–18:00

Formation of Fractal Structure in Skull Suture

Miura, Takashi — Kyushu Univ. Graduate School of Medicine

Abstract: Skull suture is also regarded as an example of fractal structure in biology. In the present study, we show the time course observation of human skull suture using 3DCT. Next we propose a new model that couples interface equation with nonlinear diffusion to reproduce fractal structures in numerical simulation. We also present scaling argument of this system to show the system can generate fractal structure.

MS-Fr-E-10 16:00–18:00 206B

Stochastic Dynamics with Applications - Part III of III

For Part 1, see MS-Th-E-10
For Part 2, see MS-Fr-D-10

Organizer: Duan, Jinqiao — Illinois Inst. of Tech

Abstract: Nonlinear systems are often under random influences. The uncertainties may be due to external fluctuations or unresolved scales. These random influences may affect system evolution at various spatial and temporal scales, subtly or profoundly. Taking uncertainty into account is essential in modeling various complex phenomena in biological, physical and chemical systems.
The objective of this special session is to bring together experts from multiple disciplines with complementary views and approaches to stochastic dynamics in the context of applications.
The topics to be discussed include: Overview of stochastic dynamics, stochastic approaches for multi-scale modeling, impact of noise, non-Gaussian dynamics, statistical physics near or out of equilibrium, adaptive dynamics, biological modeling, stochastic modeling in systems biology

▶ MS-Fr-E-10-1 16:00–16:30

Mild Solutions of Time-dependent Neutral Stochastic Evolution Equations with Jumps under Non-Lipschitz Condition

Xu, Yong — Northwestern Polytechnical Univ.
Pei, Bin — Northwestern Polytechnical Univ.

Abstract: In this paper, we consider a class of time-dependent neutral stochastic evolution equations with Markovian switching and jumps under non-Lipschitz condition. We prove an existence and uniqueness result for the mild solution by means of the Banach fixed point principle.

▶ MS-Fr-E-10-2 16:30–17:00

Dynamics of Stochastic Gene Transcription under Stimulus and Negative Regulations

Ren, Jian — Guangzhou Univ.

Abstract: Gene transcription in single cells is a stochastic process. The transcription process randomly switches between active state and inactive state. Under a two-state two-pathway model, we consider the internal stochastic mechanism of the selection of the basal pathway and the signal transduction pathway. By simulations we illustrate the difference of the dynamics of transcription between the deterministic alternation of signal transduction pathway and basel pathway and random selection of them.

▶ CP-Fr-E-10-3 17:00–17:20

The Stability of Cellular Automata Revisited

Baetens, Jan — Ghent Univ.
De Baets, Bernard — Ghent Univ.

Abstract: Despite the efforts spent on an elucidation of the dynamics of cellular automata (CA), i.e. simple mathematical models that are discrete in all senses, it is not yet clarified to what extent their specificities affect their dynamical properties. By means of non-directional (topological) Lyapunov exponents and Lyapunov profiles, which typically can only be obtained numerically, we show how the update method and CA topology affect the stability of CAs.

▶ CP-Fr-E-10-4 17:20–17:40

Growth Dynamics for Pomacea Maculata

Zhao, Lihong — Univ. of Louisiana at Lafayette

Abstract: Pomacea maculata is a relatively new invasive freshwater snail in the Gulf of Mexico region and potentially threatens local agriculture (rice) and ecosystems (aquatic vegetation). The population dynamics of Pomacea maculata have largely been un-quantified. We discuss insights gained re- garding the applesnails growth dynamics from a closed population. Due to large intra- and inter- individual variability, direct measurement of these rates was possible, but the population size was too small to yield estimates with reasonable statistical support. However, we were able to use a model comparison statistic to determine that there are distinct growth stages. Further, these data strongly suggest that male and female growth dynamics, size distributions, and overall weights, are notably different. We performed simulation studies based on knowledge of observed variability, and use these models to design additional lab experiments and field studies.

CP-Fr-E-11 16:00–18:00 203B

Hydrodynamic modeling

Chair: Zvyagin, Victor — Voronezh State Univ.

Abstract:

▶ CP-Fr-E-11-1 16:00–16:20

Theory of Attractors of Non-Newtonian Hydrodynamic Equations

Zvyagin, Victor Voronezh State Univ.

Abstract: In this report the theory of attractors is devoted to investigation of the asymptotic behavior as $t \to \infty$ of weak solutions of hydrodynamic equations describing the dynamics of incompressible fluids. Here we have used the concept of a trajectory attractor. It is effective tool for studying situations were there is no uniqueness of the corresponding boundary value problem solutions.
In the report the new approach of the investigation of attractors for non-Newtonian fluids will be considered.
Some examples of a viscoelastic media hydrodynamics for which the existence of attractors is established on the basis of the developed theory are considered. We present the example on the existence theorem of attractors for Oldroyd models of viscoelastic media motion with memory, for low concentrated aqueous polymer solution motion model, for Bingam model.
In this report the theory of pullback-attractors of weak solutions for hydrodynamic equations is also considered.

▶CP-Fr-E-11-2 16:20–16:40

3D Hydrodynamic Mathematical Modeling and Simulations for Cell Morphology and Mitotic Dynamics

Zhao, Jia Univ. of South Carolina
Wang, Qi Univ. of South Carolina & Beijing Computational Sci. Research Center

Abstract: Cells are the fundamental unit in all living organisms since animals and plants are all made up of cells of different varieties. The study of cells is therefore an essential part of research in biological science and medicine.
Recently, we have developed a framework of 3D hydrodynamic models studying the cell morphology and its mitotic dynamics by a multi-phase field approach. Quantitatively patterns of wrinkling cell morphology, mitotic cell rounding and cytokinesis have been observed. In this talk, our results on the mechanism and controlling factors guiding these interesting phenomenon would be addressed. 3D numerical simulations will be shown, as well.

▶CP-Fr-E-11-3 16:40–17:00

Modeling of driver's characteristics in a two-lane Lattice hydrodynamic traffic flow model

Sharma, Sapna DAV Univ. Jalandhar

Abstract: Due to modernization, the rapid increase of automobiles on roads leading to a serious problem of traffic congestion attracted much attention of scientists and researchers, recently. This study deals with the development of a new two-lane lattice hydrodynamic traffic flow model by considering the aggressive or timid characteristics of driver's behavior. The lane changing is allowed from one lane to another. The effect of driver's characteristic on the stability of traffic flow is examined through linear stability analysis. To describe the propagation behavior of a density wave near the critical point, nonlinear analysis is also conducted and modified Korteweg-de Varies (mKdV) equation representing kink-antikink soliton is derived. The effect of anticipation parameter on traffic flow dynamics is investigated and found that it has a significant effect on the stability of two-lane traffic flow. Numerical simulation is performed and the results are found consistent with the theoretical findings.

▶CP-Fr-E-11-4 17:00–17:20

Melting Heat Transfer in MHD Non-Darcy Flow of A Nanofluid over A Shrinking Surface in the Presence of Thermal Radiation with Second Order Slip Flow Model

Ganesh, N. Vishnu Sri Ramakrishna Mission Vidyalaya CAS,Coimbatore - 20
A.K., Abdul Hakeem Sri Ramakrishna Mission Vidyalaya CAS

Abstract: The present paper is devoted to study the melting heat transfer and second order velocity slip effects on an incompressible magnetohydrodynamic non-Darcy boundary layer flow of a water based nanofluid over a shrinking surface embedded in a porous medium in the presence of thermal radiation and internal heat generation/absorption. Scaling group of transformations is used to convert the governing nonlinear PDEs to nonlinear ODEs. The analytical solutions are derived for both momentum and energy equations for a special case. The problem is solved numerically by the fourth- order Runge-Kutta method with shooting technique. Dual solutions are obtained for momentum equation which is classified as upper and lower branch solutions. The effects of various physical parameters on the velocity and temperature profiles, local skin friction coefficient and the reduced Nusselt number are discussed. Comparisons are found to be good with previously published results.

▶CP-Fr-E-11-5 17:20–17:40

Computer Extended Series Solution for Spherical Couette Flow

Tettamanti Boshier, Florencia Imperial College London
Moore, Daniel Imperial College London
Mestel, Jonathan imperial College London

Abstract: Incompressible, viscous flows in the spherical gap between differentially rotating concentric spheres arise naturally in several engineering, geophysical and astrophysical scenarios. Moreover, they exhibit properties of interest in hydrodynamic stability and bifurcation theory. Multiple steady flow patterns are known to exist at Reynolds numbers which depend on the gap geometry and velocity differential, in a manner similar to cylindrical Taylor vortices.
Typically, this bifurcation structure has been studied by numerical path continuation techniques. Instead, we use computer extended series as pioneered by Van Dyke. This approach represents the flow as a power series in the Reynolds number. The convergence of this series is limited by a complex singularity. We analytically continue the series by generalised Pad' e approximants as introduced by Drazin & Tourigny, which are able to detect multiple solution branches. The results are compared with direct numerical results.

MS-Fr-E-12 16:00–18:00 208B

Orthogonal Polynomials, Special Functions, and their Applications - Part III of III

For Part 1, see MS-Th-E-12
For Part 2, see MS-Fr-D-12

Organizer: Qiu, Weiyuan Fudan Univ.
Organizer: Wong, Roderick City Univ. of Hong Kong
Organizer: Zhang, Lun Fudan Univ.
Organizer: Zhao, Yuqiu Sun Yat-sen Univ.

Abstract: Special functions and orthogonal polynomials is a very classical subject with numerous applications in both pure and applied mathematics. Tremendous progresses in this area have been achieved recently and new connections with other research areas such as random matrices, Riemann-Hilbert problems, etc. have been found. It is the aim of this minisymposim to provide a forum for researchers with diverse backgrounds whose research interests overlap with special functions and orthogonal polynomials. The speakers will report the latest developments in these areas, exchange their expertise, experience and insights. We hope this minisymposium will strengthen the connections among people in the relevant areas and stimulate future research.

▶MS-Fr-E-12-1 16:00–16:30

Q-partial Differential Equations and Q-polynomials

Liu, Zhiguo East China Normal Univ.

Abstract: A q-partial differential equation is an equation that contains unknown multivariable functions and their q-partial derivatives. This subject has not been well studied and explored in the community.
In this talk, we will introduce a system of q-partial differential equations and discuss its relation with q-polynomials.

▶MS-Fr-E-12-2 16:30–17:00

The Riemann-Hilbert Approach to Global Asymptotics of Discrete Orthogonal Polynomials with Infinite Nodes

Ou, Chunhua Memorial Univ.

Abstract: We develop the Riemann-Hilbert approach to study the global asymptotics of the Charlier polynomials. Three Airy-type asymptotic expansions for $C_n^{(a)}(z)$ in three different but overlaping regions are produced. The results are completely new, and one of them answers a question raised in Bo and Wong (Methods Appl. Anal., 1994). Asymptotic formulas are also derived for large and small zeros of the Charlier polynomials.

▶CP-Fr-E-12-3 17:00–17:20

An Optimal NSPRK Method with Improved CPML Boundary Condition for Solving Seismic Wave Equations

Ma, Xiao Northwestern Polytechnical Univ.
Yang, Dinghui Tsinghua Univ.

Abstract: The nearly-analytic symplectic partitioned Runge-Kutta (NSPRK) method is a type of finite difference method for solving seismic wave equations. It uses the fourth- or higher-order nearly-analytic discrete (NAD) operators to discretize the high-order spatial derivatives in the Hamiltonian PDEs, and then employs the conventional symplectic partitioned Runge-Kutta (SPRK) method to solve the resulted Hamiltonian ODEs after spatial discretization. Compared to conventional symplectic methods for wave equations, the NSPRK is numerically lower-dispersive on coarse grids and can therefore greatly save computational cost while used in large-scale modelings. However, the accumulation of conventional SPRK's phase error can lead to serious phase drift after long-time iterations, therefore undermines the phase accuracy of NSPRK. In order to resolve this issue, in this paper, we

first propose a series of SPRK with optimized coefficients which lead to minimized phase error, then we apply the new SPRK in NSPRK to obtain optimal NSPRK.. The phase drift issue of conventional SPRK in long-time simulations, and further improve the phase accuracy of NSPRK, Theoretical analysis shows, that compared to NSPRK, the new optimal NSPRK is more loose on stability criteria and more accurate on numerical dispersion. Numerical experiments also verify that the new SPRK can much better conserve the phase information of Hamiltonian systems. On the other hand, for the effective use of NSPRK-type methods in wave simulation in unbounded media, we propose a new convolutional perfectly matched layer (CPML) with improved absorption effect. In the new CPML, we introduce damping profile and phase transition functions formalized by high-degree polynomials. This technique can better reduce the numerical reflection at the boundary of computational and PML domains. Finally, several numerical simulations show that the combination of optimal NSPRK and the improved CPML is efficient.

▶ CP-Fr-E-12-4 17:20–17:40

Fast Computation of Conformal Slit Maps

Nasser, Mohamed M S — King Khalid Uinversity

Abstract: Conformal slit maps have several applications to problems in physics, engineering, and mathematics. In this talk, we review the author's method for approximating the conformal mappings from multiply connected domains of finite connectivity onto more than forty canonical slit domains. The method is based on a boundary integral equation with the generalized Neumann kernel with only the right-hand side of the integral equation is different from one canonical domain to another. For domains of connectivity $m+1$, the Nysröm method with the trapezoidal rule using n nodes in each boundary component yield an $(m+1)n \times (m+1)n$ linear system which is solved by a combination of the GMRES and FMM in $O((m+1)n \ln n)$ operations. The obtained numerical results illustrate that the presented method has the ability to handle efficiently and accurately domains of very high connectivity, domains with piecewise smooth boundaries, domains with close-to-touching boundaries, and domains of real world problems.

▶ CP-Fr-E-12-5 17:40–18:00

$(3+\varepsilon)$-Approximation for Maximum Lifetime k-Cover in Homogeneous Wireless Sensor Network

Zhang, Zhao — Zhejiang Normal Univ.
Willson, James — Univ. of Texas at Dallas
Weili, Wu — Univ. of Texas at Dallas
Ding-Zhu, Du — Univ. of Texas at Dallas

Abstract: Given a set of sensors with limited energy and a set of targets to be monitored, the goal of the maximum lifetime k-cover problem is to find an active/sleeping schedule for sensors to maximize the time period during which every target is covered by at least k active sensors. For the maximum lifetime k-cover problem in a unit disk graph, there exists a polynomial-time $(4+\varepsilon)$-approximation for $k = 1$ and a polynomial-time $(6+\varepsilon)$-approximation for $k = 2$. In this paper, we will make a significant progress by showing that for any positive integer k, there exists a polynomial-time $(3+\varepsilon)$-approximation.

MS-Fr-E-13 16:00–18:00 VIP3-2

Progress in hyperbolic problems and applications - Part VI of VI

For Part 1, see MS-We-E-13
For Part 2, see MS-Th-BC-13
For Part 3, see MS-Th-D-13
For Part 4, see MS-Th-E-13
For Part 5, see MS-Fr-D-13

Organizer: Wang, Ying — Univ. of Oklahoma
Organizer: Tesdall, Allen — City Univ. of New York, College of Staten Island

Abstract: Hyperbolic conservation laws form the basis for the mathematical modeling of many physical systems, and describe a wide range of wave propagation and fluid flow phenomena, including shock waves in nonlinear situations. For one dimensional systems with small data, a well-posedness theory of entropy weak solutions is well known. Analysis in several space dimensions, however, remains an enormous challenge. In this minisymposium, recent results in the theory and numerical analysis of hyperbolic problems will be presented. A variety of computational techniques, including finite volume, finite element, spectral, WENO, and discontinuous Galerkin methods, will be represented.

▶ MS-Fr-E-13-1 16:00–16:30

Shock Formation in A Model of Photon Scattering

Liu, Hailiang — Iowa State Univ.

Abstract: We study long-time dynamics in a model of the Kompaneets equation. The Kompaneets equation describes evolution of photon energy spectrum due to Compton scattering of photons by electrons, an important energy transport mechanism in certain plasmas. For our model, we prove global existence for initial data with any finite moment, convergence to equilibrium in large time, and failure to conserve photon number for large solutions, due to formation of a shock at zero energy.

▶ MS-Fr-E-13-2 16:30–17:00

Stiffness of Numerical Methods for Hyperbolic Problems and Orthogonal Polynomials

Krivodonova, Lilia — Univ. of Waterloo

Abstract: High order methods for solution of hyperbolic equations have a CFL number that decreases with the order of approximation, e.g. quadratically with the discontinuous Galerkin methods. We show that there is an inherent trade-off between high-order approximation and a CFL restriction, thus less stiff methods are necessarily less accurate. We discuss how this trade-off can be exploited for the best balance of accuracy and computational efficiency.

▶ MS-Fr-E-13-3 17:00–17:30

Further Results on Irregular Weak Reflection

Tesdall, Allen — City Univ. of New York, College of Staten Island

Abstract: Recent numerical solutions and physical experiments have shown the existence of a complex reflection pattern which provides a resolution of the triple point paradox. This pattern is characterized by a discontinuous transition from supersonic to subsonic flow at the rear of each patch in a sequence of tiny supersonic patches. We study numerically the possibility of an alternate structure in which the transition from supersonic to subsonic flow is smooth.

▶ MS-Fr-E-13-4 17:30–18:00

Shock Formation for Compressible Euler Equations

Chen, Geng — Georgia Inst. of Tech.

Abstract: In this talk, we introduce the recent progress on the shock formation for compressible Euler equations. The talk includes several joint works with Ronghua Pan, Shengguo Zhu, Robin Young and Qingtian Zhang.

MS-Fr-E-14 16:00–18:00 111

Effective dynamics of stochastic partial differential equations - Part III of III

For Part 1, see MS-Th-E-14
For Part 2, see MS-Fr-D-14

Organizer: Wang, Wei — Nanjing Univ.
Organizer: Gao, Hongjun — Nanjing Normal Univ.

Abstract: Stochastic partial differential equations (SPDEs) are appropriate mathematical models for many multiscale systems with uncertain and fluctuating influences. A complex system often contains different scales both in time and space, which make numerical simialtion difficult, so effective and simplifed system, governing the evolution of the system over long time scale, is desirable. The simplified system provide an effective model to be applied to simulate the complex system. This minisymposium aim to present new methods and results on the effective description complex system and application in science and engineering.

▶ MS-Fr-E-14-1 16:00–16:30

Well-posedness and Dynamics of Stochastic Generalized Fractional Benjiamin-Ono Equation

Huang, Jianhua — National Univ. of Defense Tech.

Abstract: In this talks, the well-posedness and dynamics of the Cauchy problem for the stochastic generalized Benjamin-Ono equation are presented, both Gaussian noise and fractional Brownian motion are considered respectively. By using the Bourgain spaces and Fourier restriction method and the assumption that u_0 is $\mathcal{F}_0$-measurable, The locally well-posedness of the Cauchy problem for the stochastic generalized Benjamin-Ono equation are obtained for the initial data $u_0(x,w) \in L^2(\Omega; H^s(\mathbb{R}))$ with $s \geq \frac{1}{2} - \frac{\alpha}{4}$, where $0 < \alpha \leq 1$.

▶ MS-Fr-E-14-2 16:30–17:00

A Linking Theory for Dynamical Systems with Applications to PDEs

Li, Desheng — Tianjin Univ.

Abstract: We establish a linking theory for dynamical systems, thus providing an alternative approach for finding invariant sets without using Conley index. It can be also applied to variational problems of elliptic equations that may not satisfy the P.S. Condition. As applications, the existence of recurrent solutions of a nonautonomous resonant parabolic equation and that of positive solution of Shrodinger equation are investigated by using appropriate linking theorems and moutain pass lemmas of semiflows.

▶ CP-Fr-E-14-3 17:00–17:20

Mesoscopic Stochastic Modeling and Numerical Simulation of Transiently Networked Fluids

Zhou, Lin — New York City College of Tech., CUNY
Cook, Leslie (Pam) — Univ. of Delaware

Abstract: Viscoelastic fluids under varying conditions (temperature, salinity, concentration) can exhibit exponential and/or power-law relaxations. We investigate the flows of these gel-like fluids through mesoscopic stochastic modeling and simulation of the (transiently) connected networks. Network breakage and reforming dynamics are examined through the physical processes involved. The topology of the network is tracked in shear flow, in time and space. For these multi-timescale processes, comparison of experimental and analytical predictions is delicate and is carefully explored.

▶CP-Fr-E-14-4 17:20–17:40

Analysis and Design of Jump Coefficients in Discrete Stochastic Diffusion Models.

Meinecke, Lina — Uppsala Univ.

Abstract: In computational systems biology low copy numbers introduce intrinsic noise. To simulate cells stochastically we use the mesoscopic model of reaction-diffusion kinetics, described by a continuous time, discrete space Markov process. The jump coefficients of stochastic diffusion are obtained by a discretization of the diffusion equation on unstructured grids. We quantify the error, introduced by enforcing non-negativity on the jump coefficients, by backward analysis and present two new methods to derive positive jump coefficients: one minimising the backward error and one preserving the first exit time behaviour.

▶CP-Fr-E-14-5 17:40–18:00

A Regression-Based Numerical Method for Forward-Backward Stochastic Differential Equations

Yiqi, LIU — The Univ. of Macau

Abstract: Based on Fourier cosine expansion, the approximations for conditional expectations, which appear in a theta-time discretization scheme for forward-backward stochastic differential equations (FBSDEs), are studied and analyzed. From these approximations, combining with Monte Carlo simulation, a new numerical scheme based on least-squares regression for FBSDEs is proposed. Numerical experiments for several examples are done to test the availability and stability of the new scheme for Black-Scholes call and calls combination. Moreover, an empirical expression about volatility is pointed out. All of numerical experiments support the new scheme.

MS-Fr-E-15 16:00–18:00 213B

PDEs and applications: theory and computation - Part IV of IV

For Part 1, see MS-Th-D-15
For Part 2, see MS-Th-E-15
For Part 3, see MS-Fr-D-15

Organizer: Wang, Ying — Univ. of Oklahoma
Organizer: Nie, Hua — Shaanxi Normal Univ.

Abstract: Partial differential equations (PDEs) have been widely used in the mathematical modeling of physical and biological phenomena, including mixed type equations. Many problems of an applied nature reduce to finding specific solutions and properties of PDEs of elliptic, parabolic, or of mixed type; in particular, problems of plane transonic flow of a compressible medium, and problems in the theory of envelopes. In this mini-symposium, recent results in the theory and computation of PDEs and their applications will be presented. The goal of this mini-symposium is to provide a platform for the world experts in the area of PDEs, both theory and computation, to report the recent progresses, exchange ideas and build up collaborative works. We anticipate that our speakers will have expertise in a wide-ranging array of topics, possibly including: (i) qualitative and quantitative properties enjoyed by solutions to nonlinear partial differential equations of elliptic, parabolic, or of mixed type. (ii) numerical schemes derived for various types of PDEs. (iii) physical and biology modeling involving nonlinear partial differential equations of elliptic, parabolic, or of mixed type.

▶MS-Fr-E-15-1 16:00–16:30

Two-bubble Nodal Solutions for Slightly Subcritical Fractional Laplacian

Guo, Qianqiao — Northwestern Polytechnical Univ.
Hu, Yunyun — Northwestern Polytechnical Univ.

Abstract: In this paper, we consider the existence of nodal solutions with two bubbles to the slightly subcritical problem with the fractional Laplacian. This work can be seen as a nonlocal analog of the results of Bartsch, Micheletti and Pistoia(Calc. Var. PDE (2006)).

▶MS-Fr-E-15-2 16:30–17:00

Local and Global Dynamic Bifurcations of Nonlinear Evolution Equations

Li, Desheng — Tianjin Univ.

Abstract: We establish new dynamic bifurcation results for the nonlinear evolution equation $u_t + Au = f_\lambda(u)$ on a Banach space X, where A is a sectorial operator, and $\lambda \in \mathbb{R}$ is the bifurcation parameter. Our main aim is to give a global dynamic bifurcation theorem without assuming the "crossing number" to be odd. Our method is mainly based on the Conley index theory.

▶MS-Fr-E-15-3 17:00–17:30

Regularity of Quasilinear Degenerate Subelliptic Equations with Carnot-Caratheodory's Metric

Shenzhou, Zheng — Beijingf Jiaotong Univ.

Abstract: In this talk, we establish a local comparison of its generalized Green function with its fundamental solutions for a class of quasilinear degenerate subelliptic operators with p-subharmonic as a prototype in Carnot-Caratheodory's metric. As an application, we derive a local Hölder continuity of quasilinear subelliptic equations by way of using a power of the Green function as the kernel function of some integral. On the other hand, for subelliptic p-harmonic systems with the subcritical growth defined in Carnot group we give that their weak solutions belong to $\Gamma^{1,\alpha}_{loc}$-regularity with respect to Carnot-Caratheodory's distance provided that p is close to 2. As a consequence, we make it more clear that the critical growth of nonlinearity for p-harmonic type systems in Carnot group is just a sharp borderline of partial regularity of the small "excess" energy due to the counterexamples of p-harmonic maps with p close to 2.

▶MS-Fr-E-15-4 17:30–18:00

Some Researches on Trivariate Lagrange Interpolation

LIHONG, CUI — college of Mathematics, Liaoning Normal Univ.

Abstract: in this paper, we will lay emphasis on discussing triradiate Lagrange interpolation which is closely related to the interpolation along an algebraic surface and a space algebraic curve. In order to make the further research on the problem of triradiate Lagrange interpolation , we pose the concepts of sufficient intersection of algebraic surfaces and Lagrange interpolation along a space algebraic curve, and extend Cayley-Bacharach theorem in algebraic geometry from plane to space.

MS-Fr-E-16 16:00–18:00 205A

System of Conservation Laws and Related Models - Part IV of IV

For Part 1, see MS-Th-D-16
For Part 2, see MS-Th-E-16
For Part 3, see MS-Fr-D-16

Organizer: Li, Yachun — Shanghai Jiao Tong Univ.
Organizer: Wang, Weike — Shanghai Jiao Tong Univ.
Organizer: Wang, Yaguang — Shanghai Jiaotong Univ.
Organizer: Xie, Chunjing — Shanghai Jiao Tong Universit

Abstract: This minisymposium focuses on the analysis for system of conservation laws and related models. It covers the following topics: 1. Multidimensional conservation laws and transonic flows; 2. Compressible Navier-Stokes system and singular limits for fluid dynamics; 3. Free boundary problems arising in fluid mechanics and related models.

▶MS-Fr-E-16-1 16:00–16:30

Global Smooth Supersonic Flows in Infinite Expanding Nozzles

Wang, Chunpeng — Jilin Univ.

Abstract: This talk concerns smooth supersonic potential flows with Lipschitz continuous speed in two-dimensional infinite expanding nozzles. The conditions for the global existence of smooth supersonic flows are shown. This is a joint work with Professor Zhoupin Xin.

▶MS-Fr-E-16-2 16:30–17:00

On Linear Instability and Stability of Magnetic Rayleigh-Taylor Problems

Jiang, Song — Inst. of Applied Physics & Computational Mathematics

Abstract: We investigate the stabilizing effects of magnetic fields in the linearized magnetic Rayleigh - Taylor (RT) problem of the nonhomogeneous, incompressible and viscous magnetohydrodynamic fluids of zero resistivity in the presence of a uniform gravitational field in a bounded domain, in which the velocities of fluids are non-slip on the boundary. By a modified variational method and careful energy estimates, we establish a criterion for instability and stability of the linearized problem around a magnetic RT equilibrium state. In the criterion, we find a novel conclusion that a sufficiently large horizontal magnetic field has the same stabilizing effect as that of the vertical magnetic field on growth of the magnetic RT instability. In addition, we further study the corresponding compressible fluid case, i.e., the Parker (or magnetic buoyancy) problem, in which the strength of the horizontal magnetic field decreases with height, and also show the stabilizing effect of a sufficiently strong magnetic field. (joint work with Fei Jiang)

▶MS-Fr-E-16-3 17:00–17:30

Sonic-Subsonic Limit of Approximate Solutions to Multidimensional Steady Euler Equations
Huang, Feimin — Acad. of Mathematics & Sys. Sci., Chinese Acad. of Sci.

Abstract: A compactness framework is established for approximate solutions to sonic-subsonic flows governed by the steady full Euler equations for compressible fluids in arbitrary dimension. The new compactness framework applies for both non-isentropic and rotational flows. As direct applications, we establish two existence theorems for multidimensional sonic-subsonic full Euler flows through infinitely long nozzles.

▶ MS-Fr-E-16-4 17:30–18:00
Steady Subsonic Solutions for the Euler and Euler-Poisson System in Physical Domains
Xie, Chunjing — Shanghai Jiao Tong Universit

Abstract: We will discuss the recent progress on the steady subsonic solutions for the Euler equation in nozzles or past a bump. The subsonic solutions for the Euler-Poisson equations in a bounded nozzle will be also addressed.

MS-Fr-E-18 16:00–18:00 209B
Mathematics and Optics - Part IV of IV
For Part 1, see MS-Th-D-18
For Part 2, see MS-Th-E-18
For Part 3, see MS-Fr-D-18
Organizer: Santosa, Fadil — Inst. for Mathematics & its Applications
Organizer: Bao, Gang — Zhejiang Univ.
Organizer: Weinstein, Michael — Columbia Univ.
Abstract: The importance of optics and is summarized in the 2013 US National Academy of Sciences report "Optics and Photonics: Essential Technology for Our Nation". Envisioned technologies which rely on optics include communications, imaging, sensing, and computing. What is clear from the report is that the Mathematical Sciences is poised to make significant contributions to the progress in technology. Indeed there is a growing research activity at the nexus of the Mathematical Sciences and the Optical Sciences. Together with advances in materials science and nano-structure fabrication, there is a growing role for mathematical tools, both computational and analytical.
The goal of this minisymposium is to highlight research in the mathematical sciences that deal with problems arising in optics and photonics. Topics that will be discussed in the sessions include optics in meta-materials, cloaking, photonic bandgap structures, design and control of optical devices, plasmonics, and nonlinear phenomena in optics. These topics will be emphasized during the Institute for Mathematics and its Applications (IMA) annual thematic program "Mathematics and Optics", 2016-17. The minisymposium is an invitation to mathematical scientists to participate in the IMA program.

▶ MS-Fr-E-18-1 16:00–16:30
Transformation Optics and Applications
Ma, Yungui — Zhejiang Univ.

Abstract: Transformation optics (TO) is a powerful mathematical tool that allows to control light propagation and shape light path almost in arbitrary ways. In this presentation, we will introduce our works to create interesting EM devices enabled by TO and metamaterials, including retroreflection lens, invisible cloaks and mutiphysics functional devices.

▶ MS-Fr-E-18-2 16:30–17:00
Toward A Theory of Broadband Absorption Suppression in Magnetic-Dielectric Composites
Welters, Aaron — Florida Inst. of Tech.
Figotin, Alexander — Univ. of California at Irvine

Abstract: A major problem with magnetic materials in application is they naturally have high losses in a wide frequency range of interest (e.g., Faraday rotation using ferromagnets in optical frequencies). Composites can inherit significantly altered properties from those of their components. Does this apply to losses and magnetic properties? How can broadband absorption suppression in magnetic-dielectric composites be achieved? We discuss new results towards answering these questions related to modal dichotomy and selective overdamping phenomena.

▶ MS-Fr-E-18-3 17:00–17:30
Asymptotic Characterization of Nanoparticle Plasmon Resonances
Bonnetier, Eric — Univ. of Grenoble-Alpes
Triki, Faouzi — Joseph Fourier Univ.

Abstract: In this talk, we study the asymptotic behavior of a 2D metallic nanoparticle. When the particle size is much smaller than the incident wavelength, the complex eigenvalues of the associated Helmholtz equation may get close to the real axis. We show that these eigenvalues can be derived from a nonlinear spectral problem associated to a boundary integral representation of the electric field and we derive their asymptotic expansion as the particle size tends to 0.

MS-Fr-E-19 16:00–18:00 307B
From individual interactions to collective behaviour in socio-economics and life sciences - Part II of II
For Part 1, see MS-Fr-D-19
Organizer: During, Bertram — Univ. of Sussex
Organizer: Wolfram, Marie-Therese — Radon Inst. for Computational & Applied Mathematics
Abstract: Complex, real-life systems in sociology, economics, and life sciences often consist of a large number of interacting individuals which may form patterns or develop a collective behaviour. The research on microscopic models of such systems and their kinetic, mean-field and hydrodynamic limits have recently gained a lot of momentum. The aim of the mini-symposium is to highlight recent advances on kinetic and PDE modelling in this area. The session focuses on applications such as congestion models, flocking, population dynamics as well as price and opinion formation.

▶ MS-Fr-E-19-1 16:00–16:30
Stability and Pattern Formation in Nonlocal Interaction Models in Swarming
Carrillo, Jose A. — Imperial College London

Abstract: I will review some recent results for first and second order models of swarming in terms of patterns, stationary states, and qualitative properties. I will discuss the stability of these patterns for the continuum and discrete particle cases. These non-local models appear in collective behavior for animals, control engineering, and molecular structures among others.

▶ MS-Fr-E-19-2 16:30–17:00
Derivation and Analysis of A Non-linear Cross-diffusion Model for Pedestrian Dynamics
Ranetbauer, Helene — Ricam OEAW, Linz

Abstract: In this talk we present a non-linear convection-diffusion model, which describes the evolution of two pedestrian groups walking in opposite direction. We start by deriving the system from a two-dimensional lattice based model and derive formally the corresponding limiting equations using Taylor expansion. We introduce an entropy functional, which allows us to derive the necessary estimates to prove global existence of bounded weak solutions. Furthermore we illustrate the behaviour of the model with numerical simulations.

▶ MS-Fr-E-19-3 17:00–17:30
Inhomogeneous Kinetic Models for Opinion Formation
During, Bertram — Univ. of Sussex

Abstract: The opinion formation process in a human society can be modelled using mathematical tools from kinetic gas theory. In this approach the time evolution of the opinion distribution is usually described by (systems of) homogeneous Boltzmann-type equations. In this talk we present extensions to the inhomogeneous case where the opinion formation dynamics depend on an additional independent variable, e.g. an assertiveness or spatial variable.

▶ MS-Fr-E-19-4 17:30–18:00
Estimates for the Homogeneous Landau Equation with Coulomb Potential
Gualdani, Maria — George Washington Univ.

Abstract: We present conditional existence results for the Landau equation with Coulomb potential. Despite lack of a comparison principle for the equation, the proof of existence relies on barrier arguments and parabolic regularity theory. The Landau equation arises in kinetic theory of plasma physics. It was derived by Landau and serves as a formal approximation to the Boltzmann equation when grazing collisions are predominant. We also present long-time existence results for the isotropic version of the

MS-Fr-E-20 16:00–18:00 210B
Computational Inverse Problems - Part IV of IV
For Part 1, see MS-Th-D-20
For Part 2, see MS-Th-E-20
For Part 3, see MS-Fr-D-20
Organizer: Jin, Bangti — Univ. College London
Organizer: Lu, Xiliang — Wuhan Univ.
Abstract: Inverse problems arise in a wide variety of applications, e.g., medical imaging, tomography, anomalous diffusion and compressed sensing. Their efficient and stable numerical solution is however very challenging due to the ill-posed nature of inverse problems. There have been significant progress in recent years, in novel application, new mathematical techniques and efficient optimization algorithms. In this mini-symposium, we aim

to present and discuss recent advances in the area.

▶ MS-Fr-E-20-1 16:00–16:30

Shape and Topological Sensitivity for Tomographic Imaging

Hintermueller, Michael — Humboldt-Univ. of Berlin

Abstract: Topological and shape sensitivity are applied to electrical impedance, fluorescent diffusive optical or magnetic induction tomography. Here, topological sensitivity allows for initializations, which are free of user interaction, and shape sensitivity adjusts locally for achieving a better reconstruction of the geometry of hidden inclusions. Both sensitivities are incorporated into a level-set based descent algorithm for solving an output least squares formulation of the inverse problem. Analytical result and a report on numerical tests are given.

▶ MS-Fr-E-20-2 16:30–17:00

Forward - backward splitting method for quantitative photoacoustic tomography

Zhang, Xiaoqun — Shanghai Jiao Tong Univ.

Abstract: Quantitative photoacoustic tomography (PAT) reconstructs optical maps using ultrasonic measurements, with improved resolution from conventional optical imaging due to significantly smaller acoustic scattering than optical scattering for detecting signals in depth. In this work, formulating quantitative PAT as a nonlinear least-squares problem with Ll norm sparsity regularization, we develop an efficient gradient-based reconstruction algorithm using a forward-backward splitting method, and prove its convergence for such a nonconvex problem.

▶ MS-Fr-E-20-3 17:00–17:30

An Undetermined Coefficient Problem for A Fractional Diffusion Equation

Zhang, Zhidong — Texas A&M Univ.
Zhou, Zhi — Texas A&M Univeristy

Abstract: We consider $D_t^\alpha u(x,t) - u_{xx}(x,t) + q(x)u(x,t) = 0$ in $(0,1)\times(0,T)$, where D_t^α is the Caputo fractional derivative, $0<\alpha<1$. An initial condition is given and Robin conditions are taken on the lateral boundary. The aim is to recover the unknown $q(x)$ from additional final time data $u(x,T) = g(x)$. We prove a uniqueness result and provide a constructive algorithm that produces a sequence $\{q_n\}$ converging monotonically to $q(x)$. We will also compare this fractional case with the corresponding problem for the classical case.

MS-Fr-E-22 16:00–18:00 206A

Recent development and applications of weighted essential non-oscillatory methods - Part V of V

For Part 1, see MS-Th-BC-22
For Part 2, see MS-Th-D-22
For Part 3, see MS-Th-E-22
For Part 4, see MS-Fr-D-22

Organizer: Qiu, Jianxian — Xiamen Univ.
Organizer: Shu, Chi-Wang — Brown Univ.

Abstract: The spectrum covered by the minisymposium ranges from recent development, analysis, implementation and applications, for the weighted essential non-oscillatory (WENO) methods. The WENO methods provide a practical effective framework to solve out many nonlinear wave-dominated problems with discontinuities or sharp gradient regions, which play an important role arising in many applications of computational fluid dynamics, computational astrophysics, computational plasma physics, semiconductor device simulations, among others. Devising robust, accurate and efficient WENO methods for solving these problems is of considerable importance and, as expected, has attracted the interest of many researchers and practitioners. This minisymposium serves as a good forum for researchers to exchange ideas and to promote this active and important research direction.

▶ MS-Fr-E-22-1 16:00–16:30

High Order Fixed-point WENO Sweeping Method for Steady State Problems

Zhang, Yong-Tao — Univ. of Notre Dame

Abstract: In this talk, I shall present our recent results on developing an efficient iterative fifth order WENO scheme for solving steady state hyperbolic conservation laws. The method is based on an explicit Gauss-Seidel sweeping framework combined with different new techniques. Numerical experiments will be presented to show the fast convergence of the iterations comparing with regular time marching method. This is a joint work with Liang Wu, Shuhai Zhang and Chi-Wang Shu.

▶ CP-Fr-E-22-2 16:30–16:50

LS-WENO: Weighted Least Squares Based Essentially Non-Oscillatory Schemes on Unstructured Meshes

Liu, Hongxu — Stony Brook Univ.
Jiao, Xiangmin — Stony Brook Univ.

Abstract: ENO and WENO schemes are widely used high-order schemes for solving hyperbolic conservation laws with structured meshes. For unstructured meshes, such schemes are less developed. We propose a new family of non-oscillatory schemes for unstructured meshes, called LS-WENO, based on local weighted least squares formulations. We show that LS-WENO can achieve better accuracy and stability than WENO for both structured and unstructured meshes, and verify the methodology using Burger's equation and Euler equations.

▶ CP-Fr-E-22-3 16:50–17:10

A Hybrid Method for Convection Equations and Its Applications in Population Dynamics

Yang, Chang — harbin Inst. of Tech.

Abstract: In this work, we present a new hybrid method for convection equations in order to study long term evolution dynamic of a group of cells. Indeed, lots of biological conjectures are based on the observation in long term. In modeling point of view this long term evolution dynamic is obtained by the analysis of the asymptotic behavior of the considered quantity. However, some numerical artifacts may lead to bad conjectures, caused by numerical diffusion of standard schemes in long term simulation. Thus, we develop the hybrid method, combining a high order method and an anti-diffusive method, can on the one hand achieve high accuracy for smooth solution; on the other hand avoid numerical dissipation for discontinuous one. The numerical simulations illustrate that the hybrid method can result a good agreement with the theoretical asymptotic analysis for the growth fragmentation type model.

MS-Fr-E-23 16:00–18:00 208A

Computational Methods of PDE-based Eigenvalue Problems and Applications in Nanostructure Simulations - Part IV of IV

For Part 1, see MS-Th-D-23
For Part 2, see MS-Th-E-23
For Part 3, see MS-Fr-D-23

Organizer: Bai, Zhaojun — Univ. of California, Davis
Organizer: Yang, Chao — Lawrence Berkeley National Laboratory
Organizer: Zhou, Aihui — Acad. of Mathematics & Sys. Sci., Chinese Acad. of Sci.

Abstract: PDE based eigenvalue problems arise from electronic structure calculations, band structure calculations in photonic crystals and dynamics of electromagnetic fields. This minisymposium brings together researchers working on PDE-based eigenvalue problems from areas of mathematical modeling and analysis, numerical analysis, high-performance computing and applications. This minisymposium features the latest progress on developing adaptive discretizations, stable nonlinear iterations and fast algebraic solvers, code designing and high performance computing on modern computer systems.

▶ MS-Fr-E-23-1 16:00–16:30

Why Higher-order Methods Are Preferred in PDE Eigenvalue Approximation in Some Cases?

Zhimin, Zhang — Beijing Computational Sci. Research Center, & Wayne State Univ.
Li, Huiyuan — Inst. of Software Chinese Acad. of Sci.

Abstract: We often find that in numerical approximation of PDE eigenvalues, higher-order methods, especially spectral methods, are superior to lower-order methods such as finite diffrence, finite element, and finite volume methods in many situations. In this talk, I shall discuss this phenmenon in some details. A general guide lie is that when regularity of the underlying eigenfunction is allowed, especially when it is analytic or piecewisely analytic, we should go with higher-order methods.

▶ MS-Fr-E-23-2 16:30–17:00

Adaptive Finite Element Approximations for Kohn-Sham Models

Xiaoying, Dai — Acad. of Mathematics & Sys. Sci., Chinese Acad. of Sci.)

Abstract: The Kohn-Sham model is widely used approach for computation of ground state electronic energies. In this presentation, we will talk about our study for adaptive finite element approximations for the Kohn-Sham model. Based on the residual type a posteriori error estimators, we introduce an adaptive finite element algorithm, and obtain both the asymptotic contraction property and asymptotic quasi-optimal complexity of the adaptive finite element approximations. This is a joint work with H. Chen,L. He,andA.Zhou.

▶ MS-Fr-E-23-3 17:00–17:30

The Waveguide Eigenvalue Problem and the Tensor Infinite Arnoldi Method

Jarlebring, Elias KTH

Abstract: We present a new iterative algorithm for nonlinear eigenvalue problems, the tensor infinite Arnoldi method, which is applicable to a general class of NEPs. We also show how to specialize the algorithm to the waveguide eigenvalue problem, which arises from a finite-element discretization of a partial-differential equation used in the study waves propagating in periodic medium. The algorithm is successfully applied to solve benchmark problems as well as complicated waveguides.

▶ MS-Fr-E-23-4 17:30–18:00

A Regularized Newton Method for Computing Ground States of Bose-Einstein Condensates

Wu, Xinming Fudan Univ.

Abstract: In this talk, we present a regularized Newton method for computing ground states of Bose-Einstein condensates (BECs). The energy functional and constraint are discretized by either the finite difference, or sine or Fourier pseudospectral discretization schemes. Extensive numerical experiments show that our method is efficient, accurate and robust.

MS-Fr-E-24 16:00–18:00 211

Computational Electromagnetism and Its Engineering Applications - Part IV of IV

For Part 1, see MS-Th-D-24
For Part 2, see MS-Th-E-24
For Part 3, see MS-Fr-D-24

Organizer: Duan, Huoyuan Collaborative Innovation Centre of Mathematics, School of Mathematics & Statistics, Wuhan Univ., Wuhan 430072, China

Organizer: Zheng, Weiying Chinese Acad. of Sci.

Abstract: In recent years, there arises a surge of numerical studies for electromagnetic problems in complex engineering systems, such as large power transformers, electrical machinery, magnetic fusion, etc. The mathematical models turn out to be nonlinear, multiscale, strongly singular, and coupled with multiple physical fields. It brings new challenges to researchers from both mathematical and engineering communities in developing practical mathematical models and effective and efficient numerical methods and solvers. This mini-symposium seeks to bring together researchers in both computational mathematics and electromagnetic engineering that involve the mathematical modeling, analysis, computation, and experimental validation for electromagnetic problems. The main theme will be focused on new efficient numerical methods and fast solvers for Maxwell's equations and magnetohydrodynamic equations and will address their extensive applications to engineering problems. It will promote exchange of ideas and recent developments on mathematical modeling, numerical discretization, solvers and engineering practices of computational electromagnetism.

▶ MS-Fr-E-24-1 16:00–16:30

Mixed Finite Element Methods for Incompressible Magnetohydrodynamics

Wei, Xiaoxi Inner Mongolia Univ.

Abstract: Incompressible magnetohydrodynamics studies the behaviour of electrically conducting, resistive, incompressible and viscous fluids in the presence of electromagnetic fields. It is modelled by a coupled nonlinear system of the Navier-Stokes equations and the Maxwell equations. We develop and analyze mixed discontinuous Galerkin finite element methods for the numerical approximation of incompressible magnetohydrodynamics problems. All our discretizations and theoretical results are computationally validated through comprehensive sets of numerical experiments.

▶ MS-Fr-E-24-2 16:30–17:00

On Eddy Current Model of Nondestructive Evaluation

Zheng, Weiying Chinese Acad. of Sci.
Li, Peijun Purdue Univ.
Jiang, Xue Beijing Univ. of Posts & Telecommunications

Abstract: Inversion of eddy-current data and the reconstruction of flaws is the preeminent problem in electromagnetic nondestructive evaluation (NDE). This places a premium on developing good forward models for computing field-flaw interactions. Material flaws are usually very thin compared with the characteristic length. But it generates singular eddy current density and makes numerical simulation very difficult. I shall talk about the simplification of the eddy current model and present some numerical experiments using finite element methods.

▶ CP-Fr-E-24-3 17:00–17:20

A FINITE ELEMENT MULTIGRID SOLVER FOR P-NONCONFORMING MESHES USING ADDITIVE SCHWARZ SMOOTHING

Gunatilake, Janitha Univ. of Moratuwa

Abstract: We present a new finite element multigrid solver for p-nonconforming meshes. This solver combines the features of multigrid, domain decomposition and p-hierarchical bases. Here, the smoother in each multigrid V-cycle is performed in an additive Schwarz manner which will be advantageous in parallel computing. We prove the convergence of the method. Furthermore, we present numerical results of an implementation of this algorithm in C++ to solve boundary value problems in two and three dimensions.

▶ CP-Fr-E-24-4 17:20–17:40

Enhanced Semi-analytic Method for Solving Nonlinear Fractional Differential Equations

Jang, Bongsoo UNIST

Abstract: In this work, we propose a new semi-analytic method by using the generalized Taylor series for solving nonlinear fractional differential equations, which is called the generalized differential transform method(GDTM). In GDTM, it is a key to derive a recurrence relation of the coefficients of the generalized Taylor series associated with the solution. We provide the recurrence relations of complex nonlinear functions such as exponential, logarithmic and trigonometry functions. To enhance the computational accuracy, we apply the standard GDTM in each sub-domain, namely the multistage GDTM. From the global property of the fractional operator, A new recurrence relation with effect of memory is derived. Several illustrative examples are demonstrated to show the effectiveness of the proposed method.

▶ CP-Fr-E-24-5 17:40–18:00

On Approximation Classes of Adaptive Finite Element Methods

Tsogtgerel, Gantumur McGill Univ.

Abstract: Recent studies on convergence of adaptive methods have shown that generally these methods converge at class-optimal rates with respect to approximation classes that are defined using a modified notion of error, the so-called total error, which is the energy error plus an oscillation term. In this talk, we present characterizations of those approximation classes in terms of memberships of the solution and data into Besov spaces. We will also discuss some modest improvements over the existing characterization results for the standard adaptive approximation classes (that are defined using the energy error).

MS-Fr-E-25 16:00–18:00 210A

Emerging PDEs: Analysis and Computation - Part IV of IV

For Part 1, see MS-Th-D-25
For Part 2, see MS-Th-E-25
For Part 3, see MS-Fr-D-25

Organizer: Chen, Zhiming AMSS, Chinese Acad. of Sci.
Organizer: Nochetto, Ricardo Univ. of Maryland
Organizer: Zhang, Chensong Acad. of mathematics & Sys. Sci.

Abstract: Novel models in science and engineering are governed by nonlinear integro-differential equations with increasing complexity which demand innovative techniques in both analysis and computation, such as adaptivity, fast methods and preconditioning, and structure preserving algorithms. Areas of special interest include complex fluids and new materials, electromagnetism and wave propagation, uncertainty quantification, and fractional PDEs, among others.

This minisymposium intends to gather about 16 world experts and young researchers in analysis and computation of PDE to discuss the most recent progress in this exciting field as well as future directions for research.

▶ MS-Fr-E-25-1 16:00–16:30

Explicit Finite Element Approximation and Invariant Domain Properties of Hyperbolic Systems

Yang, Yong Texas A&M Univ.

Abstract: An explicit continuous finite element approximation of hyperbolic systems will be presented. This technique is first-order in space but preserves all the invariant domain properties up to a standard CFL condition and works in any space dimension on nonuniform grids. The invariant domain property implies positivity of the density and internal energy and a minimum principle on the specific entropy for the Euler equations. A second-order extension to scalar conservation equations will also be presented.

▶ MS-Fr-E-25-2 16:30–17:00

Numerical Methods for Compositional Models in Reservoir Simulation

Zhang, Chensong Acad. of mathematics & Sys. Sci.

Abstract: Compositional models are widely used by petroleum engineers to understand oil recovery mechanisms. We focus on a general compositional model and develop a fully-implicit method as well as an efficient linear solver. We will also discuss parallel implementation of the proposed preconditioner

to solve the Jacobian system arising from the fully implicit discretization. The accuracy, robustness, and parallel scalability of the parallel simulator are then validated using large-scale black oil benchmark problems.

▶ MS-Fr-E-25-3 17:00–17:30

Finite Element Approximation of Beltrami Fields in Multiply Connected Domains

Rodriguez, Rodolfo — Universidad de Concepcion

Abstract: A couple of finite element methods to solve the eigenvalue problem for the curl operator in simply connected domains have been recently introduced and analyzed. This topological assumption is not just a technicality, since the eigenvalue problem is ill-posed on multiply connected domains, in the sense that its spectrum is the whole complex plane. However, additional constraints can be added in order to recover a well posed problem with a discrete spectrum. We consider as additional constraint a zero-flux condition of the curl on all the cutting surfaces. We introduce two weak formulations of the corresponding problem, one of them mixed and the other a Maxwell-like formulation. We prove that both are well posed and show how to take care of these additional constraints. We prove spectral convergence of both discretizations and establish a priori error estimates. We also report numerical tests which allow assessing the performance of the proposed methods.

▶ MS-Fr-E-25-4 17:30–18:00

Solitary Waves and Time-reversible Solutions to Nonlinear Hyperbolic Problems in Layered Media

LeVeque, Randall — Univ. of Washington

Abstract: Solutions to nonlinear hyperbolic equations in homogeneous media generally develop shocks. However, if the medium varies periodically or randomly, then an effective dispersion arises that can inhibit shock formation and instead lead to the appearance of solitary waves and time-reversible solutions. Numerical simulations in one and two space dimensions will be presented, along with some theoretical results and open questions. This is joint work with David Ketcheson and several other collaborators.

MS-Fr-E-27 16:00–18:00 407

Decoupling methods for multi-physics and multi-scale problems - Part VIII of VIII

For Part 1, see MS-Tu-E-27
For Part 2, see MS-We-D-27
For Part 3, see MS-We-E-27
For Part 4, see MS-Th-BC-27
For Part 5, see MS-Th-D-27
For Part 6, see MS-Th-E-27
For Part 7, see MS-Fr-D-27

Organizer: He, Xiaoming — Missouri Univ. of Sci. & Tech.
Organizer: Xu, Xuejun — Inst. of Computational Mathematics, AMSS, CAS

Abstract: The inherent multi-physics and multi-scale features of many real world problems accentuate the importance to develop efficient and stable numerical methods for the relevant PDEs, especially the decoupling methods. Although great efforts have been made for solving these problems, many practical and analytical challenges remain to be solved. This mini-symposium intends to create a forum for junior and senior researchers from different fields to discuss recent advances on the decoupling methods for multi-physics and multi-scale problems with their applications.

▶ MS-Fr-E-27-1 16:00–16:30

Domain Decomposition Proper Orthogonal Decomposition Method

Wang, Zhu — Univ. of South Carolina

Abstract: We put forth a new framework for the applications of the proper orthogonal decomposition (POD) method in a domain decomposition (DD) setting. It includes a new partitioned method of snapshots for efficiently generating the POD basis; adaption of the POD to inhomogeneous boundary value problems; and development of a heterogeneous DD methodology that will accommodate different PDEs and ROMs in different domains. A thermal flow problem is utilized to verify the proposed method.

▶ MS-Fr-E-27-2 16:30–17:00

A parallel Robin - Robin domain decomposition method with optimal convergence rate

Wang, Feng — Nanjing Normal Univ.

Abstract: In this talk, we propose a parallel Robin - Robin domain decomposition method for the second order elliptic problems. After choosing suitable parameters, we get a convergence rate which is independent of the mesh size. We also show that the idea can be generalize to other problems

▶ MS-Fr-E-27-3 17:00–17:30

Decoupling the Navier-Stokes-Darcy Model

He, Xiaoming — Missouri Univ. of Sci. & Tech.

Abstract: The Navier-Stokes-Darcy model arises in many real world applications. This model describes the free flow of a liquid by the Navier-Stokes equation and the confined flow in a porous media by the Darcy equation; the two flows are coupled through interface conditions. This presentation shows the wellposedness of the model and discusses the multiphysics domain decomposition method for decoupling this system.

MS-Fr-E-28 16:00–18:00 109

Network biology and medicine

Organizer: Zhang, Shihua — Acad. of Mathematics & Interdisciplinary Sci.

Abstract: Network Systems Biology have become intensive research topics in the recent past decade and attracted many leading scientists from applied mathematics to biology. Many mathematical models and methods have been widely used in the field. With the rapid development of biotechnology, huge number of data have been accumulated. Network is becoming a valuable tool to analyze these complex data. In this session, four speaker will present their research and views toward the network biology and medicine.

▶ MS-Fr-E-28-1 16:00–16:30

Detecting Critical Transitions of Dynamical Systems by Big Data

Chen, Luonan — Shanghai Inst.s for Biological Sci.

Abstract: We develop a model-free method to detect early-warning signals of such critical transitions, even with only a small number of samples. We derive an index based on a dynamical network biomarker (DNB) that serves as a general early-warning signal indicating an imminent bifurcation or sudden deterioration before the critical transition occurs. We show that predicting a sudden transition from small samples is achievable provided that there are a large number of measurements for each sample.

▶ MS-Fr-E-28-2 16:30–17:00

Profiling Cell/Tissue Specific Gene Regulatory Networks

Zhang, Louxin — National Univ. of Singapore

Abstract: In network biology, a cell is commonly described as a gene regulatory network and as such a cell-type is modelled by a state-dependent system over the network. Hence, understanding the topological structures of gene regulatory network plays a crucial role in uncover the biology of cell types. The talk will cover our recent work on the structures and dynamics of cell-specific regulatory networks.

▶ MS-Fr-E-28-3 17:00–17:30

HTSS MARINE NATURAL PRODUCTS FOR POTENTIAL ANTI-INFECTIVE DRUGS

Zhang, Lixin — Chinese Acad. of Sci.

Abstract: Many drugs could be more effective at a reduced dosage if low dosages of other synergistic compounds are introduced simultaneously, especially from our microbial natural product library. To rapidly discover new antifungal agents for drug-resistant pathogens, we developed a high-throughput synergy screening (HTSS) strategy for novel microbial natural products. Here we report the production of drugable secondary metabolites from microbial producers could be further increased by synthetic biology approaches.

▶ MS-Fr-E-28-4 17:30–18:00

Human Microbes-disease Network

Cui, Qinghua — Peking Univ. Health Sci. Center

Abstract: We use a large-scale manually-curated microbes-disease association dataset to construct a microbe-based human disease network and investigate the relationships among them. We reveal that the microbe-based disease loops are significantly coherent. Microbe-based disease connections have strong cross talks with those constructed by disease genes, symptoms, chemical fragments, and drugs. We confirm that the microbes-based disease analysis is powerful to predict novel connections and mechanisms for disease, microbes, genes, and drugs.

MS-Fr-E-29 16:00–18:00 305

Numerical Homogenization and Multiscale Model Reduction Methods - Part V of V

For Part 1, see MS-Th-BC-29
For Part 2, see MS-Th-D-29
For Part 3, see MS-Th-E-29
For Part 4, see MS-Fr-D-29

Organizer: Zhang, Lei — Shanghai Jiao Tong Univ.
Organizer: Peterseim, Daniel — Universität Bonn
Organizer: Jiang, Lijian — Hunan Univ.
Organizer: Chung, Eric — The Chinese Univ. of Hong Kong

Abstract: Problems that transcend a variety of strongly coupled time and

length scales are ubiquitous in modern science and engineering such as physics, biology, and materials. Those multiscale problems pose major mathematical challenges in terms of analysis, modeling and simulation. At the same time, advances in the development of multiscale mathematical methods coupled with continually increasing computing power have provided scientists with the unprecedented opportunity to study complex behavior and model systems over a wide range of scales.
This minisymposium is aimed at presenting the state-of-the-art in multiscale modeling, simulation and analysis for the applications in science and engineering. It will focus on the developments and challenges in numerical multiscale methods and multiscale model reduction methods. The lectures will cover the following subjects: - Numerical homogenization methods, e.g. Generalized FEM, MsFEM, FEM-HMM, DG methods, Partition of Unity methods, multiscale domain decomposition etc. - Multiscale model reduction methods for stochastic systems, such as stochastic PDEs and random materials. - Multiscale methods for problems arising in composite materials and heterogeneous porous media. - Multiscale methods for eigenvalue problems, high frequency waves, and multiscale hyperbolic PDEs. - Multiscale modeling in various applications such as reservoir performance prediction, bio-motility, chemical vapor infiltration, etc.

▶ MS-Fr-E-29-1 16:00–16:30
Stochastic Uncertainty Analysis for Unconfined Flow in Randomly Heterogeneous Media Using A High-dimensional Model Representation Method
He, Xinguang Hunan Normal Univ.
Jiang, Lijian Hunan Univ.
Abstract: In this study, we present a stochastic dimension reduction method for solving unconfined flow problems in randomly porous media. A high-dimensional model representation technique is applied to decompose the high-dimensional stochastic problem into a moderate-dimensional stochastic problem and a few one-dimensional stochastic problems. Then, the derived low-dimensional stochastic problems are solved separately by the sparse grid stochastic collocation method. We examine the accuracy of the approach for the unconfined flow with multiple random inputs.

▶ MS-Fr-E-29-2 16:30–17:00
A Combined Finite Element and Multiscale Finite Element Method for the Multiscale Elliptic Problems
Wu, Haijun Nanjing Univ.
Abstract: We develop a combined finite element and multiscale finite element method (FE-MsFEM) for the multiscale elliptic problems. The transmission conditions across the FE-MSFE interface is treated by the penalty technique. A rigorous error analysis for this FE-MsFEM is given under the assumption that the diffusion coefficient is periodic. Numerical experiments are carried out for the elliptic equations with periodic and random highly oscillating coefficients, as well as multiscale problems with high contrast channels or well-singularities.

▶ MS-Fr-E-29-3 17:00–17:30
An Efficient Numerical Method for Elliptic Problems with Oscillatory Boundary Data.
Ming, Pingbing Chinese Acad. of Sci.,AMSS
Abstract: We shall propose a new numerical method for elliptic problems with oscillatory boundary data. Both Dirichlet and Neumann boundary data will be discussed. Our method is based on a suitable coupling of multiscale basis functions. Theoretical results and numerical results are presented to show the efficiency of the method.

MS-Fr-E-30 16:00–18:00 VIP2-2
Numerical approaches in optimization with PDE constraints: recent progress and future challenges - Part VII of VII
For Part 1, see MS-We-D-30
For Part 2, see MS-We-E-30
For Part 3, see MS-Th-BC-30
For Part 4, see MS-Th-D-30
For Part 5, see MS-Th-E-30
For Part 6, see MS-Fr-D-30
Organizer: Yan, Ningning Chinese Acad. of Sci.
Organizer: Hinze, Michael Universität Hamburg
Abstract: The numerical treatment of optimization problems with PDE constraints is a very active field of mathematical research with great importance for many practical applications. To achieve further progress in this field of research, the development of tailored discretization techniques, adaptive approaches, and model order reduction methods has to be intertwined with the design of structure exploiting optimization algorithms in function space.
This minisymposium covers mathematical research in PDE constrained optimization ranging from numerical analysis and adaptive concepts over algorithm design to the tailored treatment of optimization applications with PDE constraints. It thereby forms a platform and fair for the exchange of ideas among young researchers and leading experts in the field, and for fostering and extending international collaborations between research groups in the field.

▶ MS-Fr-E-30-1 16:00–16:30
Modeling and Computation of Transboundary Industrial Pollution with Emission Permits Trading by Stochastic Differential Game
Zhang, Shuhua Tianjin Univ. of Finance & Economics
Abstract: In this talk, a differential game model of transboundary pollution with emission permits trading is presented. We make use of stochastic optimal control theory to derive the value function for the noncooperative and cooperative games and propose a fitted finite volume method to solve it. The optimal emission paths, which maximize the region's discounted stream of net revenue, are obtained. Several examples are presented to illustrate the results and the efficiency of the method.

▶ MS-Fr-E-30-2 16:30–17:00
Parallel Domain Decomposition Procedurs for Optimal Control Problems Governed by Parabolic Equations
Chen, Jixin East China Normal Univ.
Yang, Danping East China Normal Univ.
Abstract: Several parallel domain decomposition algorithms for solving optimal control problems governed by parabolic partial differential equations are proposed. These procedures are based on non-overlapping domain decomposition. The global problem is reduced to solving some implicit sub-problems defined on sub-domains at each time step. Optimal rates of a priori error bounds and convergence for approximation solution are derived and proved. Numerical examples are also performed to verified the theoretical analysis.

▶ MS-Fr-E-30-3 17:00–17:30
Convergent Adaptive Finite Element Method for Optimal Control Governed by Elliptic Partial Differential Equations
Li, Zheng East China Normal Univ.
Yang, Danping East China Normal Univ.
Abstract: Convergent adaptive finite element method is proposed to solve distributed optimal control problems governed by elliptic partial differential equations. Based on posteriori error estimators for standard finite element approximation in L2-norm and H1-norm, an error reduction rates of is derived. Together with a reduction rate of data oscilations, we construct a convergent adaptive FEM algorithm. Some numerical experiments are performed to verify theoretical results.

▶ MS-Fr-E-30-4 17:30–18:00
Model-free Implied Volatility, Quadratic Variation and Risk-neutral Density
Yang, Hongtao Univ. of Nevada Las Vegas
Abstract: We shall present our recent work on the relationship among three important measures used in financial derivative field: the expectation of integrated return variance, the model-free implied volatility (MFIV), and the expectation of the quadratic variation of return. In particular, we have shown that these three quantities are significantly different when asset prices contains jumps. It suggests that the CBOE volatility index should be reconsidered by incorporating with the possible jumps. We also propose a new model for risk-neutral density in order to test the consistency of information contained in the option premiums, which are used to calculate the MIFV.

MS-Fr-E-31 16:00–18:00 405
Advances on Mixed Finite Element Methods for Linear Elasticity - Part IV of IV
For Part 1, see MS-Th-D-31
For Part 2, see MS-Th-E-31
For Part 3, see MS-Fr-D-31
Organizer: Hu, Jun Peking Univ.
Organizer: Zhang, Shangyou Univ. of Delaware
Abstract: The elasticity equations are solved in many scientific and engineering problems where the stress is often more important than the displacement. In this sense, the classical Hellinger–Reissner mixed formulation of the elasticity equations, where the stress tensor is sought in a symmetric H-div space and the displacement in an L2 space, is a natural and important variational formulation for this problem. The approximation of displacement can be taken in the space of discontinuous piecewise polynomials of some degree— but the approximation of the symmetric stress tensor is a long-standing, challenging, and surprisingly hard problem. As a matter of fact, "four decades of searching for mixed finite elements for elasticity beginning in the 1960s did

not yield any stable elements with polynomial shape functions" [D. N. Arnold, Proceedings of the International Congress of Mathematicians, Vol. I: Plenary Lectures and Ceremonies (2002), 137-157].
This minisymposium will gather about 16 world experts and young researchers to discuss the most recent advances in this challenging field as well as future directions for research.

▶ MS-Fr-E-31-1 16:00–16:30
Structure Preservation and Some Discretisation Schemes in Linear Elasticity
Zhang, Shuo — Inst. of Computational Mathematics, Chinese Acad. of Sci.

Abstract: In this talk, I will report some recent works on the discretization of linear elasticity and related problems. Judging from theoretical and/or numerical analysis, I will talk about the construction and application of structure-preserving relation in designing and analyzing discretisation schemes, especially the contrast and interaction between the primal and mixed forms.

▶ MS-Fr-E-31-2 16:30–17:00
Lower Order Symmetric Finite Elements for Linear Elasticity on Simplicial Grids
Zhang, Shangyou — Univ. of Delaware

Abstract: We construct, in a unified fashion, lower order, conforming, symmetric finite elements on triangular and tetrahedral grids. These spaces are Pk polynomials (k is no less than 2 but not greater than than the space dimension n), enriched, by minimum local bubbles of polynomials of degree n+1.

▶ MS-Fr-E-31-3 17:00–17:30
The Elasticity Complex, Its Discretization, and Applications
Arnold, Douglas — Univ. of Minnesota

Abstract: Much progress in mixed finite elements for the Laplacian and electromagnetics came from their relationship with the de Rham complex within the framework of Hilbert complexes. The elasticity complex plays a similar role for the equations of elasticity, and also for the Einstein equations. The BGG construction constructs the elasticity complex from the de Rham complex and discretization leads to new stable elements for elasticity. We present this systematically and discuss applications and recent advances.

▶ MS-Fr-E-31-4 17:30–18:00
Adaptive Mixed FEM in Elasticity
Carstensen, Carsten — Humboldt-Universitaet zu Berlin

Abstract: The PEERS and Arnold-Winther FEM are discussed for the computer simulation of elastic solids with Neumann and Dirichlet boundary conditions. The presentation discusses a few a priori comparisons and a refined L2 error control of the stress variables. Some remarks on open questions towards adaptive mesh-refining concludes the presentation.
References:
C. Carstensen, M. Eigel, and J. Gedicke. Computational competition of symmetric mixed FEM in linear elasticity. Comput. Methods Appl. Mech. Engrg., 200(41-44):2903 – 2915, 2011.
C. Carstensen, D. Gallistl, M. Schedensack. L2 Best-Approximation of the Elastic Stress in the Arnold-Winther FEM. Preprint 2014-15, Department of Mathematics, Humboldt-Universität zu Berlin.
Carsten Carstensen, Joscha Gedicke, and Eun-Jae Park. Numerical experiments for the Arnold-Winther mixed finite elements for the Stokes problem. SIAM J. Sci. Comput., 34(4):A2267 – A2287, 2012.
C. Carstensen, D. Günther, J. Reininghaus, and J. Thiele. The Arnold-Winther mixed FEM in linear elasticity. I. Implementation and numerical verification. Comput. Methods Appl. Mech. Engrg., 197(33-40):3014 – 3023, 2008.

MS-Fr-E-32 16:00–18:00 307A
Structured-mesh methods for interface problems. - Part VIII of VIII

For Part 1, see MS-Tu-E-32
For Part 2, see MS-We-D-32
For Part 3, see MS-We-E-32
For Part 4, see MS-Th-BC-32
For Part 5, see MS-Th-D-32
For Part 6, see MS-Th-E-32
For Part 7, see MS-Fr-D-32

Organizer: Chen, Huanzhen — College of Mathematical Sci. Shandong Normal Univ.
Organizer: He, Xiaoming — Missouri Univ. of Sci. & Tech.
Organizer: KWAK, Do Young — Korea Advanced Inst. of Sci. & Tech.
Organizer: Zhang, Xu — Purdue Univ.
Abstract: In many real world applications it is more convenient or efficient to utilize structured meshes for solving different types of interface problems. Since the structured meshes may not fit the non-trivial interfaces, special methods need to be developed to deal with the difficulties arising from the interface problems in order to solve them on these meshes. Therefore, great efforts have been made for solving interface problems and tracing the moving interfaces based on structured meshes in the past decades. This mini-symposium intends to create a forum for researchers from different fields to discuss recent advances on the structured-mesh numerical methods for interface problems and their applications.

▶ MS-Fr-E-32-1 16:00–16:30
A Fully Discrete Method for Nonlinear Convection-diffusion Equations
Shi, Feng — Harbin Inst. of Tech., Shenzhen Graduate School

Abstract: In this talk, we present a fully discrete method for solving the nonlinear convection-diffusion equations. The time discreteization is firstly advanced by a splitting method (Shi-Liang-Zhao-Zou, CICP14') to derive a series of pure convection equations and diffusion equations. Then these equations are solved by the partition of unity (Zheng-Song- Hou-Zhang, ACM14' ; Yu-Shi-Zheng, SISC14'). The new method is very efficient and can capture the moving boundary layers. These conclusions are demonstrated by several numerical experiments.

▶ MS-Fr-E-32-2 16:30–17:00
An Upwind Discontinuous Galerkin Method for A 2-d Sediment Transportation Model and Numerical Tests.
Jian, Jin Feng — Shandong Normal Univ.
Chen, Huanzhen — College of Mathematical Sci. Shandong Normal Univ.

Abstract: In this talk, we discuss the simulation for a 2-d sediment transportation model describing the sediments in the modern yellow river delta. The mathematical model consists of the flow continuity equation, the water movement equation, the sediment continuity equation, the river bed deformation equation. An upwind discontinuous Galerkin finite element procedure is proposed , the sub-optimal L2-norm error estimates are obtained. Numerical tests are conducted to verify the theoretical findings.

▶ MS-Fr-E-32-3 17:00–17:30
Immersed Finite Element Methods with Enhanced Stability
Zhang, Xu — Purdue Univ.
Lin, Tao — Mathematics

Abstract: We discuss new immersed finite element (IFE) methods for an elliptic interface problem. The proposed methods can be used on Cartesian meshes regardless of the interface geometry. Compared to classic IFE methods using Galerkin formulation, these new IFE methods contain additional stabilization terms on interface edges. A priori error estimation shows the optimal converge in a mesh-dependent energy norm. Numerical results demonstrate that our new methods can significantly improve the accuracy around the interface.

MS-Fr-E-33 16:00–18:00 406
Mathematical and computational methods for coupling local and nonlocal models - Part IV of IV

For Part 1, see MS-Th-D-33
For Part 2, see MS-Th-E-33
For Part 3, see MS-Fr-D-33

Organizer: D'Elia, Marta — Sandia National Laboratories
Organizer: Seleson, Pablo — Oak Ridge National Laboratory
Organizer: Bochev, Pavel — Sandia Labs
Abstract: Nonlocal continuum and atomistic models are used in many scientific and engineering applications, where material dynamics depends on microstructure. The numerical solution of nonlocal models might be prohibitively expensive; therefore, concurrent multiscale methods have been proposed for efficient and accurate solutions of such systems. These methods employ nonlocal models in parts of the domain and use local, macroscopic, models elsewhere. A major challenge is to couple these models at interfaces or in overlapping regions. This minisymposium invites contributions on coupling local and nonlocal continuum models and concurrent multiscale methods for atomistic-to-continuum coupling. Related domain decomposition methods are also considered.

▶ MS-Fr-E-33-1 16:00–16:30
A Stochastic Multiscale Method for Coupling of Peridynamics and Continuum Model
Lin, Guang — Purdue Univ.

Abstract: We present a stochastic multiscale method coupling peridynamics, and continuum model. The method is able to cover a wide range of spatio-temporal scales, in particular mesoscopic with peridynamics and continuum through the elastic constitutive model (ECM). peridynamics and ECM are for-

mulated in separate domains and are coupled via the deformation communications at the domain boundaries. There are many uncertain sources in the multiscale model. The proposed method is able to quantify the uncertainty across scales.

▶ MS-Fr-E-33-2 16:30–17:00

Analysis of Finite-temperature Coupling of Atomistic and Continuum Mechanics

Shapeev, Alexander — Skolkovo Inst. of Sci. & Tech.

Abstract: The analysis of atomistic-to-continuum coupling methods at zero temperature has recently seen rapid development, but the rigorous analysis of the finite temperature case has seen little development. In my talk I will present some recent results on the accuracy of finite-temperature defect calculation. In particular, I will propose a theory allowing to compare accuracy of various methods and make predictions about their performance.

▶ CP-Fr-E-33-3 17:00–17:20

A Stabilized Explicit Scheme for Coupling Fluid-structure Interactions

Yu, Yue — lehigh Univ.
Karniadakis, George — Brown Univ.

Abstract: We develop a new stabilized explicit coupling partitioned scheme for the fluid-structure interaction problem, where the pressure and velocity are decoupled. Proper penalty terms are applied to control the variations at the interface. Using energy stability analysis, we show that the scheme is stable independent of the fluid-structure density ratio. Numerical examples are provided to show that although the penalty terms degrade the time accuracy, optimal accuracy is recovered by performing defect-correction subiterations.

▶ CP-Fr-E-33-4 17:20–17:40

Controlling Heavy Metals and Cohesive Sedimentation in Canals

Martinez, Aurea — Univ. of Vigo
Alvarez-Vazquez, Lino — Univ. of Vigo
Fanelli, Claudia — Sapieza Universita di Roma
Rodriguez, Carmen — Universidade de Santiago de Compostela

Abstract: This work deals with the mathematical modelling and control of the processes related to the sedimentation of suspended particles in large streams. To analyze this environmental problem, we propose a mathematical coupling the system for shallow water hydrodynamics with the heavy metals and sediment transport equations. Our main goal is related to establishing the optimal management of a canal in order to avoid the settling of suspended particles and their unwanted effects: channel malfunction, undesired growth of vegetation, etc. So, we formulate the problem as an optimal control problem of partial differential equations to control the velocity of water and, therefore, the settling of particles in suspension. In this first approach to the problem from the viewpoint of environmental control, in addition to a mathematically well-posed formulation of the problem, we present some theoretical and numerical results for a simple realistic case.

▶ CP-Fr-E-33-5 17:40–18:00

A Study of Radial Basis Function Method for Elliptic PDE with Multipoint Nonlocal Boundary Condition

Sajavicius, Svajunas — Vilnius Univ.

Abstract: A meshless method based on radial basis function collocation technique is applied for the solution of elliptic partial differential equation with multipoint nonlocal boundary condition. Such nonclassical boundary conditions appear in mathematical models describing various real-world processes. Besides other advantages, the examined method allows to impose multipoint nonlocal boundary condition very easily. The influence of nonlocal condition to the properties of the method (for example, accuracy and conditioning) is investigated by analysing some test examples.

MS-Fr-E-34 16:00–18:00 112

Modeling and Simulation of Complex Fluids and Biological Systems - Part IV of IV

For Part 1, see MS-Th-D-34
For Part 2, see MS-Th-E-34
For Part 3, see MS-Fr-D-34

Organizer: Zhang, Hui — Beijing Normal Unversity
Organizer: Forest, M. Gregory — Univ. of North Carolina at Chapel Hill
Organizer: Wang, Qi — Univ. of South Carolina & Beijing Computational Sci. Research Center

Abstract: This mini symposium will bring together researchers in complex fluids and biological systems to exchange ideas and perspectives as well as to share their most recent findings. The goal is to integrate advances in mathematics (theory, modeling, data analytics, algorithms, simulations, high performance computing techniques) with new experimental data from complex fluids and biological systems, and targeted applications. The specific systems represented include single living cells, biofilms, active molecular fluids, and transport properties of biological fluids such as lung mucus.
We would like to invite you to give a talk on your current research at the proposed mini-symposium. The talks are scheduled to be 25 minutes each + 5 minutes for discussion.

▶ MS-Fr-E-34-1 16:00–16:30

Single Chain Mean-field Theory of Wormlike Chain System

Zhang, Xinghua — Beijing Jiaotong Univ.

Abstract: Wormlike chain is the best model for liquid crystal and biomacromolecules. Its behaviors involve the diffusion in a five dimensional space which is hard to solve. This hindered the application of the mean-field theory in these systems. Here, the ensemble average of the density operator by directly sampling the conformations of wormlike chain in auxiliary field, and then find solution by iterating the mean-field equations. These procedures can be accelerated by parallel computation.

▶ MS-Fr-E-34-2 16:30–17:00

Deformation of Spherical Polymer Micelle Confined in A Channel

Zhang, Hui — Beijing Normal Unversity

Abstract: When the spherical polymer micelles are confined in a channel, the shape of the micelles may differ from that of the bulk micelles. We study the shape variation of a spherical micelle under confinement with different A-homopolymer length. The results reveal depletion effect and capillary condensation. This numerical result can be used to understand the ADP transport in blood.

▶ CP-Fr-E-34-3 17:00–17:20

Moving Least Squares Interpolation Applied to Octree-based Methods for Fluid Flow Simulations

Sousa, Fabricio — Univ. of Sao Paulo
Simao, Adenilso — Univ. of Sao Paulo
Castelo, Antonio — Univ. of São Paulo
Souza, Leandro — Univ. of Sao Paulo

Abstract: Octree-based methods bring the advantage of using fast cartesian grid discretizations, such as finite differences, and the flexibility and accuracy of local mesh refinement. The problem however is how to adapt the discretization stencil near the transition between grid elements of different sizes, which is usually solved by local high-order interpolations. These interpolations depend on the distribution of cells in the vicinity of the point of interest, which can become quite complex in 3D simulations, specially in staggered grids. Most methods usually avoid this by limiting the mesh configuration, reducing the number of cases to be treated locally. In this work, we employ a moving least squares meshless interpolation technique in order to allow for more complex mesh configurations, still keeping the overall order of accuracy. Numerical tests and application to fluid flow simulations are performed to illustrate the flexibility and robustness of this new approach.

▶ CP-Fr-E-34-4 17:20–17:40

Model and Algorithm for Analysis of Fluid Dynamics During Hemodialysis

Zhu, Fansan — Renal Research Inst.
Kotanko, Peter — Renal Research Inst.
Levin, Nathan W. — renal Research Inst.

Abstract: Intradialytic hypotension (IDH) is a major problem largely due to an imbalance between ultrafiltration rate and vascular refilling rate (VRR) during hemodialysis (HD). The aim of this study was to develop a mathematical model and an algorithm to predict IDH during HD. A model is based on relative blood volume (RBV), blood pressure (BP) and heart rate (HR) since alterations in the VRR can be indicated by change in the second derivative of RBV and the ratio of BP to HR. Forty five HD patients with 245 measurements were monitored during HD. Occurrence of IDH can be predicted with 72.5% sensitivity and 65% specificity about 30 minutes before IDH using the model and algorithm. The model provides information to understand fluid dynamics occurring in fluid compartments during removal of excess fluid by ultrafiltration so that the optimal parameters for individual HD treatments might be established and evaluated in future studies.

▶ CP-Fr-E-34-5 17:40–18:00

Comparison of the Minimum Gap in A Thrust Bearing for Compressible and Incompressible Flow

Bailey, Nicola — Univ. of Nottingham

Abstract: Thrust bearing technology comprises a rotor and stator separated by a thin air film used to maintain a face clearance when subjected to external axial forces. The coupled processes of the pressurised flow through the bearing and axial motion of the rotor and stator is examined for rotor under-

going prescribed periodic oscillations and stator modelled as a spring-mass-damping system. Compressible and incompressible flow models for a thin film bearing are derived in the form of modified Reynolds equations, incorporating high speed effects and a Navier slip boundary condition. For incompressible flow, the modified Reynolds equation leads to analytical expressions for the pressure and force, with the stator equation reduced to a nonlinear second order differential equation, solved for the minimum gap. The compressible Reynolds equation is solved numerically simultaneously with the stator equation, due to extra pressure derivatives. Results are compared for compressible and incompressible flow.

MS-Fr-E-35 16:00–18:00 408

Analysis, Modeling, and Numerical Methods for High Frequency Waves - Part IV of IV

For Part 1, see MS-Th-D-35
For Part 2, see MS-Th-E-35
For Part 3, see MS-Fr-D-35

Organizer: YANG, XU Univ. of California, Santa Barbara
Organizer: YING, LEXING Stanford Univ.
Organizer: HUANG, ZHONGYI Tsinghua Univ.
Organizer: RUNBORG, OLOF Department of Mathematics, KTH

Abstract: The development of modern techniques has been able to provide accurate studies on the micro- and nano-scale physics. Under this small-l scale, the objects often appear as a form of waves, and present quantum properties. On the other hand, the observation is often made at macroscopic scale which is closely related to small-scale details, therefore it is necessary to consider problems at multiple scales. Propagation of high frequency waves is one such topic. The major challenge is that one usually needs to handle the disparity between the two length scales: the large domain size and the small wavelength. This means one has to work on a large computational domain that contains thousands to millions of wavelengths, and each of them needs to be resolved if direct numerical methods are applied. Therefore the total number of grid points is huge, which usually leads to unaffordable computational cost. This minisymposium will focus on high-frequency waves and their applications in quantum mechanics and seismology. Topics on analysis, modeling and numerical methods will be discussed.

▶ MS-Fr-E-35-1 16:00–16:30

Towards A Mathematical Understanding of Surface Hopping

Lu, Jianfeng Duke Univ.

Abstract: Surface hopping algorithm is widely used in chemistry for mixed quantum-classical dynamics, while it is yet clear whether it can be derived asymptotically. We will discuss some recent progress in semiclassical asymptotics and understanding for the surface hopping algorithms. (joint work with Zhennan Zhou)

▶ MS-Fr-E-35-2 16:30–17:00

Factorizations, Sweeping, Source Transfer, Potentials and Schwarz: Why Are These Algorithms Equivalent?

Gander, Martin Universite de Geneve
Zhang, Hui Universite de Geneve

Abstract: It is not surprising that algorithms can be devised by different means and be stated in apparently different formulations but actually do the same thing. This is especially interesting for the recent emerging algorithms for the iterative solution of the Helmholtz equation such as the sweeping preconditioners, the source transfer and the single and/or double layer potential based methods. We will see how these algorithms resemble and differ in terms of optimized Schwarz methods.

▶ CP-Fr-E-35-3 17:00–17:20

A Fast Treecode Algorithm for Stokes Flow in 3D

Wang, Lei Univ. of Wisconsin, Milwaukee
Tlupova, Svetlana Epic Sys. Corporation
Krasny, Robert Univ. of Michigan

Abstract: A large number of problems in fluid dynamics are modeled as many-particle interactions in Stokes flows, for example, simulations of falling jets of particles in viscous fluids, microfluidic crystals, and vesicle flows. The formulation is often based on fundamental solutions. The Stokeslet and the Stresslet are the kernels in the single and double layer potentials, respectively. Many situations (e.g., through superposition or discretization of boundary integrals) involve sums of Stokeslets and Stresslets, which is an example of an N-body problem and the direct sum requires $O(N^2)$ operations. This can make the numerical calculation prohibitively expensive. A Barnes-Hut tree treecode algorithm is developed for speeding up the computation. The particles are restructured recursively into a tree, and the particle-particle interactions are replaced with particle-cluster interactions computed by either a far-field expansion or a direct summation. Numerical results exhibit the promising performance of the algorithm.

▶ CP-Fr-E-35-4 17:20–17:40

Asymptotic Issues

Chipot, Michel Univ. of Zurich

Abstract: We would like to present some results on the asymptotic behaviour of different problems set in cylindrical domains of the type $\ell\omega_1 \times \omega_2$ when $\ell \to \infty$. For $i = 1, 2$ ω_i are two bounded open subsets in $\mathbb{R}^{d_i}$.
To fix the ideas on a simple example consider for instance $\omega_1 = \omega_2 = (-1, 1)$ and u_ℓ the solution to

$$-\Delta u_\ell = f \text{ in } \Omega_\ell = (-\ell, \ell) \times (-1, 1) \ , \ u_\ell = 0 \text{ on } \partial\Omega_\ell.$$

It is more or less clear that, when $\ell \to \infty$, u_ℓ will converge toward u_∞ solution to

$$-\Delta u_\infty = f \text{ in } \Omega_\infty = (-\infty, \infty) \times (-1, 1) \ , \ u_\infty = 0 \text{ on } \partial\Omega_\infty.$$

However this problem has infinitely many solutions since for every integer k

$$\exp(k\pi x_1)\sin(k\pi x_2)$$

is solution of the corresponding homogeneous problem. Our goal is to explain the selection process of the solution for different problems of this type when $\ell \to \infty$.

▶ CP-Fr-E-35-5 17:40–18:00

Blow-up of Finite Difference Solutions to Nonlinear Schrodinger Equations

Sasaki, Takiko Univ. of Tokyo
Saito, Norikazu The Univ. of Tokyo

Abstract: Finite difference schemes for computing blow-up solutions of one dimensional nonlinear Schrodinger equations are presented. By applying time increments control technique, we can introduce a numerical blow-up time which is an approximation of the exact blow-up time of nonlinear Schrodinger equation. After having verified the convergence of our proposed schemes, we proved that the solution of a finite-difference scheme actually blows up in the numerical blow-up time. Then, we proved that the numerical blow-up time converges to the exact blow-up time as the discretization parameters tend to zero. Several numerical examples that confirm the validity of our theoretical results are also offered.

MS-Fr-E-36 16:00–18:00 409

Advances in MCMC and related sampling methods for large-scale inverse problems - Part IV of IV

For Part 1, see MS-Th-D-36
For Part 2, see MS-Th-E-36
For Part 3, see MS-Fr-D-36

Organizer: Bui-Thanh, Tan The Univ. of Texas at Austin
Organizer: Cui, Tiangang MIT
Organizer: Marzouk, Youssef Massachusetts Inst. of Tech.

Abstract: Inverse problems convert indirect measurements into useful characterizations of the parameters of a physical system. Parameters are typically related to indirect measurements by a system of partial differential equations (PDEs), which are complicated and expensive to evaluate. Available indirect data are often limited, noisy, and subject to natural variation, while the unknown parameters of interest are often high dimensional, or infinite dimensional in principle. Solution of the inverse problem, along with prediction and uncertainty assessment, can be cast in a Bayesian setting and thus naturally tackled with Markov chain Monte Carlo (MCMC) and other posterior sampling methods. However, designing scalable and efficient sampling methods for high dimensional inverse problems that involve expensive PDE evaluations poses a significant challenge. This mini-symposium presents recent advances in sampling approaches for large scale inverse problems.

▶ MS-Fr-E-36-1 16:00–16:30

Quasi-Monte Carlo and Multilevel Monte Carlo Methods for Computing Posterior Expectations in Elliptic Inverse Problems

Scheichl, Robert Univ. of Bath
Stuart, Andrew Univ. of Warwick
Teckentrup, Aretha Univ. of Warwick

Abstract: We present an approach (based on Bayes' formula and ratio estimates) to apply QMC and multilevel MC methods for the computation of posterior expectations of functionals of the solution of an elliptic PDE, typically used as a model for uncertainty quantification in subsurface flow. We give a rigorous analysis of their cost to achieve a total mean square error bounded by a given tolerance and numerical results that confirm their superiority over standard approaches.

▶ MS-Fr-E-36-2 16:30–17:00

Online Estimation of Weather Model Parameters

Haario, Heikki LUT

Abstract: Ensemble Prediction Systems (EPS) are used to quantify the uncertainty of weather predictions, by launching predictions with perturbed initial values. Here we extend EPS, with essentially no additional CPU costs, to online estimation by perturbing the model parameters as well. The estimation can be performed both by a covariance update process using importance weights, or by employing evolutionary optimisation. Both single and multiple cost function criteria cases are discussed.

▶ MS-Fr-E-36-3 17:00–17:30

Adaptive Randomize-then-Optimize: A Sampling Algorithm for Bayesian Inference

Wang, Zheng Massachusetts Inst. of Tech.
Marzouk, Youssef Massachusetts Inst. of Tech.

Abstract: In Bayesian inference, the uncertainty of parameters of a physical system is characterized by a probability distribution. Numerical algorithms are typically used to draw samples from this distribution. (Bardsley et al., 2014) introduced one such sampling algorithm, titled Randomize-then-Optimize (R-TO). We present a new geometric interpretation of RTO that builds intuition on the algorithm's strengths and weaknesses, and from this interpretation, we propose an adaptive version of RTO that is more robust and efficient.

▶ MS-Fr-E-36-4 17:30–18:00

Probability Measures on Numerical Solutions of ODEs and PDEs for Uncertainty Quantification and Inference

Conrad, Patrick Univ. of Warwick
Girolami, Mark Univ. of Warwick
Stuart, Andrew Univ. of Warwick

Abstract: Deterministic ODE and PDE solvers are widely used, but characterizing the error in numerical solutions within a coherent statistical framework is challenging. We successfully address this problem by constructing a probability measure over functions consistent with the solution that provably contracts to a Dirac measure on the unique solution at rates determined by an underlying deterministic solver. The measure straightforwardly derives from important classes of numerical solvers and is illustrated on uncertainty quantification and inverse

CP-Fr-E-37	16:00–18:00	301B
Numerical solution		

Chair: XU, Houbao Beijing Inst. of Tech.

Abstract:

▶ CP-Fr-E-37-1 16:00–16:20

Approximating Method for Instantaneous Indexes of A Repairable System

XU, Houbao Beijing Inst. of Tech.
Fan, Ruonan Beijing Inst. of Tech.

Abstract: A typical two-state repairable system is considered in this paper. To analyze the instantaneous reliability index of the system, we describe the system as an abstract Cauchy problem. With the approximating theory of semi-group and Tortter-Kato theorem, we present a new method to solve the instantaneous index of the repairable system. Numerical examples are also shown to verify the effectiveness of this method. At last, the paper points out how to improve the precision of the numerical algorithm through error analysis.

▶ CP-Fr-E-37-2 16:20–16:40

A Simple Method for Numerical Solution of Singular Integral Equation Involving Cauchy Type Kernel

PANDA, SRIKUMAR INDIAN Inst. OF Tech. ROPAR
Martha, Subash Chandra INDIAN Inst. OF Tech. ROPAR
Chakrabarti, Aloknath Indian Inst. of Sci., Bangalore

Abstract: An approximate method is proposed for the solution of a more general class of Cauchy type singular integral equation of the first kind. The present method is illustrated through several examples of singular integral equations. In addition, the approximate solutions are compared with the known solutions. The study reveals that the proposed method is reliable, simple and computationally more efficient and it is useful to solve the singular integral equation involving more complicated kernel.

▶ CP-Fr-E-37-3 16:40–17:00

Numerical Solution of the Kupershmidt Equation by Chebyshev-Legendre Pseudo-Spectral Method

Abdur, Rashid Gomal Univ.

Abstract: A Chebyshev-Legendre Pseudo-Spectral method is applied for solving Kupershmidt equation. In time direction we used a leapfrog scheme, while Chebyshev-Legendre Pseudo-Spectral method is used for space direction. For practical computation Chebyshev-Gauss-Lobatto (CGL) nodes are used. The error estimates of semi-discrete and fully-discrete of Chebyshev-Legendre Pseudo-Spectral method for Kupershmidt equation are obtained by energy estimation method. The numerical results of the present method are compared with the exact solution for two test problems.

▶ CP-Fr-E-37-4 17:00–17:20

Numerical Study of the Square-root Formulation for A MAC-type Method: Computing Highly Elastic Flows of Viscoelastic Fluids

Oishi, Cassio UNESP - Sao Paulo State Univ.
Lopes Palhares Junior, Irineu FCT-UNESP
Afonso, Alexandre FEUP

Abstract: We present in this work a numerical study of the square-root formulation which is a stabilization method for computing highly elastic flows of viscoelastic fluids. The underlying mathematics of this factorization is rooted on an important property of the conformation tensor which is symmetric and positive definite. Different of the famous Log-conformation transformation, that is widely used to treat the High Weissenberg Number Problem, the symmetric factorization of the conformation tensor does not require the numerical computation of the eigenvectors and eigenvalues of the conformation tensor reducing the CPU times of the simulation. In this work, in the context of the Marker-And-Cell method, we describe the application of the square-root formulation for finite difference scheme including free surface boundary conditions. According to the numerical results, the square-root formulation is able to address important problems at high-Weissenberg number flows, for instance, the lid-driven cavity flow and the die-swell free surface problem.

▶ CP-Fr-E-37-5 17:20–17:40

Numerical Solution of Fourth Order Parabolic Partial Differential Equation Using Parametric Septic Splines

Sultana, Talat Janki Devi Memorial College, Univ. of Delhi, New Delhi, India
Khan, Arshad Jamia Millia Islamia, New Delhi

Abstract: In this paper, we report three level implicit method of high accuracy schemes of $O(k^4 + h^8)$, $O(k^6 + h^8)$ and $O(k^6 + h^{10})$ for the numerical solution of fourth order non-homogeneous parabolic partial differential equation, that governs the behavior of a vibrating beam. Parametric septic spline is used in space and finite difference discretization in time. The linear stability of the presented method is investigated. The presented method is tested on three examples. The computed results are compared wherever possible with those already available in literature. This shows the superiority of the presented method.

▶ CP-Fr-E-37-6 17:40–18:00

Numerical Solutions of Moisture and Thermal Transfer in A Bulk of Stored Corn.

Yomsatieankul, Warisa Department of Mathematics Faculty of Sci. King Mongkut's Univ. of Tech. Thonburi
Khuttiyamart, Nut Department of Mathematics Faculty of Sci. King Mongkut's Univ. of Tech. Thonburi
Sujaritnarakorn, Tirawat Department of Mathematics Faculty of Sci. King Mongkut's Univ. of Tech. Thonburi

Abstract: A mathematical modeling for stored corn proposed by Lopes et al. [Lopes D. de C. et al. 2006. Aeration simulation of stored grain under variable air ambient conditions. Postharvest Biology and Technology. 42, 115-120] is studied. The finite difference method, forward time backward space, is applied for discretization of the differential equations that described the heat and mass transfer in a silo of stored corn. The numerical solutions are compared with the collected data during October and November 2013. Numerical results show that the quality of the results obtained by forward time backward space verifies the efficiency and applicability for the simulation.

MS-Fr-E-38	16:00–18:00	302A
Control of partial differential equations - Part II of II		

For Part 1, see MS-Fr-D-38

Organizer: Coron, Jean-Michel Univ. Pierre et Marie Curie
Organizer: Alabau-Boussouira, Fatiha Universite de Lorraine, IECL UMR 7502

Abstract: This mini-symposium will present an overview of recent advances on the control of PDE's and stochastic PDE's, as well as their challenging applicative issues for the control of complex models in quantum mechanics, fluid mechanics, climatology, conservation laws... The first session will focus on the control of quantum systems, stochastic PDE's, hyperbolic system-

s and applied control problems. The second session will present different mathematical methods to solve control issues for degenerate parabolic or hypoelliptic PDE' s, bang-bang control of parabolic questions, under-observed coupled hyperbolic systems and hierarchic control for coupled parabolic systems.

▶MS-Fr-E-38-1 16:00–16:30

Control of Certain Classes of Hypoelliptic Diffusions

Cannarsa, Piermarco Univ. of Rome "Tor Vergata"

Abstract: The control of diffusion models is very well developed for uniformly parabolic operators, much less so for degenerate problems. In the latter case, a general theory which covers controllability/observability issues is still missing. However, we can give a fairly complete analysis of such properties for certain classes of degenerate parabolic equations. This talk will focus on controllability, observability, and Lipschitz stability for diffusions associated with hypo-elliptic operators such as the Grushin and Heisenberg laplacian.

▶MS-Fr-E-38-2 16:30–17:00

Coupling influence on indirect control and inverse problems for cascade systems of PDE' s

Alabau-Boussouira, Fatiha Universite de Lorraine, IECL UMR 7502

Abstract: We consider indirect control and inverse problems for coupled systems. For such problems the number of controls or measurements is strictly less than the number of unknowns. This raises challenging questions related to unique continuation, exact controllability or stability estimates for all the unknowns. We shall present general results and stress the influence of the coupling operators, of the geometric hypotheses and the main differences with respect to the scalar case.

▶MS-Fr-E-38-3 17:00–17:30

TIME OPTIMAL CONTROL OF HEAT EQUATIONS

WANG, GENGSHENG WUHAN Univ.

Abstract: This talk presents some progress and comments on time optimal control problems of heat equations. It focuses on the bang-bang property. We will present a new way to derive the bang-bang property for time invariant heat equations. This method might be applied to time varying systems. We will show that some conditions can ensure the bang-bang property for time varying heat equations. One of them is connected with the completion of the space of all solutions for the time varying heat equations with initial data in L2( ), under a suitable norm.

▶MS-Fr-E-38-4 17:30–18:00

Criteria of Kalman's Type for the Approximate Controllability and the Approximate Synchronization of A Coupled System of Wave Equations

Rao, Bopeng Univ. of Strasbourg

Abstract: In this talk, we give some necessary conditions, presented as criteria of Kalman's type, for the approximate null controllability, the approximate synchronization and the approximate synchronization by groups respectively, for a coupled system of wave equations with Dirichlet boundary controls. The sufficiency of these conditions is proved for 2x2 symmetric system, cascade system and one-dimensional systems.

MS-Fr-E-39 16:00–18:00 302B

New methods and trend in the field of nonlinear filtering - Part II of II

For Part 1, see MS-Fr-D-39

Organizer: Luo, Xue School of Mathematics & Sys. Sci., Beihang Univ., Beijing, P. R. China, 100191

Organizer: Yau, Stephen Department of Mathematical Sci., Tsinghua Univ., Beijing, P. R. China, 100084

Abstract: We shall focus on various aspects of the nonlinear filtering(NLF), including the new methods and related fields. The general idea of NLF is to form some kind of "best estimate" for the true state of some system, given only some potentially noisy observations, and either the system or the observation (or both) is nonlinear. The NLF has been widely used in many science and engineering disciplines, such as radar tracking problems, signal processing etc. There have been intensive research on new methods recently, including the particle filters, methods based on Duncan-Mortensen-Zakai equation, cubature Kalman filter and their variants. The scope of this mini symposium is to discuss all sorts of newly developed methods and the potential trend in the field of NLF.

▶MS-Fr-E-39-1 16:00–16:30

Partially Observed Linear Exponential Quadratic Stochastic Differential Games

Duncan, Tyrone Univ. of Kansas

Abstract: The information filter has been used for the partially observed linear exponential quadratic Gaussian control problem. The linear exponential stochastic differential game has been solved in a direct way by the author. It is natural to consider a partially observed linear exponential quadratic (two person) stochastic differential game. A generalization of the information filter is given. Linear exponential quadratic stochastic differential games with stochastic coefficients and linear state dependent noise are also considered.

▶MS-Fr-E-39-2 16:30–17:00

Discrete Time Linear Exponential Quadratic Gaussian Control and Estimation

Pasik-Duncan, Bozenna Univ. of Kansas

Abstract: A discrete time linear exponential quadratic Gaussian control problem is solved by a direct method that does not use dynamic programming or a stochastic maximum principle. For the corresponding partially observed control problem the information filter for the estimation part of the solution is obtained in a direct way. This approach can be used to generalize to some non-Markovian noise processes. Some generalizations of these control and estimation results are also described.

▶CP-Fr-E-39-3 17:00–17:20

FILTERING TECHNIQUES FOR MRI IMAGES

Gonzalez, Maria C. Univ. of California, Davis
Xiao, Hong Univ. of California

Abstract: Many algorithms for denoising image are focused in Gaussian noise. Nevertheless there are other images that in addition of Gaussian noise may include other types of distortion. Concretely image obtained through Magnetic Resonance Imaging technology common in the medical field may be affected by Rician noise. Common noise removal techniques such time averaging or increasing the voxel volume increase the time acquisition or reduce the resolution of the image. For this reason, denoising techniques applied to the data already acquired that improve the signal-to-noise are of interest. Here, we quantify the Rician noise removal after applying a 2D low pass filter built by truncating the ideal impulse function with several windows and under different design parameters.

MS-Fr-E-41 16:00–18:00 303B

Variational image analysis and applications - Part II of II

For Part 1, see MS-Fr-D-41

Organizer: Guo, Weihong Case Western Reserve Univ.
Organizer: Qin, Jing Univ. of California, Los Angeles

Abstract: Variational/PDE is a powerful tool in image processing and analysis. After decades of intensive research, it is still a challenge to recover high quality images from their noisy, blurry, low-resolution counterparts and/or incomplete measurements. It is especially difficult for images containing important details of various scales. Effective regularity schemes and efficient algorithms play important roles in these problems. This mini-symposium brings together leading researchers to discuss the state-of-the-art theoretical developments in variational image reconstruction, image segmentation, image super-resolution and their applications in medicine biology, etc.

▶MS-Fr-E-41-1 16:00–16:30

Fuzzy Image Segmentation Based on TV Regularization and L1-norm Fidelity

Li, Fang East China Normal Univ.
Qin, Jing Univ. of California, Los Angeles
Yan, Ming UCLA

Abstract: We propose a variational multi-phase image segmentation model based on Total Variation (TV) regularization and L1-norm fidelity. To deal with the non-smooth regularization term, we apply the Alternating Direction Method of Multipliers by splitting variables. In particular, we reorder the membership functions and intensities to obtain fuzzy median. Experimental results and comparisons show that the L1-norm based method is more robust to outliers such as impulse noise and preserves contrast better than its L2-norm counterpart.

▶MS-Fr-E-41-2 16:30–17:00

Convex Variational Model for Restoring Blurred Images with Rician Noise

Zeng, Tieyong Hong Kong Baptist Univ.

Abstract: In this talk, a new convex variational model for restoring images degraded by blur and Rician noise is proposed. Due to the convexity, the solution of our model is unique and independent of the initialization of the algorithm. We utilize a primal-dual algorithm to handle the minimization. Numerically, our model outperforms some of the state-of-the-art models in both medical and natural images. Other non-Gaussian noise will be addressed if time permitted.

▶MS-Fr-E-41-3 17:00–17:30

Tight Frame Based Image Segmentation and Applications

Zhang, Xiaoqun Shanghai Jiao Tong Univ.

Abstract: Motivated by the theoretical connection between wavelet frames based and total variation based image restoration models; we consider wavelet frame based segmentation models for image and video segmentation. The proposed models allow us to automatically identify complex tubular structures, including blood vessels, leaf vein systems, etc. We also present the application to ultrasound image segmentation and tracking incorporating shapes priori. In addition, we discuss some theortical aspects of the solutions and the convergences of algorithms.

▶ MS-Fr-E-41-4 17:30–18:00

Empirical Bayes Estimation of Hypermodel Parameters in Brain Activity Imaging

Calvetti, Daniela Case Western Reserve
Somersalo, Erkki Case Western Reserve Univ.

Abstract: MEG is a noninvasive modality to image brain activity from magnetic field measurements outside the skull. We present a very efficient algorithm for estimating the brain activity that uses anatomical information and automatically updates the prior variance.

IM-Fr-E-42 16:00–18:00 301A
Computational Social Sciences

Organizer: Choi, Sou-Cheng NORC at the Univ. of CHicago

Abstract: In the last decade, we have seen an enormous growth of social networks (Facebook, Twitter), e-commerce (Amazon, Netflix), and many other novel applications providing services over the internet. This has allowed human and social behavior to be measured and collected on an unprecedented scale. Social sciences have been gradually transformed into a data science that could in principle be studied and understood from an analysis of these massive datasets. The key to gaining insights from these large datasets however requires new techniques and algorithms.
This minisymposium serves to explore some of the latest computational, mathematical, or statistical techniques for processing and analyzing big-volume, high-velocity complex data stemming from social sciences such as annual national surveys, online social networks, or public-domain forums. We focus on both the challenges and solutions for social science problems that arise from industries or government sectors.

▶ IM-Fr-E-42-1 16:00–16:30

Social Data Science Needs Theories of Social Data: the Case of Sociopolitical Regime Shift During the 2011 Singapore General Election Detected from Online Social Media

Cheong, Siew Ann Nanyang Technological Univ.

Abstract: Big Data promises to revolutionize the way we make business, personal, or political decisions. However, insights from such data remain limited, unless they are supplemented by theories on the data. In this talk, I will illustrate how a theory of online discussions can help us discover early warning signals of a shift in sociopolitical sentiments during the 2011 Singapore General Election that could not be identified any other way from four Singapore-based online forums.

▶ IM-Fr-E-42-2 16:30–17:00

Machine Learning for Machine Data

Choi, Sou-Cheng NORC at the Univ. of CHicago

Abstract: We present machine learning and high-accuracy prediction methods of rare events in semi-structured or unstructured log files produced at high velocity and high volume by NORC's computer-assisted telephone interviewing network. These machine log files are generated by our internal Voxco Servers for a telephone survey. We adapt natural language processing (NLP) techniques and data-mining methods to train powerful learning and prediction models for errors in the absence of source code, updated documentation, and relevant dictionaries.

▶ IM-Fr-E-42-3 17:00–17:30

Estimating Online Performance of Predictive Models

Yi, Jeonghee Microsoft Corp

Abstract: Offline evaluation metrics, such as AUC (the Area Under the Receiver Operating Characteristic Curve) and RIG (Relative Information Gain) are indicators of the expected model performance on real data. However, a substantial discrepancy between the offline and online performance exists in practice.
We designed a new model evaluation paradigm that simulates the online user behavior from the historic user behaviors. The experimental results on click prediction models for search advertising are highly promising.

▶ IM-Fr-E-42-4 17:30–18:00

Critical Points of Networks

Yao, Yuan Peking Univ.

Abstract: We will introduce a notion of critical nodes associated with networks with free energy functions, docking on the recent development of computational topology. It leads to a concise and hierarchical representation of the network. Applications are discussed in social and biological networks, which show that critical nodes carry important information about structures and transition paths in such networks.

MS-Fr-E-43 16:00–18:00 VIP4-1
Optimization algorithms and application - Part V of V

For Part 1, see MS-Th-BC-43
For Part 2, see MS-Th-D-43
For Part 3, see MS-Th-E-43
For Part 4, see MS-Fr-D-43

Organizer: Wen, Zaiwen Peking Univ.
Organizer: Yuan, Ya-xiang Inst. of Computational Mathematics & Scientific/Engineering Computing
Organizer: Xia, Yong Beihang Univ.

Abstract: This minisymposium consists 5 sessions. It highlights recent advances in theory, algorithms and applications of mathematical optimization on solving huge problems that are intractable for current methods.

▶ MS-Fr-E-43-1 16:00–16:30

Uniform Quadratic Programming and Extension

Xia, Yong Beihang Univ.

Abstract: The uniform quadratic optimizatin problem (UQ) is a nonconvex quadratic constrained quadratic programming (QCQP) with the same Hessian matrix. A sufficient condition to guarantee strong duality for (UQ) is characterized and then extended to (QCQP). It covers many well-known results. For convex constrained nonconvex (UQ), we propose a new approximate algorithm. In particular, we give the first approximation ratio for the problem of finding the Chebyshev center of the intersection of several balls.

▶ MS-Fr-E-43-2 16:30–17:00

An SSQP Framework for A Class of Composite L_q Minimization over Polyhedron

Liu, Ya-Feng Acad. of Mathematics & Sys. Sci., Chinese Acad. of Sci.

Abstract: The composite $L_q(0 < q < 1)$ minimization problem over a general polyhedron has received various applications in machine learning, wireless communications, image restoration, signal reconstruction, etc. In this talk, we shall present a theoretical study on this problem. In particular, we shall talk about its exact recovery, computational complexity, and optimality conditions. We shall also propose a smoothing sequential quadratic programming (SSQP) framework for solving the problem, and analyze the worst-case iteration complexity of the proposed framework.

▶ MS-Fr-E-43-3 17:00–17:30

RSP-Based Analysis for Sparsest Solutions to the System of Linear Equalities and Inequalities

Huang, Zheng-Hai Tianjin Univ.

Abstract: In this paper, we consider the problem to find the sparsest solution to the system of linear equalities and inequalities. We propose the range space property for the concerned problem and investigate the necessary and sufficient conditions for the uniqueness of the solution to the relaxed problem; in particular, we show that the original problem is equivalent to its convex relaxation under mild conditions.

▶ MS-Fr-E-43-4 17:30–18:00

Subspace Methods for Large-scale Optimization

Grapiglia, Geovani Federal Univ. of Parana
Yuan, Jinyun Federal Univ. of Parana
Yuan, Ya-xiang Inst. of Computational Mathematics & Scientific/Engineering Computing

Abstract: Subspaces methods are presented for large-scale optimization problems. The main feature of this class of methods is that the trial steps are obtained by solving the subproblems in low-dimensional subspaces. Obviously, the main question in this approach is: how to choose the subspaces? We provide suitable choices in the context of trust-region and regularization methods for unconstrained and equality-constrained problems. Numerical results are also reported.

MS-Fr-E-44 16:00–18:00 VIP2-1
Pseudo-Differential Operators in Industries and Technologies - Part IV of IV
For Part 1, see MS-Th-D-44
For Part 2, see MS-Th-E-44
For Part 3, see MS-Fr-D-44
Organizer: Wong, M.W. York Univ.
Abstract: Pseudo-differential operators, first appeared in 1960s in the paper by Joseph J. Kohn and Louis Nirenberg in the Communications on Pure and Applied Mathematics, have been used in the explicit descriptions of solutions of Partial Differential Equations. Since wavelet transform and related transforms came to the fore and became understood by scientists and engineers in the physical sciences, biomedical sciences, atmospherical sciences and geological sciences in the context of time/space -frequency representations, pseudo-differential operators and their variants such as Weyl transforms and noncommutative quantization with operator-valued symbols have become instrumental in signal and image analysis in the role of filters. Extensions of classical pseudo-differential operators to Weyl transforms and pseudo-differential operators to H-type groups can be thought of as noncommutative quantization. The aim of this minisymposium is to provide a platform for dialogs on several developments of pseudo-differential operators in some areas of industries and technologies such as information, communication and signals.

▶MS-Fr-E-44-1 16:00–16:30
The Roles of Pseudo-Differential Operators and Related Mathematics in Industries and Technologies
Wong, M.W. York Univ.
Abstract: Pseudo-differential operators, first appeared in 1960s in the paper by Joseph J. Kohn and Louis Nirenberg in the Communications on Pure and Applied Mathematics, have been used in the explicit descriptions of solutions of Partial Differential Equations. Since wavelet transform and related transforms came to the fore and became understood by scientists and engineers in the physical sciences, biomedical sciences, atmospherical sciences and geological sciences in the context of time/space -frequency representations, pseudo-differential operators and their variants such as Weyl transforms and noncommutative quantization with operator-valued symbols have become instrumental in signal and image analysis in the role of filters. Extensions of classical pseudo-differential operators to Weyl transforms and pseudo-differential operators to H-type groups can be thought of as noncommutative quantization. The aim of this minisymposium is to provide a platform for dialogs on several developments of pseudo-differential operators in some areas of industries and technologies such as information, communication and signals.

▶MS-Fr-E-44-2 16:30–17:00
Pseudo-Differential Operators for Weyl Transforms
Duan, Xiaoxi York Univ.
Wong, M.W. York Univ.
Abstract: Pseudo-differential operators with operator-valued symbols for Weyl trasforms are introduced. We give suitable conditions on the symbols for which these operators are in the trace class and give a trace formula for them.

▶MS-Fr-E-44-3 17:00–17:30
Local Sampling and Approximation of Operators with Bandlimited Kohn-Nirenberg Symbol
Pfander, Goetz Jacobs Univ.
Abstract: Available sampling of operator results are inherently non-local; indeed,to recover a bandlimited operator precisely, the so-called identifier cannot decay in time nor in frequency. Here, we illustrate, that to obtain a local approximation of an operator, it is sufficient to test the operator on a compactly supported Schwarz class function. (This talk is part of a series of operator sampling talks of David Walnut and myself at ICIAM.)

▶MS-Fr-E-44-4 17:30–18:00
Sampling Theory for Operators with Bandlimited Kohn-Nirenberg Symbols
Walnut, David George Mason Univ.
Abstract: The problem of identifying an operator with bandlimited symbol is rooted in work of Kailath and Bello in the 1960s on the sounding of spread-spectrum communication channels. The theory has striking similarities with classical sampling theory which it generalizes. We describe notions of sampling rate, density, and critical sampling in this case. (This talk is part of a series of operator sampling talks of Goetz Pfander and myself at ICIAM.)

MS-Fr-E-45 16:00–18:00 213A
Optimization Methods for Inverse Problems - Part V of V
For Part 1, see MS-Th-BC-45
For Part 2, see MS-Th-D-45
For Part 3, see MS-Th-E-45
For Part 4, see MS-Fr-D-45
Organizer: LIU, XIN AMSS
Organizer: WANG, YANFEI The Inst. of Geology & Geophysics, CAS
Abstract: In this minisymposium, inverse problems arisen from various areas such as geoscience and petroleum engineering, related optimization models like L1 norm regularization, and advanced optimization methods for solving these models such as first order methods, subspace methods, alternating direction method of multipliers and distributed optimization approaches are discussed.

▶MS-Fr-E-45-1 16:00–16:30
Multiscale Collocation Methods for Ill-posed Integral Equations with A Modified Posteriori Parameter Selection
Xingjun, Luo School of Mathematics & Computer Sci., Gannan Normal Univ.,
Abstract: Multiscale collocation methods are developed for solving a system of integral equations which is a reformulation of the Lavrentiev-regularized second-kind equation of an ill-posed integral equation of the first kind, if the associated resolvent integral operator fulfils a condition with respect to a sector. The method is developed based on a matrix compression strategy resulting from using multiscale piecewise polynomial basis functions and their corresponding multiscale collocation functionals. A modified a posteriori parameter choice strategy is presented, which leads to optimal convergence rates. Numerical results are presented to demonstrate the efficiency and accuracy of the proposed method.

▶MS-Fr-E-45-2 16:30–17:00
The Size of the Domain of Measurement in Continuation Problem as the Regularization Parameter
Shishlenin, Maxim Sobolev Inst. of Mathematics, Novosibirsk State Univ.
Abstract: We investigate a continuation problem for the elliptic equation. We will show that the size of the domain of measurement can be treated as the parameter of regularization. Theoretical and numerical results will be presented. The work was supported by the Russian Foundation for Basic Research grant 15-01-09230 and the Ministry of Education and Science of the Russian Federation.

▶MS-Fr-E-45-3 17:00–17:30
Inverse Elastic Surface Scattering with Near-Field Data
Li, Peijun Purdue Univ.
Abstract: We present a novel computational method for solving the inverse elastic surface scattering problem by using the near-field data. The method requires only a single illumination with one frequency and one incident angle. An error estimate provides a deep insight on the trade-off among resolution, accuracy, and stability of the solution. Numerical experiments show that it is capable of reconstructing the surfaces with subwavelength resolution.

IM-Fr-E-46 16:00–18:00 306B
Recent mathematical advances in seismic modeling, imaging and inversion - Part II of II
For Part 1, see IM-Fr-D-46
Organizer: Yarman, Evren Schlumberger
Organizer: Flagg, Garret Schlumberger
Abstract: Confidence in recovering earth’s properties requires good understanding of the underlying physics of wave propagation to synthetically generate data matching the measurements. This data matching problem, also known as full waveform inversion, requires three steps: (1) modeling: simulation of seismic wave propagation; (2) imaging (linearized inversion): reconstruction of the medium’s singularities by linearization of the forward modeling with respect to a known background; (3) inversion (non-linear inversion): updating the background model to match the measurements. This mini symposium scopes recent methods that are being developed in industry and academia addressing various aspects of these three steps.

▶IM-Fr-E-46-1 16:00–16:30
Recent Developments in Sweeping Preconditioner for High Frequency Wave Equations
YING, LEXING Stanford Univ.
Abstract: This talk will discuss the recent developments in sweeping preconditioner for high frequency wave equations

▶ IM-Fr-E-46-2 16:30–17:00

Reduced Order Models for Seismic Full Waveform Inversion.

Mamonov, Alexander Schlumberger
Druskin, Vladimir Schlumberger-Doll Research
Zaslavsky, Mikhail Schlumberger-Doll Research

Abstract: We present a framework for the seismic full waveform inversion (FWI) using the reduced order models (ROMs). The ROM is a projection of the PDE operator on the subspace spanned by the snapshots of the solutions of the forward problem. The ROM can be found directly from the measured time domain seismic data. The use of the ROM in FWI improves the convergence and completely removes the multiple reflections.

MS-Fr-E-48 16:00–18:00 212B

Image restoration: new algorithms and new applications - Part III of III

For Part 1, see MS-Th-E-48
For Part 2, see MS-Fr-D-48

Organizer: Sgallari, Fiorella Univ. of Bologna
Organizer: Chan, Raymond The Chinese Univ. of Hong Kong

Abstract: The field of digital image restoration is concerned with the reconstruction or estimation of uncorrupted images from noisy, blurred ones. This blurring may be caused by optical distortions, object motion during imaging, or atmospheric turbulence. There are existing or potential applications of image restoration in many scientific and engineering fields, e.g. aerial imaging, remote sensing electron microscopy, and medical imaging. From these arise some real challenging problems related to image reconstruction/restoration that open the way to some new fundamental scientific questions closely related with the world we interact with and Mathematics has become one of the main driving forces of the modern development of image restoration.
The purpose of this mini-symposium is to gather the leading researchers in the areas of image restoration/reconstruction to present a series of talks that will expose the current state of knowledge in the algorithmic and application field. Our goal is also to establish connections between different techniques, talk about important issues in the emerging application fields and generate novel ideas for future development.

▶ MS-Fr-E-48-1 16:00–16:30

Total-variation-based-denoising of Gravitational Wave Signals

Marquina, Antonio Univ. of Valencia

Abstract: In this talk we formulate total variation based denoising algorithms to recover numerically-simulated gravitational wave signals. We shall give a brief introduction to the variational denoising and compressing models to better understand the purpose of this research work. We also introduce the fundamentals of the theory of gravitational wave signals generated by high energy astrophysical events and the interest to detect these signals. We present some numerical results for two types of waveforms, namely, ”bursts” and ”chirps” for which catalogs are available.

▶ MS-Fr-E-48-2 16:30–17:00

An Adaptive Inner-outer Iterative Regularization Method for Image Edge Recovery

Kilmer, Misha Tufts Univ.

Abstract: We consider a new inner-outer iterative algorithm for edge recovery in image restoration and reconstruction problems. We propose a sequence of dynamically updated regularized least squares problems where the value of the regularization parameter for each problem is determined on-the-fly for each through a hybrid regularization approach. We present results on applications in X-ray CT and image deblurring that show that our algorithm has the potential to produce high-quality images in a computationally efficient manner.

▶ MS-Fr-E-48-3 17:00–17:30

Distributed Regularization Parameter Choice Based on Bilevel Optimization

Hintermueller, Michael Humboldt-Univ. of Berlin

Abstract: Based on the pre-dual formulation of the total variation regularization (TV) model in image restoration, a bilevel optimization approach to the choice of a spatially distributed regularization parameter is introduced. The upper level problem contains the TV-model as a constraint and has an objective which depends on a variance corridor for a locally averaged residual. Stationarity conditions for the bilevel problem are derived, a solution algorithm is devised, and numerical results are discussed.

MS-Fr-E-49 16:00–18:00 107

Mathematical Models of Retinal Degeneration and Treatments

Organizer: Wirkus, Stephen Arizona State Univ.

Abstract: While mathematical physiology has given numerous insights into biological systems, only recently have mathematical models been proposed to study retinal degeneration. Many conditions that lead to blindness have cures but the degenerative conditions Retinitis Pigmentosa (genetic) and retinal detachment (usually caused by physical trauma) do not have cures. This session focuses on recent work involving mechanistic mathematical models of photoreceptor degeneration and potential therapies some of which have been physiologically proposed. Dynamical systems and control theory are used to investigate the various mathematical models presented here and interpret their results.

▶ MS-Fr-E-49-1 16:00–16:30

Optimal Control of MANF to Prevent Apoptosis in Retinitis Pigmentosa

Melara, Luis Shippensburg Univ.
Villalobos, Cristina Univ. of Texas-Pan American
Wirkus, Stephen Arizona State Univ.
Camacho, Erika Arizona State Univ.

Abstract: Protein misfolding is one of the major causes of apoptosis in Retinitis Pigmentosa, where apoptosis is programmed cell death. Mesencephalic-Astrocyte-derived-Neurotrophic Factor (MANF) is a protein that has been shown to correct protein misfolding, thus reducing the death of cells due to ”cell suicide.” In this talk, we formulate an optimal control problem that incorporates MANF treatment to rescue photoreceptors in the eye. Numerical results are shown and discussed.

▶ MS-Fr-E-49-2 16:30–17:00

Optimal Control in the Treatment of Retinitis Pigmentosa

Villalobos, Cristina Univ. of Texas-Pan American
Melara, Luis Shippensburg Univ.
Wirkus, Stephen Arizona State Univ.
Camacho, Erika Arizona State Univ.

Abstract: Given the recent discovery of the RdCVF protein, we study its potential therapy in the treatment of the degenerative eye disease, Retinitis Pigmentosa (RP). We build on an existing mathematical model of photoreceptor interactions in the presence of RP and incorporate various treatment regiments via RdCVF. In addition, we present numerical results for various cases of degeneration.

▶ MS-Fr-E-49-3 17:00–17:30

The Role of RdCVF in Photoreceptor Degeneration

Camacho, Erika Arizona State Univ.
Wirkus, Stephen Arizona State Univ.

Abstract: Retinitis pigmentosa is an inherited disease characterized by death of the rod photoreceptors due to mutation(s) within the rod. Death of cones is also inevitable even though they do not carry any mutation. Experimentalists have developed numerous hypotheses including the observed production of a rod-derived cone viability factor (RdCVF) that is necessary for cone survival. This talk examines a mathematical model of RdCVF and investigates its effect on the stability of solutions.

▶ MS-Fr-E-49-4 17:30–18:00

A Mathematical Model of Photoreceptor Death: Retinitis Pigmentosa and Retinal Detachment

Wirkus, Stephen Arizona State Univ.
Camacho, Erika Arizona State Univ.

Abstract: This talk will provide a brief overview of the relevant physiology of the eye as it pertains to photoreceptor degeneration. With mathematical models, we will explore the experimentally observed photoreceptor death and rescue in retinitis pigmentosa and retinal detachment, comparing known datasets with our model. Our work highlights the delicate balance between the availability of nutrients, and photoreceptors’ energy uptake and consumption needed for a normal functioning retina.

MS-Fr-E-50 16:00–18:00 207

Mathematical and Numerical Aspects of Electronic Structure Theory - Part V of V

For Part 1, see MS-Th-BC-50
For Part 2, see MS-Th-D-50
For Part 3, see MS-Th-E-50
For Part 4, see MS-Fr-D-50

Organizer: Lin, Lin Univ. of California at Berkeley
Organizer: Lu, Jianfeng Duke Univ.

Abstract: Electronic structure theory and first principle calculations are among the most challenging and computationally demanding science and engineering problems. This minisymposium aims at presenting and discussing new developments of mathematical analysis, and numerical methods for achieving ever higher level of accuracy and efficiency in electronic structure theory. This includes ground state and excited state density functional theory calculations, wavefunction methods, together with some of their applications

in computational materials science and quantum chemistry. We propose to bring together experts on electronic structure theory, which include not only mathematicians, but also physicists working actively in the field.

▶ MS-Fr-E-50-1 16:00–16:30

Parallel Scalability of Hartree-Fock Calculations

Chow, Edmond Georgia Inst. of Tech.

Abstract: Quantum chemistry is increasingly performed using large cluster computers consisting of multiple interconnected nodes. For a fixed molecular problem, calculation efficiency usually decreases as more nodes are used. We empirically investigate the parallel scalability of Hartree-Fock calculations. We use density matrix purification from the linear scaling methods literature, but without using sparsity. When using large numbers of nodes for moderately-sized problems, density matrix computations are network-bandwidth bound, making purification methods potentially faster than eigen-decomposition methods.

▶ MS-Fr-E-50-2 16:30–17:00

H-P Finite Element Method for Electronic Structure Calculations

Marcati, Carlo Laboratoire J.-L. Lions, Univ. Pierre et Marie Curie
Maday, Yvon Laboratoire J.-L. Lions, Univ. Pierre et Marie Curie

Abstract: The (continuous) finite element approximations of different orders for electronic structures approximation has recently been proposed and the performance of these approaches is becoming appreciable and is now well understood. In this presentation we propose to extend this discretization by combining the refinement of the finite element mesh where the solution is most singular with the increase of the degree of the polynomial approximations in the regions where the solution is mostly regular.

▶ MS-Fr-E-50-3 17:00–17:30

Localized Resolution-of-identity Approach to Correlated Methods under Periodic Boundary Condition

Ren, Xinguo Univ. of Sci. & Tech. of China

Abstract: The implementation of correlated methods with numerical atomic orbitals (NAO) for infinite periodic systems is challenging. With a recently developed resolution-of-identity technique, we implemented the random-phase approximation and the GW method in the NAO-based FHI-aims code. In this talk, we will present the basic algorithm behind our implementation as well as benchmark results to demonstrate the accuracy and efficiency of the algorithm. The promise and the remaining challenges will be highlighted.

▶ MS-Fr-E-50-4 17:30–18:00

Large-scale Ab Initio Simulations Based on Systematically Improvable Atomic Basis

He, Lixin Univ. of Sci. & Tech. of China

Abstract: Atomic orbitals have many advantages as basis sets for ab initio electronic structure calculations. However, the atomic basis sets must be constructed very carefully to ensure both good accuracy and transferability. We have proposed a unique scheme to construct systematically improvable optimized atomic basis sets. This scheme has been implemented in our home made first-principles packages ABACUS. Our benchmark tests show that our atomic bases work very well for wide range of physical systems, including bulks, molecules, surfaces, defects, etc.

MS-Fr-E-51 16:00–18:00 209A

Recent Developments in the Modeling, Simulation and Analysis of Mathematical Models Arising from Biology - Part III of III

For Part 1, see MS-Th-E-51
For Part 2, see MS-Fr-D-51

Organizer: Jain, Harsh Florida State Univ.
Organizer: Zhao, Kun Tulane Univ.

Abstract: Mathematical modeling is an effective and powerful tool in understanding complex biological phenomena. These models, using tools from diverse areas of mathematics ranging from partial and ordinary differential equations to group theory and topology, provide deep insights into the complex nature of biology that would otherwise be difficult to capture experimentally or in a clinical setting. Active research areas in mathematical biology include modeling of human vascular system, chemotaxis, wound healing, population dynamics, angiogenesis, cancer, morphogenesis and epidemiology. Speakers in this mini-symposium will discuss current research progress on the modeling, analysis and numerical simulation of models in these areas.

▶ MS-Fr-E-51-1 16:00–16:30

Identifiability and Interacting Scales in Modeling Disease Dynamics

Eisenberg, Marisa Univ. of Michigan, Ann Arbor

Abstract: Disease dynamics involve interacting factors at multiple scales, and modeling these processes can involve working with a wide range of (sometimes incomplete) data sets. I will discuss identifiability and parameter estimation of disease transmission models, and examine how these issues are affected when incorporating processes and data from a range of scales (from cellular to environmental). I will highlight examples from some of our recent work, including applications to cholera, ebola, and human papillomavirus (HPV).

▶ MS-Fr-E-51-2 16:30–17:00

Identifiability and Nature of Solutions in Models of Tumor Growth and Treatment

Jain, Harsh Florida State Univ.
Eisenberg, Marisa Univ. of Michigan, Ann Arbor

Abstract: Delay differential equation models of solid tumor treatment with taxanes (anti-mitotic drugs) and platinum-based compounds will be presented. Necessary and sufficient conditions for stability of the cancer free equilibrium are derived, and in the cases where chemotherapy is administered periodically, the existence of periodic solutions is investigated analytically. Issues of model identifiability will be discussed, together with several numerical examples.

▶ MS-Fr-E-51-3 17:00–17:30

Gierer-Meinhardt System with Activator Production Saturation and Gene Expression Time Delays

Shi, Junping College of William & Mary

Abstract: Gierer-Meinhardt reaction-diffusion system is one of prototypical models for spatial-temporal pattern formation. The dynamics of Gierer-Meinhardt system with activator production saturation and gene expression time delays is considered here. We analyze (i) bifurcation and pattern formation of non-delay model; (ii) global asymptotic stability for large saturation coefficient; (iii) delay-induced oscillations.

MS-Fr-E-52 16:00–18:00 212A

Recent Development of Mathematical Models in Computational Biology - Part V of V

For Part 1, see MS-Th-BC-52
For Part 2, see MS-Th-D-52
For Part 3, see MS-Th-E-52
For Part 4, see MS-Fr-D-52

Organizer: Zhang, Lei Peking Univ.
Organizer: Ge, Hao Peking Univ.
Organizer: Lei, Jinzhi Tsinghua Univ.

Abstract: One of the central problems in biology is to understand the design principles of complex biological systems. Mathematical and computational models of biological processes can be characterized both by their level of biological detail and by their mathematical complexity. In this minisymposium, we focus on recent findings of computational models and methods to gain insights of the complexity of cellular life and efficiently analyze the experimental observations. Topics of interests include stem cells, developmental patterning, gene regulatory networks, neuron networks, uncertainty quantification of biological data, etc.

▶ MS-Fr-E-52-1 16:00–16:30

Injury-initiated Clot Formation under Flow: A Mathematical Model with Warfarin Treatment

Ma, Yanping Loyola Marymount Univ.

Abstract: When an individual at risk for forming a thrombus is treated with anticoagulant medication, the International Normalized Ratio (INR) must be measured regularly. We explore the conditions under which an injury-induced thrombus may form in vivo but not in vitro. We extend previous models and present numerical simulations that compare scenarios in which drug doses and flow rates are modified. Our results indicate that traditional INR measurements may not accurately reflect in vivo clotting times.

▶ CP-Fr-E-52-2 16:30–16:50

Red Queen Dynamics in Specific Predator-prey Systems

Harris, Terence Univ. of New South Wales
Cai, Anna Univ. of New South Wales,

Abstract: The dynamics of a predator-prey system are studied, with a comparison of discrete and continuous strategy spaces. For a 2X2 system, the average strategies used in the discrete and continuous case are shown to be the same. It is further shown that the inclusion of constant prey switching in the discrete case can have a stabilising effect and reduce the number of available predator types through extinction.

▶ CP-Fr-E-52-3 16:50–17:10

A New Mathematical Model of Tumor Growth, Treatment and Regression

Saltzman, Jeffrey AstraZeneca

Abstract: Pharmacometricians are often constrained in what types of mathematical constructs they may apply to modeling drug efficacy and safety. Current scientific frameworks limit models to sets of algebraic and/or differential equations yet many questions arise in tumor modeling that simply cannot be answered by the current paradigm. We have developed a set of age-structured partial differential equations describing tumor evolution that are both efficiently approximated numerically and provide modelers with a higher fidelity modeling platform.

MS-Fr-E-53 16:00–18:00 311B

Risk Management and Financial Regulation

Organizer: Ludkovski, Mike UC Santa Barbara
Organizer: Leung, Tim Columbia Univ.
Organizer: Peng, Xianhua Hong Kong Univ. of Sci. & Tech.

Abstract: There has been a growing interest in the study of issues related to risk management and financial regulation in the financial mathematics community. This minisymposium will cover issues related to how to design risk weights and how to measure risk for setting capital requirements in financial regulations and the risk analysis and hedging of financial derivatives

▶ MS-Fr-E-53-1 16:00–16:30

On the Measurement of Economic Tail Risk

Peng, Xianhua Hong Kong Univ. of Sci. & Tech.

Abstract: This paper attempts to provide a decision-theoretic foundation for the measurement of economic tail risk, which is related to utility theory and statistical model uncertainty. The main result is that the only tail risk measure that satisfies a set of economic axioms for Choquet expected utility and the statistical property of elicitability (there exists an objective function such that minimizing the expected objective function yields the risk measure) is median shortfall.

▶ MS-Fr-E-53-2 16:30–17:00

Unbiased Estimators of the Greeks for General Diffusion Processes

Kang, Wanmo KAIST

Abstract: Computing derivative price sensitivities is widely applicable in financial engineering. Discretization schemes are conventionally used for the simulation of general diffusion models because of unknowingness of distributions associated with general diffusions. Taking advantage of Roberts-Beskos method which is an exact simulation algorithm of one dimensional SDE, we propose estimators of Delta and Gamma without discretization bias. We detail the algorithms and give numerical results. This is a joint work with Jongmun Lee.

▶ MS-Fr-E-53-3 17:00–17:30

Multiname Default Intensity Models under Stochastic Time-change

Gordy, Michael Federal Reserve Board

Abstract: We develop a reduced-form multiname model of credit risk that incorporates stochastic volatility in default intensity via stochastic time-change. The model is estimated by particle Markov chain Monte Carlo on panel data of credit default swap spreads on five major banks. We find strong evidence of dependence on a common volatility factor, as well as a common factor in intensities. Implications for forecasting the probability of systemic events in the finance sector are illustrated.

MS-Fr-E-54 16:00–18:00 VIP1-2

Modeling and Simulations of Complex Biological Systems - Part IV of IV

For Part 1, see MS-Th-D-54
For Part 2, see MS-Th-E-54
For Part 3, see MS-Fr-D-54

Organizer: Liu, Xinfeng Univ. of South Carolina
Organizer: Ju, Lili Univ. of South Carolina

Abstract: This mini-symposium aims to bring together researchers focusing on using modeling and numerical approach to study complex biological systems including (but not limited to) cell signaling pathways, complex bio-fluids, biofilms, cell polarization, developmental and cell biology, and stem cells, and etc. Such complex biological systems in general consist of multiple interacting components that exhibit complicated temporal and spatial dynamics. Furthermore, feedback, nonlinearities and multiple time and length scales often make such systems extremely difficult to describe, model or predict. The invited speakers will discuss the challenges of modeling such complex systems, introduce new computational techniques to simulate them and, where possible, present novel analytical techniques to extract meaningful information.

▶ MS-Fr-E-54-1 16:00–16:30

PDCD5 Interacts with P53 and Functions as A Regulator of P53 Dynamics in the DNA Damage Response

Lei, Jinzhi Tsinghua Univ.

Abstract: In this talk we introduce a computational model that includes PDCD5 interactions into the p53 signalling network and study the effect of PDCD5 to the p53-mediated cell fate decision in DNA damage response.

▶ MS-Fr-E-54-2 16:30–17:00

Modeling Active Liquid Crystal Flows with Applications to Complex Biological Systems

Wang, Qi Univ. of South Carolina & Beijing Computational Sci. Research Center
Zhao, Jia Univ. of South Carolina

Abstract: In this talk, we will present a continuum model for active polar liquid crystals and discuss how to use it to model complex biological systems in a multiphase complex fluid model formulation for cells and drops of active particles. Numerical examples will be given for cytokinesis of eukyriotes and active liquid crystal drops.

▶ MS-Fr-E-54-3 17:00–17:30

Phase Field Modeling of Inter-Vesicle and Vesicle-Substrate Interactions

Wang, Xiaoqiang Florida State Univ.

Abstract: The study for cell membranes has been a hot topic for many years due to its wide application in bio-medical science. Here we introduce a phase field method for tracking vesicle deformation and movement, focusing on the modeling of the vesicle-vesicle and vesicle-substrate interactions. Several phase field functions are integrated into the phase field model to derive a uniform phase field model. We will show the numerical experiments and compare them with biological experiments.

▶ MS-Fr-E-54-4 17:30–18:00

Morphological Stability of A Tumor Using A Two-phase Flow Model

Li, Shuwang Illinois Inst. of Tech.

Abstract: We consider the morphological stability of a tumor spheroid in S-tokes flow, where the viscosity of the tumor and host microenvironment is different. We demonstrate that tumor evolution is regulated by a reduced set of nondimensional parameters that characterize apoptosis, cell-cell/cell-extracellular matrix adhesion, vascularization and viscosity ratio. When the tumor is more viscous than its environment, it tends to develop invasive fingers. This is a joint work with Kara Pham, Emma Turian and John Lowengrub.

MS-Fr-E-55 16:00–18:00 106

Wavelet Methods for Inverse Problems Modelling Real World Systems - Part IV of IV

For Part 1, see MS-Th-D-55
For Part 2, see MS-Th-E-55
For Part 3, see MS-Fr-D-55

Organizer: Siddiqi,Prof., Abul Sharda Univ.,NCR
Organizer: Al-Lawati, M.A. Sultan Qaboos Univ.

Abstract: In a direct problem an effect is determined by a cause while in an inverse problem cause is determined from an effect. In an image processing the direct problem is to find out how a given sharp photograph would look like while camera is incorrectly focused.A related inverse problem is to find sharp photograph from a given blurry image.Inventors of CAT and MRI were awarded Nobel Prize of Medicine and Physiology respectively in 1979 and 2003.Inverse problems typically involve certain quantities based on indirect measurements of these quantities.Seismic exploration,CAT,MRI,X-ray are examples of inverse problems. Bio metric identifiers are measurements from human body;examples are ear,face,facial thermogram,hand thermogram,hand vein,hand geometry,finger print,iris,retina,signature and voice..The direct and indirect problems of biometrics correspond to the analysis and synthesis of biometric information,respectively.Recognition of face is a direct problem while face reconstruction is an an inverse problem.Refinement of Fourier methods,called wavelet methods including curve lets,shear lets play important role for study of inverse problems occurring in above themes. The symposium is devoted to updated research on applications of wavelets to the above problems.

▶ MS-Fr-E-55-1 16:00–16:30

Statistical and Synthetic Methods Used in Flood Calculation and Estimation

OdabaŞı, Didem Istanbul Gelisim Univ.

Abstract: This paper aims to examine statistical methods used in flood calculation and also it indicates that hydrologic series are related to notions of probability theory and statistical methods. Too many reliable mathematical methods to estimation of flood exist. These methods are related to formulas, statistical methods, observations and hydrograps obtained by synthetic way. An evaluation of hydrological synthetic techniques which are Snyder, Kirpich,

Mockus and S.C.S. for making flood estimations have been explained with details.

▶ MS-Fr-E-55-2 16:30–17:00

A Class of Wavelets for Inverse Problem

Irfan, Nagma — Sharda Univ.
Al Lawati, Mohamed — Sultan Qaboos Univ.
Siddiqi,Prof., Abul — Sharda Univ.,NCR

Abstract: In the recent years a series of papers are devoted to study of inverse problems representing phenomenon of different disciplines using wavelet methods. Special focus is given on themes like wavelet methods in tomography, atmospheric tomography. Well known wavelets like Haar, Daubechies have been used but the application of Sine-cosine wavelets have escaped attention in these areas. The talk is mainly focused on application of Sine-cosine wavelets to Radon Transform and atmospheric tomography.

▶ CP-Fr-E-55-3 17:00–17:20

Overcoming Element-Quality Dependency with Adaptive Extended-Stencil Finite Element Method

Delaney, Tristan — Stony Brook Univ.
Jiao, Xiangmin — Stony Brook Univ.
Conley, Rebecca — Stony Brook Univ.

Abstract: FEMs are widely used, but one of their major limitations is the severe dependency on element quality. We propose a generalization of FEM, called AES-FEM, which overcomes this dependency by adaptively replacing the basis functions and test functions around poor-quality elements. The new basis functions are Lagrange least squares basis, allowing easy enforcement of boundary conditions. We demonstrate that AES-FEM significantly improves the accuracy and stability of standard FEM for 2-D and 3-D elliptic PDEs.

▶ CP-Fr-E-55-4 17:20–17:40

Discrete Maximal Regularity for Abstract Cauchy Problems and Its Application to the Finite Element Method

Kemmochi, Tomoya — The Univ. of Tokyo
Saito, Norikazu — The Univ. of Tokyo

Abstract: Maximal regularity is one of significant concepts for parabolic partial differential equations. It is widely applied to analysis of quasilinear parabolic equations and the Navier-Stokes equation. On the other hand, we are interested in numerical analysis of nonlinear partial differential equations. It is thus natural to ask whether the discrete analogue of maximal regularity is available. If this is the case, it is expected that discrete maximal regularity can be applied to the numerical analysis of nonlinear equations. From the above perspective, we are studying the discrete maximal regularity for abstract Cauchy problems. In this paper, we first prove discrete maximal regularity for time-discrete Cauchy problems in a UMD space. We also report an application of this result to the finite element method and obtain a priori estimate. Furthermore, we apply the estimate to linear or semilinear heat equation and derive the optimal error estimates for finite element approximation.

▶ CP-Fr-E-55-5 17:40–18:00

Finite Element Approximation for the Stokes Equations under A Unilateral Boundary Condition

Sugitani, Yoshiki — Graduate School of Mathematical Sci., the Univ. of Tokyo
Zhou, Guanyu — University of Tokyo
Saito, Norikazu — The Univ. of Tokyo

Abstract: One of the main issues in simulations of blood flow in arteries is a proper setting of the outflow boundary condition at artificial boundaries. The common outflow boundary conditions are a prescribed constant pressure, traction, and velocity profiles. However, the flow distribution and pressure field are unknown and cannot be prescribed at the outflow boundary in many simulations. In order to tackle this problem, we recently proposed an unilateral outflow condition, which needs no profiles of verocity and traction but only restricts their directions. With this condition, we obtain an energy inequality so that numerical solutions are expected to be stable. In this talk, we consider a model Stokes problem and report some results on the well-posedness, penalty formulation, and finite element approximation. We derive the error estimates of order 1/2 with respect to the discretizing parameter h, and verify the results by numerical experiments.

MS-Fr-E-56 16:00–18:00 403

Mathematical trends, challenges and future applications for liquid crystal theories - Part IV of IV

For Part 1, see MS-Th-D-56
For Part 2, see MS-Th-E-56
For Part 3, see MS-Fr-D-56

Organizer: Majumdar, Apala — Univ. of Bath
Organizer: Wang, Changyou — Purdue Univ.
Organizer: Zhang, Pingwen — Peking Univ.

Abstract: Liquid crystals are mesogenic phases of matter intermediate between the solid and liquid phases of matter. Liquid crystals typically exhibit partial ordering and are consequently, highly sensitive to light, electric fields, mechanical and rheological effects. The proposed minisymposium focuses on key questions in liquid crystal research, based on defects, atomistic to continuum modelling, phase transitions, pattern formation and hydrodynamics. The minisymposum will comprise four themed sessions on (i) analysis, (ii) modelling, (iii) simulations and (iv) related areas, with invited talks from physicists, mathematicians and materials scientists, thus providing an ideal platform for the cross-fertilization of expertise from around the globe.

▶ MS-Fr-E-56-1 16:00–16:30

Discontinuous Order Parameters in Liquid Crystal Theories

Ball, John — Univ. of Oxford

Abstract: The talk will discuss various issues surrounding the mathematical description of defects in models of liquid crystals, drawing on experience from solid mechanics. The roles played by a suitable choice of function space and by growth properties of the free-energy density are highlighted. Models in which the director can jump across surfaces are formulated, and their relevance for nematic elastomers, order reconstruction and smectic A thin films discussed. This is joint work with Stephen Bedford.

▶ MS-Fr-E-56-2 16:30–17:00

Liquid Crystal Colloids

Calderer, Maria-Carme — Univ. of Minnesota

Abstract: Colloidal particles in liquid crystal media show remarkable new properties, not found for an isotropic matrix, in both cases, with and without applied electric field. This is due, in part, to the defects induced in the liquid crystal due to the inserted particles. We will study models of AC-driven electrophoresis and electroosmosis, and illustrate the remarkable capability of a liquid crystal to foster control of particle motion.

▶ MS-Fr-E-56-3 17:00–17:30

Landau Theory for Nematic Liquid Crystals with Hard and Soft Interactions

Palffy-Muhoray, Peter — Liquid Crystal Inst.
Minkowski, Fred — Kent State Univ.
Zheng, Xiaoyu — Kent State Univ.

Abstract: Landau theory, via its elegant simplicity, can describe the essential behavior of systems near phase transitions. In this talk, I will present our results in constructing a Landau theory for nematics which consistently combines and incorporates both long-range attractive and short-range repulsive interactions. The model describes the temperature and pressure dependence of the order parameter and of phase equilibria. Limitations of this approach and directions for future improvement will also be outlined.

▶ MS-Fr-E-56-4 17:30–18:00

Cubic Instability in the Q-tensor Theory for Nematic Liquid Crystals

Xu, Xiang — purdue Univ.

Abstract: The Landau-de Gennes theory is a phenomenological theory in which stable states of the material correspond to minimizers of a free energy. In its free energy form, there is however an unusual cubic term. We will discuss the dynamic effects induced by this cubic term by considering a gradient flow dynamics. We focus on understanding the relations between the physicality of the initial data and global well-posedness of the system.

MS-Fr-E-57 16:00–18:00 402A

Modeling, Applications, Numerical Methods, and Mathematical Analysis of Fractional Partial Differential Equations I - Part V of V

For Part 1, see MS-Th-BC-57
For Part 2, see MS-Th-D-57
For Part 3, see MS-Th-E-57
For Part 4, see MS-Fr-D-57

Organizer: Wang, Hong — Univ. of South Carolina
Organizer: Karniadakis, George — Brown Univ.

Abstract: Fractional Partial Differential Equations (FPDEs) are emerging as a new powerful tool for modeling many difficult complex systems, i.e., systems with overlapping microscopic and macroscopic scales or systems with

long-range time memory and long-range spatial interactions. They offer a new way of accessing the mesoscale using the continuum formulation and hence extending the continuum description for multiscale modeling of viscoelastic materials, control of autonomous vehicles, transitional and turbulent flows, wave propagation in porous media, electric transmission lines, and speech signals. FPDEs raise modeling, computational, mathematical, and numerical difficulties that have not been encountered in the context of integer-order partial differential equations. The aim of this minisymposium is to cover the recent development in mathematical and numerical analysis, computational algorithms, and applications in the context of FPDEs and related nonlocal problems.

▶ MS-Fr-E-57-1 16:00–16:30

Fractional Diffusion: from Discrete Time Random Walks to Continuous Time Random Walks and Back

Angstmann, Christopher UNSW Australia
Henry, Bruce UNSW Australia

Abstract: Starting with the continuous time random walk (CTRW) we derive the generalized master equation for an ensemble of particles with reactions and forcing. We show reductions, in the diffusion limit, to nonlinear fractional PDEs where numerical solutions are sought. Rather than discretising the PDEs we start with a discrete time random walk (DTRW). The master equations for the DTRW share the CTRW diffusion limit thus providing a novel numerical method that is explicit and stable.

▶ MS-Fr-E-57-2 16:30–17:00

On Two Fully Discrete Schemes for the Subdiffusion Equation

Jin, Bangti Univ. College London

Abstract: In this talk we discuss two fully discrete schemes based on the Galerkin finite element method and L1 scheme/convolution quadrature. We shall establish error estimates optimal with respect to the regularity of the initial data. Both schemes are first order accurate in time for smooth and nonsmooth initial data. Extensive numerical experiments confirm the convergence analysis. The numerical results indicate that they are accurate and robust for nonsmooth data.

▶ MS-Fr-E-57-3 17:00–17:30

Wellposedness of Variable-coefficient Conservative Fractional Elliptic Differential Equations

Yang, Danping East China Normal Univ.

Abstract: The previous theoretical results for constant-coefficient fractional differential equations (FDEs).cannot be extended to variable-coefficient FDEs. We derive a Petrov-Galerkin weak formulation to variable-coefficient FDES and prove that the bilinear form of the Petrov-Galerkin weak formulation is weakly coercive and so the weak formulation has a unique solution and is well posed. Finally, we outline potential application of these results in the development of numerical methods for variable-coefficient conservative FDEs.

▶ MS-Fr-E-57-4 17:30–18:00

Time-splitting Schemes for Fractional Differential Equations

Cao, Wanrong Southeast Univ.
Zhang, Zhongqiang Worcester Polytechnic Inst.
Karniadakis, George Brown Univ.

Abstract: We propose time-splitting schemes for nonlinear time-fractional differential equations with both smooth solutions and nonsmooth solutions, and prove the convergence and stability of proposed schemes. Numerical examples illustrate the flexibility and the efficiency of these time-splitting schemes and show that they work for multi-rate and stiff time fractional differential systems successfully.

MS-Fr-E-58 16:00–18:00 401

Theoretical and numerical studies of phase field model - Part IV of IV

For Part 1, see MS-Th-D-58
For Part 2, see MS-Th-E-58
For Part 3, see MS-Fr-D-58

Organizer: Wang, Cheng Univ. of Massachusetts Dartmouth
Organizer: Qiao, Zhonghua The Hong Kong Polytechnic Univ.
Organizer: Wang, Xiaoping Hong Kong Univ. of Sci. & Tech.

Abstract: Phase field equations, which treat the phase variable as a continuous function instead of a sharp interface, model a great number of physical and biological phenomena, such as phase transformations of materials at different scales, the process in biological growth and development, and the topological change involved in multi-phase flows. This mini symposium is focused on the developments of the phase field models. Both the theoretical analysis for these highly nonlinear PDEs and the numerical approximations are of great interests.

▶ MS-Fr-E-58-1 16:00–16:30

Numerical Simulation of Endocytosis: Diffuse Interface Models for Membranes with Curvature-inducing Molecules

Lowengrub, John UC Irvine

Abstract: We develop new diffuse interface models for the dynamics of inextensible vesicles in a viscous fluid with stiff, curvature-inducing molecules. A local Lagrange multiplier harmonically extended off the interface enforces inextensibility. A local relaxation scheme dynamically corrects local stretching/compression errors thereby preventing their accumulation. Hydrodynamic effects are thus accurately captured during endocytosis. By varying the membrane coverage of curvature-inducing molecules, we find that there is a critical neck radius and a critical budding time.

▶ MS-Fr-E-58-2 16:30–17:00

An Immersed Interface Method for Solving Two-fluid Interfacial Flows

Tan, Zhijun Sun Yat-sen Univ.

Abstract: An immersed interface method based on augmented variables for solving incompressible two-fluid flows involving interfaces is presented. The augmented variables and/or the forces along the interface/boundary are related to the jumps in both pressure and velocity and the jumps in their derivatives across the interface/boundary. The discretized fluid equations incorporating the jump contributions on a staggered Cartesian grid are solved by the fast solver. The numerical results show that the overall scheme is second order.

▶ MS-Fr-E-58-3 17:00–17:30

Unconditional Stable Method for the Amplitude Description of the Phase-Field Crystal Model

Guan, Zhen Univ. of California, Irvine
Lowengrub, John UC Irvine
Wang, Cheng Univ. of Massachusetts Dartmouth
Wise, Steven Univ. of Tennessee

Abstract: The amplitude description of the Phase-Field Crystal model is widely used coarse-grained approach for studying polycrystalline solidification. In addition to the obvious computational advantages over the atomistic models, the amplitude description allows for isolating variables associated with macroscopic description of continuum media such as order parameter or displacement fields. Here we present an unconditional energy stable method with parallelogram mesh. The resulting nonlinear scheme is handled by highly efficient nonlinear multigrid method.

▶ MS-Fr-E-58-4 17:30–18:00

A Fast Explicit Operator Splitting Method for the Molecular Beam Epitaxy Model

Zhang, Hui Beijing Normal Unversity
Li, Xiao Beijing Normal Univ.

Abstract: We present a fast explicit operator splitting method to solve numerically the molecular beam epitaxy model in the 1-D case. The equation is split into nonlinear and linear parts which are approximated by the finite difference method and pseudo-spectral method, respectively. The algorithm is second-order convergent in time and fourth-order in space. Both the stability and the discrete L^2-error estimate are proved rigorously and verified numerically. Some numerical experiments show the robustness of the algorithm.

MS-Fr-E-59 16:00–18:00 402B

Energy-Driven Pattern Formation - Part IV of IV

For Part 1, see MS-Th-D-59
For Part 2, see MS-Th-E-59
For Part 3, see MS-Fr-D-59

Organizer: Kohn, Robert New York Univ.

Abstract: Energy-driven pattern formation examines how energy minimization leads to the formation of defects and microstructure in a variety of physical systems. Examples include the wrinkling of a stretched elastic membrane, the twinning produced by martensitic phase transformation, and the defects seen in liquid crystals. In these and many other examples, the physics is modelled by a nonconvex variational problem regularized by a higher-order term with a small coefficient, and energy-driven pattern formation can be studied by considering the limiting behavior of minimizers as the small parameter tends to zero. Another recurrent theme is the use of ansatz-free bounds to identify and explore the features of energy-minimizing configurations. A third recurrent theme is dynamics, since the patterns of interest are sometimes transient states of steepest-descent processes.

▶ MS-Fr-E-59-1 16:00–16:30

Island Formation in Epitaxially Strained Crystalline Films

Zwicknagl, Barbara Univ. of Bonn

Abstract: I will discuss analytical results on variational models that have been

introduced in the physical literature to describe the shape of an epitaxially strained crystalline film deposited on a rigid substrate when there is a mismatch between the lattice parameters of the two crystals. The resulting energy functional is a nonlocal isoperimetric functional. This talk is based on joint works with P. Bella and M. Goldman, and with I. Fonseca and A. Pratelli.

▶MS-Fr-E-59-2 16:30–17:00

Defects in Landau-de Gennes Theory

Robbins, Jonathan — Univ. of Bristol

Abstract: We present some recent results concerning point defects in liquid crystals in two dimensions within the Landau-de Gennes model. In the deep nematic regime, we establish the existence of global minimisers of the Landau-de Gennes energy for defects of arbitrary degree, and obtain explicit profiles in the limit of vanishing elastic constant. The stability of index-1/2 defects under relaxed assumptions and the case of unequal elastic constants will be briefly discussed.

▶MS-Fr-E-59-3 17:00–17:30

Nucleation of Austenite and Martensite

Ball, John — Univ. of Oxford

Abstract: When a new phase is nucleated in a martensitic phase transformation, it has to fit geometrically onto the parent phase. The talk will describe different situations in which this leads to striking phenomena, drawing on collaborations with C. Carstensen, R. D. James, K. Koumatos and H. Seiner.

▶MS-Fr-E-59-4 17:30–18:00

Optimal Martensitic Inclusions

Otto, Felix — Max Planck Inst. for Mathematics in the Sci.
Knuepfer, Hans — Univ. of Heidelberg
Kohn, Robert — New York Univ.

Abstract: We are interested in alloys that undergo a martensitic phase transition of the cubic-to-tetragonal symmetry breaking, which we study variationally based on geometrically linearized elasticity. In order to unfold the energy landscape, we add an interfacial energy for twin boundaries. We identify the scaling of the minimal energy of a martensitic inclusion of prescribed volume in the austenitic surrounding. The construction features a hierarchical microstructure. This is joint work with H. Knuepfer and R. Kohn.

MS-Fr-E-60 16:00–18:00 310

Mathematical methods in biomedical applications - Part III of III

For Part 1, see MS-Th-E-60
For Part 2, see MS-Fr-D-60

Organizer: Amigo, Jose — Universidad Miguel Hernandez
Organizer: Liang, X. San — Nanjing Inst. of Meteorology
Organizer: Small, Michael — Univ. of Western Australia

Abstract: Mathematics is being successfully applied to a number of important topics in biology and medicine like biofluids, data analysis, drug design and discovery, epidemiology, evolution, genetics, image processing, immunology, medical instrumentation, neuroscience, plant growth, population dynamics (including ecology and microbiology), tumor propagation, virus dynamics, etc. The list of tools include virtually the whole applied mathematics. To cite just the most familiar ones: discrete dynamical systems, ordinary and time-delay differential equations, graph and network theory, integral transforms, numerical and computational mathematics, partial and stochastic differential equations, statistics, probability, and time series analysis. All this research has contributed and is increasingly contributing both to a better understanding of complex biological phenomena and to find practical ways of action. On the wake, new branches of applied mathematics have emerged, e.g., mathematical biology, theoretical biology, and computational neuroscience. But the most important consequence is the improvement in health care and life quality that results from, say, early and better diagnoses, more efficient drugs, plague control, or biotechnological know-how, all of which owe much to the mathematical research.
This being the case, the scope of the minisymposium hereby proposed is to give researchers the opportunity to share their latest applications of mathematical methods to biology and medicine in a multi- and interdisciplinary environment. The topics addressed have been intentionally left open with the objective of having a broader participation. Thus, researchers in computational neuroscience can benefit very much from a network-based approach or time series analysis. Researchers in deterministic models can get further inspiration from stochastic methods or fractional analysis. Moreover, specialists in one particular field can learn new, possibly unexpected applications of their technical skills or hear about other approaches.
With this scope in mind, the organizers of this minisymposium have invited a reduced number of experts who work on applications of mathematics to medicine and biology. Their theoretical backgrounds cover mainly nonlinear dynamics, computational neuroscience, time series analysis, network theory, and partial differential equations, thus a representative blend of current research. Specially important are the actual and potential applications to the biomedical industry of topics such as complex fluids, drug discovery, computational methods and information analysis, all of them included in the minisymposium. For instance, the parametric study of the flow in ventricular catheters for the treatment of hydrocephalus presented in one of the communications, has led new designs which are patent pending.
If approved, this minisymposium will be certainly a great place to create synergies in an area of mathematics which has scientific interest, applications to the biomedical industry, and social impact.

▶MS-Fr-E-60-1 16:00–16:30

Information Flow and Causality as Rigorous Notions Ab Initio

Liang, X. San — Nanjing Inst. of Meteorology

Abstract: Information flow/transfer the widely applicable physical notion can be rigorously derived from first principles, rather than axiomatically proposed as an ansatz. Its logical association with causality is stated as a fact in proved theorems. Presented here is an application to the consciousness study, aiming at distinguishing the information flow structures for the awake or dreaming state and the state of non-dreaming sleep or anesthesia, and understanding the frontal-parietal communication in a human brain.

▶MS-Fr-E-60-2 16:30–17:00

Rithmomimetic Drug Delivery

Calderer, Maria-Carme — Univ. of Minnesota

Abstract: We study a prototype model of drug delivery based on a polyelectrolyte gel membrane driven by glucose. We formulate and analyze related system of partial and ordinary differential equations modeling the device and characterize the associated limit cycles, in several dimensions. This is joint works with Lingxing Yao, Yoichiro Mori and Ronald Siegel.

▶MS-Fr-E-60-3 17:00–17:30

Key Parameter Identification of Fractional-order Dynamics for Helicobacter Pylori Bacteria in Antibiotic Environment

Li, Yan — Shandong Univ.
Sun, Yundong — Shandong Univ.

Abstract: This paper first combines fractional calculus with dynamics of helicobacter pylori bacteria in antibiotic environment. The fractional modeling is applied so that the antibiotic - bacteria concentration data can be analyzed quantitatively. Considering the fractional order intrinsic property of body, a series of novel test methods are proposed based on identification results. The above results are hopefully to improve the consensus of test and in vivo effects for triple therapy.

▶MS-Fr-E-60-4 17:30–18:00

Model Reduction for Networks of Coupled Oscillators

Gottwald, Georg — Univ. of Sydney

Abstract: We present a collective coordinate approach to describe coupled phase oscillators. We apply the method to study synchronisation in a Kuramoto model. In our approach an N-dimensional Kuramoto model is reduced to an n-dimensional ordinary differential equation with n¡¡N, constituting an immense reduction in complexity. The onset of both local and global synchronisation is reproduced to good numerical accuracy, and we are able to describe both soft and hard transitions. By introducing 2 collective coordinates the approach is able to describe the interaction of two partially synchronised clusters in the case of bimodally distributed native frequencies. Furthermore, our approach allows us to accurately describe finite size scalings of the critical coupling strength. We corroborate our analytical results by comparing with numerical simulations of the Kuramoto model with all-to-all coupling networks for several distributions of the native frequencies.

MS-Fr-E-67 16:00–18:00 Function Hall C

Minisymposium on Mathematical Modeling Education for High School Students - Part II of II

For Part 1, see MS-Fr-D-67

Organizer: Cheung, Alfred — NeoUnion ESC Organization
Organizer: Bai, Fengshan — Tsinghua Univ.
Organizer: Qiao, Zhonghua — The Hong Kong Polytechnic Univ.

Abstract: This minisymposium will introduce the newly instituted international contest in modeling for high school students - International Mathematical Modeling Challenge (IM2C or IMMC) whose co-founders and co-organizers are Consortium for Mathematics and its Application (COMAP) and NeoUnion ESC Organization. The meaning and significance of mathematical modeling education for fostering students innovation competencies will be addressed

in response to the global trend in STEM education. Award presentation to local teams will be held during the minisymposium. A team of students and their teacher advisor who won the Outstanding Prize in the first Annual IM2C 2015 will make presentation. Review in depth of the contest problem Movie Scheduling and commentary on solution papers by awarded teams will be lectured. Hands-on workshop on mathematical modeling teaching and learning will be offered in the minisymposium.

▶MS-Fr-E-67-1 16:00–16:30

Mathematical Modeling Education in High School

Wang, Yaoyang Affiliated High School of Peking Univ.

Abstract: Mathematical Modeling Education in High School

▶MS-Fr-E-67-2 16:30–17:00

Mathematical Modeling Education in High School

Wang, Yaoyang Affiliated High School of Peking Univ.

Abstract: Mathematical Modeling Education in High School

▶MS-Fr-E-67-3 17:00–17:30

Hands-on Workshop in Mathematical Modeling for High School Students

Xie, Jinxing Tsinghua Univ

Abstract: Hands-on Workshop in Mathematical Modeling for High School S-tudents

Posters

▷ PP-A01-1

New Methods for Solving Positive Definite and Positive Semidefinite Total Least Squares Problems

Bagherpour, Negin — Sharif Univ. of Tech.
Mahdavi-Amiri, Nezam — Sharif Univ. of Tech.

Abstract: We have firstly defined a new error formulation and presented a method to solve an over determined linear system of equations with multiple right-hand side vectors, where the unknown matrix is to be symmetric and positive definite A more complicated problem is encountered when the unknown matrix is to be positive semi-definite. We defined an efficient error formulation for the semi-definite case and test both algorithms in MATLAB to show their efficiency.

▷ PP-A01-2

The Proof of the Twin Primes Conjecture

Ye, Zhijiu — Shaanxi technical college of finance & economics

Abstract: This report proves that a class of congruence equations has no solutions using mathematical induction. If so, then Twin Primes Conjecture is true, i.e. there are infinite numbers of twin primes within the domain of natural numbers. Thus Twin Primes Conjecture is true.

▷ PP-A01-3

Cycles of Linear and Semilinear Mappings

Klymchuk, Tetiana — Taras Shevchenko National Univ. of Kyiv

Abstract: We give a canonical form of matrices of a cycle of linear or semilinear mappings $V_1 \;-\!\!-\; V_2 \;-\!\!-\; \cdots \;-\!\!-\; V_t \;-\!\!-\; V_1$ in which all V_i are complex vector spaces, each line is an arrow $\to$ or $\leftarrow$, and each arrow denotes a linear or semilinear mapping. Its special cases are the canonical forms of matrix pencils, contragredient matrix pencils, and pairs consisting of a linear and semilinear mappings.

▷ PP-A01-4

On Condition Number of Weighted Least Squares Problem and Its Statistical Estimation

Wang, Shaoxin — Chongqing Univ.
Yang, Hu — Chongqing Univ.

Abstract: we mainly focus on the derivation of a flexible condition number for weighted linear least squares problem. With the Fréchet derivative and kronecker product, the explicit expression of condition number is taken into consideration. When the coefficient matrix is large and dense, considering the difficulties of explicitly forming the expression of condition number in computer, we also present its simplified form. The probabilistic condition estimation method is introduced, and the numerical experiments are also performed.

▷ PP-A01-5

LINEAR 2-NORMED SPACES

Krishna Reddy, Basireddy — Osmania Univ.

Abstract: The defining properties of normed linear spaces are well-known and many important and useful results have been derived for these spaces. However, in certain application involving vector spaces these properties are not, appropriate, and another type of norm referred to as 2- norm, in general n-norm is more useful. Some necessary and sufficient conditions for n-norms to be equivalent on a linear normed space are given and some properties of linear n-normed spaces are explored.

▷ PP-A01-6

Novel Krylov-subspace Solver of Generalized Shifted Linear Equations for Massively Parallel Quantum Material Simulations

Hoshi, Takeo — Tottori Univ.
Imachi, Hiroto — Tottori Univ.

Abstract: Novel Krylov-subspace algorithms were developed for massively parallel quantum material simulations or electronic structure calculations. The method solves the generalized shifted linear equations ((zS-H) x = b), instead of conventional generalized eigen-value equation. The paper presents the algorithms and the results of 100-nm-scale or one-hundred-million-atom materials on the K supercomputer with a high parallel efficiency. The paper also presents recent linear-algebraic algorithms based on time-dependent Schroedinger-type equations and its application to organic electronics materials.

▷ PP-A02-1

Szegő Asymptotics of Extremal Polynomials on the Segment [-1,1]

Khaldi, Rabah — Badji Mokhtar Annaba Univ.

Abstract: We study, the Szegő asymptotics of extremal polynomials with respect to a measure which consists of an absolutely continuous part on [-1, 1] and a infinite number of discrete masses which are distributed on the real axis outside the interval [-1,1], under the assumptions that the mass points satisfy Blaschke's condition and that the absolutely continuous part satisfies Szegő's condition. We apply the results to the study of spectral properties of discrete Sturm-Liouville operators

▷ PP-A02-2

INTEGRALS OF GENERALIZED BESSEL FUNCTIONS OF THE FIRST KIND

Jain Agarwal, SHILPI — Poornima College of Engineering
AGARWAL, PRAVEEN — Anand Internatioal College of Engineering

Abstract: In this poster our aim is to derive two generalized integral formulas involving generalized Bessel functions of the first kind, which are expressed in terms of the generalized Wright hypergeometric function. Some interesting special cases of our main results are also considered.

▷ PP-A02-3

Transformation Formulas of Incomplete Hypergeometric Functions via Fractional Calculus Operators

Purohit, Sunil Dutt — Rajasthan Technical Univ., Kota
Raina, R.K. — M.P. Uinversity of Agriculture & Tech., Udaipur

Abstract: The main object of this paper is to derive certain transformation formulas expressing potentially useful incomplete hypergeometric functions in terms of a finite sum of lower order functions by making use of the fractional calculus operators. We further consider certain new forms of extensions of the main results. Some consequences and special cases of the various results are also pointed out.

▷ PP-A02-4

Unified Fractional Integral Formulas for the Incomplete Hypergeometric Functions

Bohra, Mahesh — Govrnment Women Engineering College, Ajmer
Purohit, Sunil Dutt — Rajasthan Technical Univ., Kota

Abstract: The aim of this paper is to study some properties of the generalized incomplete hypergeometric functions. Here we establish two theorems which provides the images of this function under the generalized fractional integral operators involving Fox's H-function as kernel. Corresponding assertions in terms of Saigo, Erdelyi-Kober, Riemann-Liouville and Weyl type of fractional integrals are also presented. Further, we also point out their relevance with other related known results.

▷ PP-A02-5

Subordination Results for A New Class of Analytic Functions Defined by Fractional Q-Calculus Operators

Selvakumaran, K A — Dept. of Mathematics, R.M.K College of Engg. & Tech. , Puduvoyal – 601206, Tamil Nadu
Purohit, Sunil Dutt — Rajasthan Technical Univ., Kota

Abstract: The subject of fractional calculus has gained noticeable importance and popularity due to its established applications in many fields of science and engineering during the past three decades or so. In this article, we introduce and investigate a new class of Bazilevic functions with respect to k-symmetric points defined by fractional q-calculus operators. Several interesting subordination results are also derived for the functions belonging to this class in the open unit disc.

▷ PP-A02-6

ON APPLICATIONS OF Q-LAPLACE TRANSFORMS TO THE BASIC ANALOGUE OF THE GENERALISED HYPERGEOMETRIC FUNCTIONS

Vyas, Vijay Kumar — The ICFAI Univ. Jaipur
Patel, Saurabh — Rai Univ. ahmedabad

Abstract: The q-Laplace transforms of the basic analogue of H-function of two variables have been evaluated in the present paper. Special cases of the main results are also discussed

▷ PP-A02-7

Certain Geometric Properties of the Mittag-Leffler Function

PRAJAPAT, JUGAL KISHORE CENTRAL Univ. OF RAJASTHAN

Abstract: In the present investigation, the Mittag-Leffler function with their normalization are considered. Several sufficient conditions are obtained so that the Mittag-Leffler function have certain geometric properties including univalency, starlikeness, convexity and close-to-convexity in the open unit disk. Partial sums of Mittag-Leffler function are also studied. The results obtained are new and their usefulness is depicted by deducing several interesting corollaries and examples.
Mathematics Subject Classification (2010) 33E12, 30C45

▷ PP-A02-8

The Algebraic Equalities and Their Topological Consequences in Weighted Spaces

Tien, Pham Hanoi Univ. of Sci.

Abstract: We study algebraic equalities and their topological consequences in weighted Banach, Fréchet, or (LB)-spaces of holomorphic-like functions on a locally compact and σ-compact Hausdorff space X. One of our main results is the following: The algebraic equality $\mathcal{V}A(X) = \mathcal{V}_0A(X)$ for (LB)-spaces with O- and o-growth conditions given by a weight sequence $\mathcal{V} = (v_n)_n$ always implies that these spaces are (DFS).

▷ PP-A02-9

Nonuniform Multiresolution Analyses with Multiplicity D

Mittal, Shiva SPM Govt. Degree College, Phaphamau, Allahabad (A constituent college of Univ. of Allahabad)

Abstract: A notion of nonuniform multiresolution analysis (NUMRA) with multiplicity D (a positive integer) based on the theory of one-dimensional spectral pairs is studied which is a generalization of MRA as well as NUMRA. The concept of NUMRA was introduced by Gabardo and Nashed in which the translation set is a spectrum that is no longer a group. In this nonstandard setting, we obtain a characterization of multiscaling functions associated to the NUMRA with multiplicity D (NUMRA-D). Further, we obtain a characterization of nonuniform multiwavelets associated with NUMRA-D in terms of their dimension function that generalizes a result obtained by Gabardo and Yu for NUMRA as well as Calogero and Garrigós for MRA.

▷ PP-A02-10

A Note on Dynamics in C0-semigroups

Yang, Chong Beijing Univ. of Tech.

Abstract: We prove that a C0-semigroup is hereditarily hypercyclic with respect to a syndetic sequence, then it is mixing.Then we get characterizations of LiYorke chaos in C0-semigroups. Firstly, we characterize Li-Yorke chaos in terms of the existence of irregular vectors. Then we present necessary and sufficient criteria for Li-Yorke chaos. Finally, we give the interplay between the continuous and the discrete cases.

▷ PP-A02-11

On Compact-continuous Mappings

Guo, Zhi-Fang Beijng Univ. of Tech.

Abstract: We study some properties of compact-continuous mappings, which are related to function space theory. We prove that if f:X→Y is a compact-continuous surjection and X is a Lindelof Σ-space (sequentially compact space), then Y is a Lindelof Σ-space(sequentially compact space). We introduce a notion of a weak Tychonoff space. Some properties of weak Tychonoff spaces are discussed in this note.

▷ PP-A02-12

Refinable Function-based Construction of Affine Dual Frames for Reducing Subspaces

Zhang, Jianping Beijing Univ. of Tech.

Abstract: In this work we provide three new characterizations of affine dual wavelet frames constructed from a pair of refinable functions in the setting of reducing subspaces. We show that these characterizations are valid without any decay assumptions on the generators of the affine system. As an application, we also obtain a Fourier domain characterization of affine Parseval frames.

▷ PP-A02-13

Some Characterizations of Function-valued Frames on Half Space

Zhang, Wei Beijing Univ. of Tech.

Abstract: Affine frames have been extensively studies. In recent years, function-valued frames were studied by some mathematicians. Interestingly, the literature shows that function-valued frames can be used for construction of frames on half spaces which are generated by dilated and modulated versions of a function. In this paper, we give some characterizations of such frames. These characterizations are easily realized, and many examples are also provided.

▷ PP-A03-1

Error Analysis of Analytic Solution for High-order Boundary Value Problems and Applications

Zhang, Xiaolong Dalian Univ. of Tech.

Abstract: The homotopy analysis method is a powerful analytic method for seeking approximate series solutions to differential equations with initial/boundary conditions. However, error analysis for the homotopy analysis method has not been given so far. For general 2n-order linear boundary value problems, significant estimates for the absolute errors of the approximations, along with sufficient conditions for the existence and uniqueness of solutions will be given in this talk.

▷ PP-A03-2

Existence, Uniqueness and Stability of Periodic Solutions for A Hematopoiesis Model.

Balderrama, Balderrama Univ. of Buenos Aires
Amster, Pablo Universidad de Buenos Aires

Abstract: To explain the regulation of hematopoiesis Mackey and Glass introduced a nonlinear autonomous delay differential equation. Various aspects of the environment that turn out influential were analyzed and incorporated to the model. Existence of positive $T-$periodic solutions of the model and its generalizations has been studied. However, almost periodic effects are even more frequent in the real world. We prove the existence, uniqueness and stability of positive almost periodic solutions for a more general model.

▷ PP-A04-1

Entropy and Renormalized Solutions for Nonlinear Elliptic Problem Involving Variable Exponent and Measure Data

Benboubker, Mohamed Badr National School of Applied Sci. (ENSA) of Tetouan

Abstract: We give an existence result of entropy and renormalized solutions for strongly nonlinear elliptic equations in the framework of Sobolev spaces with variable exponents of the type:

$$-\text{div}\left(a(x,u,\nabla u)+\phi(u)\right)+g(x,u,\nabla u)=\mu,$$

where the right hand side belongs to $L^1(\Omega) + W^{-1,p'(x)}(\Omega)$, $-\text{div}\Big(a(x,u,\nabla u)\Big)$ is a Leray-Lions operator defined from $W^{-1,p'(x)}(\Omega)$ into its dual and $\phi \in \mathcal{C}^0(I\!R, I\!R^N)$. The function $g(x,u,\nabla u)$ is a non linear lower order term.

▷ PP-A04-2

Existence Results for Strongly Nonlinear Elliptic Equations of Infinite Order

CHRIF, MOUSSA faculty of Sci. Fes

Abstract: In this work, generalized Sobolev spaces and Sobolev spaces of infinite order are considered. Existence of solutions for strongly nonlinear equation of infinite order of the form $Au + g(x,u) = f$ is established. Here A is an elliptic operator from a functional space of Sobolev type to its dual and $g(x,s)$ is a lower order term satisfying a sign condition on s.

▷ PP-A04-3

Traveling Waves for A Diffusive SIS Model

Fu, Sheng-Chen Chengchi Univ.

Abstract: We study a diffusive SIS model for a disease that the infectives recover without immunity. We analytically show that there exists a family of traveling waves with the minimum speed; and investigate the dynamical behavior of the solution with the initial distribution that the susceptible species is at the level of the carrying capacity,and the infective species has exponentially small tails near infinity, which will lead to the formation of a pair of diverging waves.

▷ PP-A04-4

A Triangular Spectral Element Method for Stokes Eigenvalues

Shan, Weikun Inst. of Software, Chinese Acad. of Sci.
Li, Huiyuan Inst. of Software Chinese Acad. of Sci.

Abstract: A triangular spectral element method is proposed for Stokes eigenvalues utilizing generalized Koornwinder polynomials. Based on natural local-to-global mapping, Fortin interpolation is established, and then its stability is analysed such that an optimal estimate on discrete inf-sup constant of divergence can be derived theoretically. Next, we obtain the error estimate for H^1-orthogonal projection and Stokes eigenvalues. Finally, numerical experiments are presented to illustrate our theories on discrete inf-sup constant and the accuracy of computational eigenvalues.

▷ PP-A04-5

Scattering of Surface Gravity Waves by A Floating Flexible Porous Plate

Koley, Santanu — Indian Inst. of Tech. Kharagpur
Mondal, Ramnarayan — Univ. of Tokyo
Sahoo, Trilochan — IIT Kharagpur

Abstract: In recent decades, permeable floating flexible structures are in great demand in coastal engineering practices for creating a tranquility zone. The present study deals with the scattering of obliquely incident waves by a two-dimensional floating flexible porous plate in water of finite and infinite depths. The associated boundary value problem is converted into an integro-differential equation in terms of the plate deflection. The effectiveness of the floating flexible porous plate as wave barrier is analyzed.

▷ PP-A04-6

Simultaneous Identification of Convection Parameters in the Reaction Diffusion Convection System

Gnanavel, Soundararajan — Central Univ. of Kerala

Abstract: Inverse problems associated with the convection-diffusion equation are of much scientific importance, as they appear in the modelling of many practical problems.In this paper, we study an inverse problem of reconstructing two space and time dependent convection parameters via the optimal control framework and the stability estimate has been established with the upper bound given by some Sobolev norms of the over specified data.

▷ PP-A04-7

Inverse Coefficient Problems for the Coupled Kuramoto-Sivashinsky Equation with Heat Equation

Natesan, Barani Balan — Central Univ. of Tamil Nadu

Abstract: In this work, we present an inverse coefficient problems for the Kuramoto-Sivashinsky equation coupled to a heat equation. More precisely, we study the simultaneous reconstruction of two smooth coefficients from the measurement of the solution on a part of the domain/boundary and also at some particular time. The proof of these results relies on an appropriate Carleman estimate and certain energy estimates for the given system.

▷ PP-A04-8

The P-Laplacian and Geometric Structure of Riemannian Manifolds

Dung, Nguyen Thac — Hanoi Univ. of Sci.

Abstract: It is well-known that there are beautifull relationship between the theory of p-harmonic function, topology and geometric structure of Riemannian manifolds. In this paper, I will recall some results on this topic. Moreover, I show that if the first eigenvalue for the p-Laplacian achievies its maximal value on a Kahler manifold or a quaternionic Kahler manifold then such a manifold must be connected at infinity unless it is a topological cylinder.

▷ PP-A04-9

Bifurcation and Stability Analysis of A Diffusive Predator-prey Model with Ratio-dependent Type III Functional Response

Muthusamy, Sivakumar — Bharathiar Univ., Coimbatore

Abstract: This poster is concerns the diffusive Leslie-Gower predator-prey system with ratio dependent Holling type III functional response subject to Neumann boundary conditions. By linearizing the system the local stability, existence of Hopf bifurcation at the co-existence of the equilibrium and stability of bifurcating periodic solutions in the absence of diffusion are studied. Furthermore, Turing instability and Hopf bifurcation analysis with diffusion are studied. Finally, numerical simulations are provided in order to verify our theoretical results.

▷ PP-A04-10

On A Nonlinear Renewal Equation with Diffusion

Bhargav Kumar, Kakumani — Univ. of Hyderabad

Abstract: In this article we consider a nonlinear age structured McKendrick-Von Foerster population model with diffusion term. Here we prove existence and uniqueness of the solution of the equation. We consider a particular type of nonlinearity in the renewal term and prove Generalized Relative Entropy type inequality. Longtime behavior of the solution has been addressed for both linear and nonlinear versions of the equation.

▷ PP-A04-11

Dolfin-adjoint: Automatic Adjoint Models for FEniCS

Funke, Simon — Simula Research Laboratory
Farrell, Patrick — Univ. of Oxford
Ham, David — Imperial College London
Rognes, Marie — Simula Research Laboratory

Abstract: The implementation of adjoint models for nonlinear, time-dependent models is notoriously challenging. dolfin-adjoint solves this problem by automatically analyzing the high-level mathematical structure inherent in finite element methods. It raises the traditional abstraction of algorithmic differentiation from the level of individual floating point operations to that of whole systems of differential equations. This approach delivers a number of advantages: hands-off automation of adjoint model derivation, efficiency native parallel support. We demonstrate this by numerical examples.

▷ PP-A04-12

Global Spatial Regularity Results for Elasticity Models with Nonsmooth Constraints

Knees, Dorothee — Univ. of Kassel

Abstract: For the analysis of strongly coupled material models it is useful to have deeper insight into the spatial regularity properties of the involved quantities like displacement fields or internal variables. In this poster we will present some recent results for non-smooth situations with a special focus on certain rate-independent damage models in the small strain regime and Tresca friction models along cracks.

▷ PP-A04-13

Numerical Study of A Renewal Equation with Diffusion

Tumuluri, Suman Kumar — Univ. of Hyderabad

Abstract: We present a numerical scheme for McKendric vonFoerster equation with diffusion which arises naturally in population dynamics. In our scheme we first discretize the time variable to get a system of elliptic equations. Later we use a standard discretization for age variable to solve the elliptic equation numerically. We perform stability analysis for our scheme. Numerical results are presented in some cases and compared with the corresponding analytic solutions where the latter is known explicitly.

▷ PP-A04-14

Existence of Solutions for A Fourth Order Eigenvalue Problem with Variable Exponent under Neumann Boundary Conditions

El Allali, Zakaria — Polydisciplinary Faculty of Nador

Abstract: In this work we will study the eigenvalues for a fourth order elliptic equation with $p(x)$-growth conditions $\Delta^2_{p(x)}u = \lambda|u|^{p(x)-2}u$, under Neumann boundary conditions, where $p(x)$ is a continuous function defined on the bounded domain with $p(x) > 1$. Through the Ljusternik-Schnireleman theory on C^1-manifold, we prove the existence of infinitely many eigenvalue sequences and $\sup \Lambda = +\infty$, where Λ is the set of all eigenvalues.

▷ PP-A04-15

Exact Solution of Navier-Stokes's Equation

HungKuk, Oh — Ajou Univ.

Abstract: The equation for quantum state particles are derived for non-steady state and steady state. General relativity is completed by deriving the equations for quantum state particles.
The two dimensional stress tensors in the partial differential equilibrium equations can be converted to one dimensional tensors per unit volume, which generate Laplacian.
The Laplacian has exact analytical solution and needs boundary conditions.
It gives us exact solution of Navier – Stokes' s equation.

▷ PP-A04-16

Numerical Treatment of Diffusion Equation of Fractional Order with Reflecting and Absorbing Boundary Conditions

Ali, Iftikhar — King Fahd Univ. of Petroleum & Minerals

Abstract: Fractional order differential equations arise naturally in the modeling of many complex physical processes in various engineering and science disciplines. In this work, we find numerical solutions of time fractional diffusion equation in Caputo's form by using an explicit and an implicit finite difference numerical schemes. Reflecting and Absorbing boundary conditions are considered both on finite and infinite domains together with delta initial conditions. We also provide Matlab code to help the readers.

▷ PP-A04-17

Overcoming Element-Quality Dependency with Adaptive Extended-Stencil Finite Element Method

Conley, Rebecca — Stony Brook Univ.
Delaney, Tristan — Stony Brook Univ.
Jiao, Xiangmin — Stony Brook Univ.

Abstract: FEMs are widely used, but one of their major limitations is the severe dependency on element quality. We propose a generalization of FEM, called AES-FEM, which overcomes this dependency by adaptively replacing the basis functions with Lagrange least squares basis functions around poor-quality elements. We explore a parallel algorithm for improved efficiency. We demonstrate that AES-FEM significantly improves the accuracy and stability

of standard FEM for 2-D and 3-D elliptic PDEs.

▷ PP-A04-18

A Discontinuous Galerkin Method for Neutron Transport Equations on 3-D Unstructured Grids

Wei, Junxia — Inst. of Applied Physics & Computational Mathematics

Abstract: Time-dependent neutron transport equation is a kind of important hyperbolic partial differential equation in nuclear science and engineering applications. High dimension neutron transport calculation include computing of space grid, angle direction, energy group and time step, is very complex and huge scale scientific calculation problem. Discontinuous finite element discrete ordinates (DFE-Sn) method is very efficient for solution of such equations especially while concerned with complicated physics including multimedia, larger grid distortion, complex initial and boundary conditions. In this paper, the discrete scheme of Sn discrete ordinate and discontinuous finite method 3-D unstructured tetrahedral meshes are presented. we developed a serial solver with DFE-Sn method to solve time-dependent neutron transport equations on unstructured tetrahedral grids. Domain decomposition scheme and parallel Sn sweep algorithm on unstructured grids are adopted to improve the efficiency , the parallel computation for the scheme is realized on MPI systems. Numerical experiments demonstrate the accuracy and efficiency of these methods.

▷ PP-A04-19

Coupled Thermo-mechanical Simulations on Distributed Devices Due to Electromagnetic Loss

Liu, Qingzhe — Department of Mathematics & Computer Sci., Univ. of Greifswald
Pulch, Roland — Univ. of Greifswald

Abstract: In the apparatus such as transformers and rotating machines the main source of heat consists of winding losses generated by resistances and power loss in the core due to eddy currents and hysteresis effect. The total losses are then dissipated to all parts of the machine and make the machine hotter. We present a finite element simulation of thermo-mechanical behaviours to capture deformation and stresses based on the electromagnetic loss.

▷ PP-A04-20

Electrical Impedance Spectroscopy-based Defect Sensing Technique in Estimating Cracks

Zhang, Tingting — Yonsei Univ.

Abstract: A defect sensing method based on electrical impedance spectroscopy is proposed to image cracks and reinforcing bars in concrete structures. The method utilizes the frequency-dependent behavior of thin insulating cracks: low-frequency electrical currents are blocked by insulating cracks, whereas high-frequency currents can pass through thin cracks to probe the conducting bars. From various frequency-dependent EIT images, we can show its advantage in terms of detecting both thin cracks with their thickness and bars.

▷ PP-A04-21

On the Variations of the Vortex Number in A Periodic Ginzburg-Landau Model

ZHANG, Peng — Shanghai Jiao Tong Univ.

Abstract: In this paper, we study the variations of the number of vortices contained in the minimizer of a two-dimensional Ginzburg-Landau functional describing a Type-II superconductor in the London limit, with periodic conditions on the boundary of the sample. We prove that if the sample is rectangular with height small enough, the number of vortices contained in the minimizer of the periodic Ginzburg-Landau functional jumps by unit step as the applied magnetic field increases.

▷ PP-A04-22

Firedrake: Automating Finite Element by Composing Abstractions

Ham, David — Imperial College London

Abstract: Firedrake automates the portable solution of partial differential equations using the finite element method. Firedrake takes separation of concerns in automated FEM to a new level. In addition to the Unified Form Language from the FEniCS project, and PETSc's linear algebra abstraction, Firedrake introduces the PyOP2 abstraction for mesh iteration and the COFFEE abstraction for kernel vectorisation and optimisation. The result is faster, more flexible and more capable automated simulation.

▷ PP-A04-23

Constitutive Framework of Maxwell Nanofluid with Cattaneo-Christov Upper-convected Derivative

Sui, Jize — Univ. of Sci. & Tech. Beijing
Zheng, Liancun — Univ. of Sci. & Tech. Beijing
Zhao, Jinhu — Univ. of Sci. & Tech. Beijing

Abstract: The Cattaneo-Christov upper-convected material derivative is introduced in characterizing the constitutive relationship of Maxwell nanofluid shear flow, thermal and nanoparticles concentration diffusion over a stretching slipping sheet. The effects of Brownian motion and thermophoretic force are also taken into account. Results show that the internal elastic stress aggregates initially and then release along with the growth of the boundary layer. Moreover, the effects of velocity slip on three boundary layer are also discussed.

▷ PP-A04-24

A New Eulerian Approach to Crystal Plasticity

Minakowski, Piotr — Univ. of Warsaw

Abstract: Looking at severe plastic deformation experiments, it seems that crystalline materials at yield behave as a special kind of anisotropic, highly viscous fluids flowing through an adjustable crystal lattice space. Using the energy estimates we prove global in time existence of a weak solution to the proposed model. As a test example we analyze a micropillar compression. We propose finite element scheme for a numerical solution in the Arbitrary Lagrangian Eulerian (ALE) configuration.

▷ PP-A05-1

On Hamiltonian Colorings of Block Graphs

BANTVA, DEVSI — Lukhdhirji Engineering College, Morbi

Abstract: A hamiltonian coloring c of a graph G with order p is an assignment of colors to the vertices of G such that D(u, v) + —c(u) - c(v)— ¿= p - 1, where D(u, v) denotes the detour distance between u and v. In this paper, we discuss for minimum span of hamiltonian colorings of block graphs and as an example we present symmetric block graphs and its hamiltonian coloring with minimum span.

▷ PP-A05-2

Radio Number for Cacti of Wheels

BANTVA, DEVSI — Lukhdhirji Engineering College, Morbi

Abstract: A radio labeling of a graph G is a function f from the vertex set V(G) to the set of non-negative integers such that —f(u)-f(v)—¿=diam(G)+1-d(u,v), for every pair of distinct vertices u, v of V(G). The radio number of G is the smallest integer k such that G has a radio labeling f with maxf(v) : v in V(G) = k. In this article, we determine the exact radio number for some cacti of wheels.

▷ PP-A05-3

On the Metric Dimension of Join of A Graph with Op

ACHUTHODIKA, SHAHIDA — National Inst. of Tech. Calicut, Kerala
Sunitha, M S — National Inst. of Tech. Calicut, Kerala

Abstract: Given a graph G = (V,E), a subset W of V is a resolving set if for each pair of distinct vertices v1, v2 in V there is a vertex w in W such that d(v1, W) is not equal tod(v2,W) . In this paper, we investigate the metric dimension of Kn + Op; Pn + Op and K1,n + Op and try to find out an application in the field of Robotics.

▷ PP-A05-4

Weakly Connected Closed Geodetic Numbers of Graphs

Patangan, Rachel — MSU-Iligan Inst. of Tech.

Abstract: A subset S of $V(G)$ is called a weakly connected closed geodetic set if $I_G[S_k] = V(G)$ and $\langle S\rangle_w$ is connected, where $\langle S\rangle_w = \langle N[S], E_w\rangle$ with E_w consists of edges $uv \in E(G)$ such that $u \in S$ or $v \in S$. In this paper, we characterize the weakly connected closed geodetic sets of some common graphs and graphs under binary operations. Also, we determine the weakly connected closed geodetic numbers of these graphs.

▷ PP-A06-1

Mixed Finite Element Methods for Time Fractional Parabolic Optimal Control Problems - A Priori Error Estimates

Kandasamy, Manickam — Periyar Univ., Salem 636011, Tamil Nadu, INDIA

Abstract: In this paper, a numerical theory based on mixed finite element methods for time fractional parabolic optimal control problems is presented and analyzed. The space discretization of the state variable is done using usual mixed finite elements, whereas the time discretization is based on difference methods. We derive, a priori error estimates for both the control variable and the state variables. We illustrate with a numerical example to confirm our theoretical results.

▷ PP-A06-2

Strong Stability Preserving Multi-Derivative Runge-Kutta Time Discretization

Grant, Zachary Univ. of Massachusetts Dartmouth

Abstract: We extend the standard SSP analysis to Taylor Series like schemes by introducing a new stability condition for the treatment of higher derivative terms. With these new conditions we are able to develop SSP MDRK methods that obtain high orders of accuracy while maintaining a low number of stages, 2 stage 4th order and 3 stage 5th order. We show the performance of these methods in several test cases to showcase their efficiency and accuracy.

▷ PP-A06-3

Finite Element Method for Some Nonlinear Problems in Orlicz-Sobolev Spaces

MOHAMED, RHOUDAF Sci. Faculty

Abstract: We study in this paper a $P1$ finite element approximation of the solution of nonlinear elliptic equations in Orlicz spaces. No growth assumption is made on the nonlinearities and the N-function does not satisfy the Δ_2-condition. We establish the fundamental theorems of numerical analysis concerning the finite element methods for non-polynomial operator namely: Polynomial interpolation, generalization of Cea's Theorem in the setting of Orlicz-Sobolev spaces and error estimation and convergence for M-laplacian problem.

▷ PP-A06-4

Combination of modified Newton's and Secant method for solving nonlinear equations with order of convergence (3+ √ 17)/2

Jnawali, Jivandhar Inst. of Sci. & Tech. ,Tribhuvan Univ.,Nepal

Abstract: A method for solving nonlinear equation of single variable is derived by combining modified Newton' s and secant method. The order of convergence of modified Newton's method is 1+ √ 2 and the order of convergence of secant method is 1.6. The order of convergence of new method is (3+ √ 17)/2 and is free from second order derivative.

▷ PP-A06-5

A Variant of Newton's Method for Solving Non-linear Equations with Fourth-orderconvergence

Bhatta, Chet Raj Inst. of Sci. & Tech.,Tribhuvan Univ.,Kirtipur Kathmandu

Abstract: In this paper, we prove that combination of arithmetic Newton's method,harmonic Newton's method and mid point Newton's method is unique for the method solving non-linear equations with fourth order convergence. Also a new variant of Newton's method based on inverse function has been developed. This method is free from second order derivative and rate of convergence is four.

▷ PP-A06-6

Computable Error Estimates for FEMs for Elliptic PDE with Lognormal Data

Hall, Eric KTH Royal Inst. of Tech.
Hoel, Haakon Univ. of Oslo
Sandberg, Mattias KTH Royal Inst. of Tech.
Szepessy, Anders KTH Royal Inst. of Tech.
TEMPONE, RAUL KING ABDULLAH Univ. OF Sci. & Tech.

Abstract: We derive computable error estimates for finite element approximations to elliptic PDE with rough, stochastic coefficients. In particular, we consider problems arising in subsurface flow where the coefficients are assumed to have a lognormal distribution. These estimators, based on local error indicators, are for observables of the expected Galerkin and quadrature errors committed in piecewise linear finite element approximations. Our theory is supported by numerical experiments for test problems in one and two dimensions.

▷ PP-A06-7

Scalable Hierarchical Algorithms for EXtreme Computing or Scalable Hierarchical Algorithms for PDEs and UQ

Litvinenko, Alexander KAUST, UQ & ECRC Centers

Abstract: This project aims to tackle the challenge that is facing linear algebra community due to unprecedented level of on-chip concurrency, introduced by the manycore era. HiCMA is a high performance numerical library designed for efficient compressions and fast implementations of (H-matrix) algorithms across a range of architectures. Core idea is to redesign numerical algorithms as implemented in HLib and to formulate them as successive calls to computational tasks, which are then scheduled on underlying system.

▷ PP-A06-8

A Posteriori Error Estimates for Elliptic Problems with Point Sources in Weighted Spaces.

Agnelli, Juan Pablo Univ. of Cordoba

Abstract: We develop a posteriori error estimates for elliptic problems with point sources in two- and three-dimensional domains. We prove a global upper bound and a local lower bound for the error measured in a weighted Sobolev space. The weight is a power of the distance to the support of the Dirac delta source term, and belongs to the Muckenhoupt's class A_2. Numerical experiments with an adaptive algorithm yield optimal meshes and very good effectivity indices.

▷ PP-A06-9

Multi-level Decoupling of Free Flow Coupled with Porous Media Flow

Chidyagwai, Prince Loyola Univ. Maryland

Abstract: We present a multi-level decoupling technique for solving the coupled Stokes-Darcy model. The model describes the interaction between free flow and porous media flow. We present a multi-numerics scheme based on continuous finite elements for the flow in the free flow region and the Discontinuous Galerkin method to approximate the flow in the porous medium. Multi-level methods offer computational efficiency by solving the fully coupled problem on a coarse mesh (thus computationally less expensive) and using the solution from the coarse mesh to decouple the model on successively finer meshes for a desired accuracy.This method naturally decouples the problem into two systems; one for the free flow region and the other for the porous medium region. We present numerical results to verify the theoretical convergence rate of the numerical solution from the decoupled scheme. Further, we compare the accuracy of the decoupled numerical scheme to the fully coupled scheme.

▷ PP-A06-10

Exponential Quartic Spline Solution of Fifth Order Singularly Perturbed Boundary Value Problems

Khandelwal, Pooja Jamia Millia Islamia, New Delhi

Abstract: In this paper, we develop a numerical technique for the solution of fifth order singularly perturbed boundary value problems using exponential quartic spline. End conditions of the spline are derived. Convergence analysis of the method is briefly discussed and the method is proved to be second order convergent. Numerical examples are provided to show the efficiency and accuracy of the technique.

▷ PP-A06-11

Research on the Extension of Cubic Spline Function

Li, Ning Chongqing Univ.

Abstract: Based on the analysis of basic cubic spline function, we promote the boundary conditions of the traditional cubic spline interpolation, and research how to solve cubic spline interpolation on the condition that the first derivative and second derivative of arbitrary node are given, at the same time, we give out the corresponding solving methods, then we uses these some examples to illustrates the effectiveness of the solving methods.

▷ PP-A06-12

Numerical Methods for One-Dimensional Stefan Problems

CALDWELL, James OPEN Univ. OF HONG KONG
NG, Kei Shing Douglas OPEN Univ. OF HONG KONG
CHU, Chun Fai Carlin OPEN Univ. OF HONG KONG

Abstract: This paper describes and compares several effective methods for the numerical solution of one-dimensional Stefan problems. We restrict our attention to problems and geometries which include melting in the half-plane, outward cylindrical solidification and outward spherical solidification. Effectively, a range of methods is introduced including (1) enthalpy method, (2) boundary immobilization method, (3) perturbation method, (4) nodal integral method, and (5) heat balance integral method. These methods are then applied to test problems.

▷ PP-A06-13

Numerical Solution of Stefan Problems by Variable Space Grid Method

CALDWELL, James OPEN Univ. OF HONG KONG
CHU, Chun Fai Carlin OPEN Univ. OF HONG KONG
NG, Kei Shing Douglas OPEN Univ. OF HONG KONG

Abstract: The variable space grid method based on finite-differences is applied to the one-dimensional Stefan problem with time-dependent boundary conditions describing the solidification/melting process. The temperature distribution, position of the moving boundary and its velocity are evaluated in terms of finite differences. The computational results by the variable space grid method exhibit good agreement with the exact solution. Also the present results are superior to those from the variable time step method.

▷ PP-A06-14

A Mortar Finite Element Method Using Non-conforming Crouzeix-Raviart Space.

Patel, Ajit — The LNM Inst. of Information Tech.
Pradhan, Debasish — Defence Inst. of Advanced Tech.

Abstract: In this article, we have discussed a domain decomposition method with non-matching grids (known as mortar method) for solving second order elliptic problems using non-conforming Crouzeix-Raviart space. The continuity condition across the common interfaces between the adjacent subdomains has been relaxed by the help of Mortar condition. Inter-element continuity constraint inside the sub-domains is also no more required by the help of introducing Crouzeix-Raviart space. Optimal error estimates are derived in both H^1 and L^2-norm.

▷ PP-A06-15

Numerical Techniques for Variable Order Fractional Semilinear Diffusion Problems

Birajdar, Gunvant — Tata Inst. of Social Sci.

Abstract: The aim of our study is to obtain the numerical solution of first initial boundary value problem (IBVP) for semilinear variable order fractional diffusion equation. We develop the three numerical techniques namely explicit difference scheme, implicit difference scheme and Crank-Nicolson difference scheme respectively. The stability as well as convergence of schemes are studied via Fourier method. As an application test problems are also solved using MATLAB.

▷ PP-A06-16

Numerical Homogenization of Harmonic Maxwell's Equation with A Heterogeneous Multiscale Method

Stohrer, Christian — POEMS team, ENSTA ParisTech

Abstract: The approximation of an electromagnetic wave propagating through a highly oscillatory medium is challenging. Using standard edge finite elements a very fine mesh is needed to obtain reliable numerical solutions. Hence, this approach may lead easily to infeasible computational costs. We propose a finite element heterogeneous multiscale method for the Maxwell's equations in frequency domain, which overcomes this issue. The method relies on estimating effective parameters solving small cell problems on the fly.

▷ PP-A06-17

Approximation of Semilinear Stochastic Evolution Equations Driven by Colored Noise

Kamrani, Minoo — Razi Univ.

Abstract: We investigate the approximation by space and time discretization of semi linear stochastic evolution equations driven by colored noise. A numerical method will be introduced and an error bound for the method is given. Convergence rate of the scheme will be obtained. Numerical examples are also presented to examine the theoretical results.

▷ PP-A06-18

Convergence Proof and Error Analysis of the Homotopy Analysis Method

Ma, Junchi — Dalian Univ. of Tech.

Abstract: The homotopy analysis method has been applied to solve many problems. However, proof of convergence for the method has not been given. For second-order linear differential equations, a proof of convergence for the series solutions is presented. An approach for seeking convergent series solutions is proposed, which includes the determination of a valid region of the convergence-control parameter for ensuring convergence, and an upper bound for the absolute error of a series approximation.

▷ PP-A06-19

Numerical Applications of Tikhonov Regularization for the Fourier Multiplier Operators

Almarashi, Adel — Thamar Univ.

Abstract: In this manuscript we present a simple and efficient approximation for some class of Fourier multiplier operators Tm on the Paley-Wiener spaces Hh, using the theory of reproducing kernels to the Tikhonov regularization. Furthermore, we give several numerical computational examples to test and validate the theory.

▷ PP-A06-20

Discontinuous Finite Volume Methods for Semilinear Parabolic Optimal Control Problems.

Sandilya, Ruchi — Indian Inst. of Space Sci. & Tech.
Kumar, Sarvesh — Indian Inst. of Space Sci. & Tech.

Abstract: This paper deals with discontinuous finite volume approximations of the distributed optimal control problems governed by a class of semilinear parabolic partial differential equations and subject to inequality control constraints. For discretizing the control parameter, the variational discretization technique is employed. A priori error estimates are derived in different norms for the semi-discrete and fully-discrete piecewise linear discontinuous finite volume methods. Several numerical experiments are presented to test the theoretical findings.

▷ PP-A06-21

On the Analysis of Numerical Methods for Nonstandard Volterra Integral Equation

Mamba, Hlukaphi — Univ. of Johannesburg
Khumalo, Melusi — Univ. of Johannesburg

Abstract: We consider the numerical solutions of a class of nonlinear (nonstandard) Volterra integral equation. These VIEs arise from nonlinear ordinary differential equations used to represent conservative systems. We prove the existence and uniqueness of the one point collocation solutions and the solution by the repeated trapezoidal rule for the nonlinear Volterra integral equation. We analyze the convergence of the collocation methods and the repeated trapezoidal rule.

▷ PP-A06-22

A New Approach to Finite Element Simulation of General Relativity

Quenneville-Belair, Vincent — Univ. of Minnesota

Abstract: To study gravitational waves, I introduce a new approach to finite element simulation of general relativity. This approach is based on approximating the Weyl curvature directly through new stable mixed finite elements for the Einstein-Bianchi system. I design and analyze these elements by adapting the Finite Element Exterior Calculus framework to abstract Hodge wave equations. This recent framework had a transformative impact on related computational problems, and I am now expanding it to general relativity.

▷ PP-A06-23

An Adaptive Bubble-type Local Mesh Generation Method and Its Application in Solving Elliptic Problem with Discontinuous Coefficients

Zhou, Yuqing — Northwestern Polytechnical Univ.
Nie, Yufeng — Northwestern Polytechnical Univ.
Zhang, Weiwei — Northwestern Polytechnical Univ.

Abstract: According to the a posteriori error estimator, a bubble placement method and constrained BLMG strategy are applied to solve elliptic problem with discontinuous coefficients which has strong singularity adaptively and efficiently, several numerical experiments are reported to support the efficiency of our adaptive method, including that the triangle remain well-shaped at any particular refinement levels, the grid size varies by several orders of magnitude.

▷ PP-A06-24

Fast Sweeping Methods for Solving Eikonal Equations on Implicit Surfaces

Wong, Ka Wah — Hong Kong Univ. of Sci. & Tech.

Abstract: We use fast sweeping method to solve intrinsic eikonal equations defined on the implicit surfaces. The numerical scheme is based on rectangular grid where the numerical solution is computed in a narrow computation tube of the surfaces. We present a special treatment to handle the boundary values of the computation tube in order to make the numerical scheme converges to the correct viscosity solution.

▷ PP-A06-25

Asymptotic-preserving Well-balanced Scheme for the Electronic M1 Model in the Diffusive Limit.

GUISSET, Sebastien — CELIA laboratory
Brull, Stephane — Institut Polytechnique de Bordeaux

Abstract: This work is devoted to the derivation of an asymptotic-preserving scheme for the electronic M1 model in the diffusive regime. The derivation of the scheme is based on an approximate Riemann solver where the intermediate states are chosen consistent with the integral form of the approximate Riemann solver. This choice enables the derivation of a numerical scheme which also satisfy the admissible conditions and is well-suited for capturing steady states. Moreover, it enjoys asymptotic-preserving properties.

▷ PP-A06-26

Solutions and Perturbation Analysis of A Nonlinear Matrix Equation

Al-Dubiban, Asmaa — Faculty of Sci. & Arts, Qassim Univ.

Abstract: Nonlinear matrix equations have many applications in engineering, nano research, control theory etc. In this paper, we propose inversion free variant of the basic fixed point iteration method for obtaining positive definite solutions of a nonlinear matrix equation. Necessary and sufficient conditions for the existence of solutions are derived. The rate of convergence of the iterative sequence and perturbation bound for the solution are obtained. We give numerical examples to ensure the effectiveness of the method.

▷ PP-A06-27

Regularization of Operator DAEs

Altmann, Robert TU Berlin

Abstract: We consider semi-explicit operator differential equations with saddle point structure such as the Stokes equations. A semi-discretization in space then leads to DAEs of higher index. We propose a regularization of the operator equations which generalizes the concept of an index reduction to infinite dimensions.

▷ PP-A06-28

Numerical Dispersion Analysis of the Convected Helmholtz Equation

Kwon, Ohsung National Inst. for Mathematical Sci.
Sim, Imbo National Inst. for Mathematical Sci.

Abstract: We present the numerical dispersion effects in solving the convected Helmholtz equation by the conforming and nonconforming quadrilateral finite elements. Particularly, we evaluate the dispersion relations for the numerical schemes and analyze the dispersive behaviors focusing on Mach number and the angular frequency. Moreover, numerical experiments are conducted to verify that the numerical dispersion represents the relation between the numerical error and the parameters.

▷ PP-A06-29

Structure-preserving Numerical Schemes for the One-phase Interior/exterior Hele-Shaw Problems by the Charge Simulation Method

Sakakibara, Koya The Univ. of Tokyo
Yazaki, Shigetoshi Meiji Univ.

Abstract: The solutions to the classical Hele-Shaw problem are discretized in space by means of a modified charge simulation method combined with the discrete asymptotic uniform distribution method, and then a system of ordinary differential equations is obtained, which is solved by the usual fourth order Runge-Kutta method. The Hele-Shaw problem has curve-shortening and area-preserving properties. Our scheme realizes these properties asymptotically in a discrete sense.

▷ PP-A06-30

Control of Parasitism in G-symplectic Methods via Projection

Habib, Yousaf National Univ. of Sci. & Tech.

Abstract: G-symplectic general linear methods approximately preserve symplectic invariants for Hamiltonian systems over long times. However being multivalue in nature, these methods are prone to parasitic corruption of the numerical solution. As a remedy and in order to control parasitism, standard projection as well as symmetric projection is employed to project the numerical solution on the invariant manifold.

▷ PP-A06-31

Numerical Homogenization Method with Partition of Unity Property

Chen, Hongfei Shanghai Jiaotong Univ.
Zhang, Lei Shanghai Jiao Tong Univ.

Abstract: Numerical homogenization is a typical and widely applied multiscale method It is believed that a multiscale method with partition of unity property has better stability and convergence. We aim to seek the general method in constructing a specific numerical homogenization method with partition of unity property and analyze its stability ,convergence and computational complexity. Moreover, we wish to generalize it to high-dimensional and nonlinear problems. This is a joint work with Professor Lei Zhang

▷ PP-A06-32

A Moving Grid Method via A Hodograph Transformation for the Short-pulse Equation under the Periodic Condition

Sato, Shun The Univ. of Tokyo

Abstract: When the pair of PDEs are associated with each other via hodograph transformation, a numerical integrator of one PDE can be obtained from that of the other, which gives rise to moving grid effect. Oguma−Matsuo−Feng showed that this can be in fact realized for the short-pulse and sine-Gordon equations. However, they only considered it on whole real line. We show that their result can be generalized to the periodic case.

▷ PP-A06-33

The Construction of the Basis of the Multi-scale Finite Element Method and Its Parallel Realization

Chi, Hai Shanghai Jiao Tong Univ.
Zhang, Lei Shanghai Jiao Tong Univ.

Abstract: With the development of subjects like material science, biological medical engineering and so on, the problem of how to deal with the interaction between different scales feasibly and efficiently becomes more important. Our research designs an efficient parallel package to realize different multi-scale algorithms. Based on the package, we try to design a Multi-scale algorithm with the property of the partition of unity. Furthermore, we will try to generalize it to the non-linear function.

▷ PP-A06-34

IB-BGMRES-DR: An Augmented Block Krylov Method with Inexact Breakdowns

Jing, Yanfei Univ. of Electronic Sci. & Tech. of China

Abstract: A block GMRES method for solution of large linear systems with multiple right-hand sides given simultaneously is presented. This new algorithm addresses the problems related to spectral augmentation at restart and the partial convergence of some linear combinations of the right-hand sides. Through numerical experiments, we show that the new algorithm combines efficiently the attractive numerical features of its two parents that it outperforms.

▷ PP-A06-35

Mixed Discontinuous Galerkin Discretizations for Photonic Crystals

Lu, Zhongjie Univ. of Sci. & Tech. of China

Abstract: Photonic crystals are nanostructures that contain periodic variations in dielectric materials on length scales comparable to the wavelength of light. Light with frequencies inside the photonic band gap cannot exist in these materials. To find those gaps, we need to solve the Maxwell eigenproblem. Here, we use mixed discontinuous Galerkin finite element discretization with basis functions modified according to the Bloch-Floquet theory. And we prove the correctness of the spectrum of the corresponding numerical operator.

▷ PP-A06-36

Exponential Convergence for Numerical Solution of Integral Equations Using Radial Basis Functions

Avazzadeh, Zakieh Nanjing Normal Univ.

Abstract: In this work, we solve Urysohn types of integral equations using the radial basis functions. Since RBFs have normic structures that utilize approximation in higher dimension, we also implement the method for higher dimension. Furthermore, numerical experiments show using RBF for solving integral equations leads to the exponential convergence coincided with the results of solving PDEs using RBFs. In fact, numerical results confirm the shape parameter and number of collocation points exponentially effect on accuracy.

▷ PP-A06-37

Continuous Galerkin Methods for Delay Differential Equations of Pantograph Type

Huang, Qiumei Beijing Univ. of Tech.

Abstract: We discuss the global convergence and local superconvergence of the continuous Galerkin (CG) solutions for delay differential equations with proportional delay under uniform meshs and quasi-geometric meshs. Under uniform meshs, we also locate all the superconvergence points based on the supercloseness between the continuous Galerkin solution and the interpolation of the exact solution. The nodal superconvergence order of CG solutions under quasi-geometric meshs is significantly higher than that of CG solutions under uniform meshs.

▷ PP-A06-38

New Fast Algorithms for A Modified TV-Stokes Model

Jia, Zhigang Jiangsu Normal Univ.

Abstract: In this poster, we present some new fast algorithms for the modified TV-Stokes models.In the first step, we use the dual formulation of denoising and multigrid method to get a fast algorithm. Another new imcompressibility-preserved algorithm is proposed for the tangent field smoothing. In the second step, completely new algorithms are presented by us.

▷ PP-A06-39

Polynomiographs and Convergence Planes of Multi-point Root Finding Methods

Junjua, Moin-ud-din Bahauddin Zakariya Univ. Multan, Pakistan
Zafar, Fiza Bahauddin Zakariya Univ. Multan
Akram, Saima Bahauddin Zakariya Univ., Multan
Yasmin, Nusrat Bahauddin Zakariya Univ. Multan Pakistan

Abstract: We demonstrate some polynomiographs drawn by locating the roots of nonlinear equations using our newly constructed iterative methods. Polynomiographs are constructed using two types of attraction basins. Through these polynomiographs the convergence domains can be easily visualized and identified. The convergence planes are also drawn in real domain. S-ince, the methods involve parameters, therefore, through these planes we can choose the suitable values of these parameters for which the methods perform efficiently.

▷ PP-A06-40

Computed Aided Detection Method for Early Detection of Cerebrovascular Disease

NG, Kei Shing Douglas — OPEN Univ. OF HONG KONG
CALDWELL, James — OPEN Univ. OF HONG KONG

Abstract: With the aging of our population, stroke has been raised the third highest cause of death in the world. The aim of this study is to establish a computer aided diagnosis system for early detection of ischemic stroke using Computed Tomography (CT). A CAD scheme for accurate diagnosis of ischemic stroke with small lesions is proposed. The modelling method can be applied in other imaging modalities.

▷ PP-A07-1

Detrended Fluctuation Analysis of Monthly Sunspot Number Time Series and Its Long-range Correlation

Chattopadhyay, Surajit — Pailan College of Management & Tech., Kolkata
Chattopadhyay, Goutami — Calcutta Univ.

Abstract: Present paper analyzes long-range autocorrelation in total ozone time series and subsequently develops autoregresseive neural network (AR-NN) as a predictive model . A univariate clustering is carried out to identify the centroids of the clusters. It has been examined for white-noise process and spectral densities have been computed. Finally, detrended fluctuation analysis has been carried out. Long-range power-law correlation has been observed and performance of AR-NN(3) is identified as better than AR(3) and ARMA(3,1) .

▷ PP-A07-2

Big Step Acceleration Fast Multipole Method

Fengli, Zuo — Inst. of Applied Physics & Computational Mathematics

Abstract: To control the rapid increasing memory of Fast Multipole Method (FMM) in highly accurate numerical simulations, we propose a new Big Step Acceleration Fast Multipole Method (BSAFMM) . The new method is reconstructed based on FMM by restricting the number of grid levels. We analyze both qualitatively and quantitatively the number of grid levels and the special/temporal complexity of both methods. The analysis shows that BASFMM remarkably save memory compared with FMM.

▷ PP-A07-3

Analyzing Standing Waves on Periodic Waveguides by Pseudospectral Modal Method

Song, Dawei — Nanjing Univ. of Aeronautics & Astronautics

Abstract: For some periodic waveguides, there are standing waves, which are special guided modes, non-propagating and localized around the waveguide core, and they are related to transmission anomalies and other resonant phenomena. A recently developed pseudospectral modal method (PSMM) for diffraction gratings is reformulated to analyze standing waves on periodic waveguides.

▷ PP-A07-4

Galina Reshetova, Egor Lys, Vladimir Tcheverda Numerical Simulation of Sonic Log in Anisotropic Viscoelastic Media: Parallel Implementation

Reshetova, Galina — Inst. of Compuitational Math. & Math. Geoph

Abstract: Modern high performance computers allow to study complete wave fields which of acoustic logging for 3D heterogeneous media with realistic properties such as anisotropy and attenuation. Anisotropy is rather widespread property of reservoirs as it is caused by thin-layering or systems of oriented fractures, while attenuation may indicate fluid saturation. We present a new approach to finite difference simulation of sonic log for anisotropic viscoelastic media on the base of Lebedev scheme in cylindrical coordinates.

▷ PP-A07-5

An Adaptive Approach Based on Least-squares Finite Element Approximations to Viscoelastic Fluid Flows

Lee, Hsueh-Chen — Wenzao Ursuline Univ. of Languages

Abstract: We implemented an adaptive least-squares finite element method for viscoelastic fluid flows. To capture the flow region, we developed an adaptive mesh redistribution approach based on the mesh redistribution functions varied with grading functions of the least-squares solutions. We provided an a prior error estimate and presented numerical results to support the estimation. Numerical results showed that adaptive grids were required in areas with varying flow features for gaining the expected accuracy.

▷ PP-A07-6

High-resolution Numerical Schemes for Hyperbolic Conservation Laws, and Their Performance on Modern HPC Architectures

Prugger, Martina — Univ. of Innsbruck

Abstract: The modeling of fluids usually results in a number of partial differential equations that relate the change of local properties (such as density, velocity, temperature,...) in time to the corresponding change in space. Mathematically the proper discretization of conservation laws is of importance to obtain physically relevant result. The problems are challenging from a numerical point of view, since care has to be taken to propagate shock waves without diminishing the performance of the scheme.

▷ PP-A07-7

A Hybrid Method for Solving the Poisson's Equation in the Presence of Multiple Closely Compacted Dielectric Spheres

Gan, Zecheng — Inst. of Natural Sci., Shanghai Jiao Tong Univeristy
Jiang, Shidong — New Jersey Inst. of Tech.
Xu, Zhenli — Shanghai Jiao Tong Univ.

Abstract: A new closed-form formula is developed for the image of a general multipole source with arbitrary degree (order) outside a dielectric sphere. A method of images based on this formula is developed, then coupled with the method of moments and the fast multiple method to solve boundary value problems for systems consists of multiple closely compacted charged dielectric spheres. The accuracy and efficiency for this new hybrid method is demonstrated through several numerical experiments.

▷ PP-A07-8

A Single-sweep Algorithm for Computing the Asymptotic Spectrum for Networks with Pairwise Rates of the Form $K_{ij}\exp(-U_{ij}/T)$

Gan, Tingyue — Univ. of Maryland at College Park
Cameron, Maria — Univ. of Maryland

Abstract: We propose a single-sweep algorithm to compute the asymptotic eigenvalues and eigenvectors of a matrix with entries of the form $L_{ij} = k_{ij}\exp(-U_{ij}/T)$ for $i! = j$, and $L_{ii} = -\sum_{j!=i} L_{ij}$. Parameter $T > 0$ and tends to zero. This problem is essentially reduced to the computation of the family of so called optimal W-graphs(Wentzell) of a weighted directed graph.

▷ PP-A07-9

The Entropy Dissipation Scheme for Two-Dimensional Hyperbolic Equations

Li, Hongxia — Zhejiang Univ. of Finance & Economics

Abstract: We design the entropy dissipation scheme for the two-dimensional hyperbolic equations. The scheme computes both the numerical solution and the numerical entropy. We use the entropy dissipation term that simulates the variation of the entropy to stabilize the computation. Finally, numerical experiments for scalar case are presented.

▷ PP-A07-10

Fast Numerical Contour Integral Method for Fractional Diffusion Equations

Pang, Hong-Kui — Jiangsu Normal Univ.
SUN, Hai-wei — Univ. of Macau

Abstract: The numerical contour integral method with hyperbolic contour is exploited to solve space-fractional diffusion equations. By making use of the Toeplitz-like structure of spatial discretized matrices and the relevant properties, the regions that the spectra of resulting matrices lie in are derived. Suitable parameters in the hyperbolic contour are selected based on these regions to solve the fractional diffusion equations. Numerical experiments are provided to demonstrate the efficiency of our contour integral methods.

▷ PP-A07-11

Comparison of Weak Galerkin Finite Element Method with Dgfem and Mfem.

Sadre-Marandi, Farrah — Colorado State Univ.

Abstract: We present a comparative study on the newly introduced weak Galerkin finite element methods (WGFEMs) with the widely accepted discontinuous Galerkin finite element methods (DGFEMs) and the classical mixed finite element methods (MFEMs) for solving second-order elliptic boundary value problems. The differences, similarities, and connection among these methods in scheme formulations, implementation strategies, accuracy, and computational cost are compared. We demonstrate that WGFEMs are viable alternatives to MFEMs and hold some advantages over DGFEMs.

▷ PP-A07-12

A Generalized Extending Compacts Method for Inverse Source Problems on Sourcewise Represented Sets

Ye, Zhang — Örebro Univ.

Abstract: In this work, we consider an inverse source problem for elliptic partial differential equations with both Dirichlet and Neumann boundary conditions. The unknown source term is to be determined by additional boundary data. This problem is ill-posed since the boundary is one dimension lower

than the inner domain. To overcome the ill-posed nature, using the a priori information (sourcewise representation) based on the coupled complex boundary method we will propose a generalized extending compacts method.

▷ PP-A07-13

A New Globally Hyperbolic Moment System by Generalized Hermite Expansion

Fan, Yuwei — School of Mathematical Sci., Peking Univ.
Ruo, Li — Peking Univ.

Abstract: In gaskinetic theory, Grad's expansion actually is using a polynomial to approach the distribution divided by local Maxwellian. However, distribution function is usually anisotropic while Maxwellian is isotropic. In the sense of distribution, Grad's expansion can be treated as a linear approximation of Levermore's maximum entropy around Maxwellian. Why Maxwellian? Here we expand the distribution around a Gaussian, which is anisotropic and closer to maximum entropy, and the resulting moment system is better Grad's.

▷ PP-A07-14

AN ADAPTIVE INDEPENDENCE SAMPLER MCMC ALGORITHM FOR INFINITE-DIMENSIONAL BAYESIAN INFERENCE

Feng, Zhe — Shanghai Jiao Tong Univ.
Li, Jinglai — shanghai jiaotong univerisity

Abstract: In this work we develop an independence sampler based MCMC method for the Bayesian inferences in function spaces. We represent the proposal distribution as a mixture of a finite number of specially parametrized Gaussian measures. We show that the resulting MCMC algorithm is dimension independent. We also design an efficient adaptive algorithm to adjust the mixture parameters from the sample history. Examples are provided to demonstrate the efficiency and robustness of the proposed method.

▷ PP-A07-15

A Stable WKBJ Propagator for Schrodinger Equations in the Semi-Classical Regime

Kwan, Wing Fai — The Hong Kong Univ. of Sci. & Tech.

Abstract: Fast Huygens sweeping method is used to evaluate the Schrodinger equation in the semi-classical regime using FFT. It combines short-time WKBJ propagators into Huygens principle. Approximations is developed using Taylor expansion and a convolution is formed which has to be computed numerically. Previous work has been done by explicit scheme but it has lower bounds for each time-step. In this project, a numerical algorithm is proposed to suit time-mesh of arbitrary size.

▷ PP-A07-16

A Fast Computational Method for Optimizaing Hyper-parameters in Bayesian Linear Inverse Problems

Liu, WenQing — Shanghai Jiao Tong Univ.
Li, Jinglai — shanghai jiaotong univerisity

Abstract: In Bayesian inferences the hyper-parameters are often determined by maximizing the evidence. We present a fast computational method to do so in linear Bayesian inverse problems. The method approximates the objective function by by using an "optimal low rank approximation" of the posterior covariance matrix. We also combine several computational techniques such as randomized algorithms to accelerate the evaluation of the objective function. Finally we present an adaptive algorithm to solve the optimization problem.

▷ PP-A07-17

A Non-Gaussian Prior for Infinite Dimensional Bayesian Inverse Problems.

Hu, Zixi — Shanghai Jiao Tong Univ.
Yao, Zhewei — Shanghai Jiao Tong Univ.
Li, Jinglai — shanghai jiaotong univerisity

Abstract: We consider the Bayesian methods for solving inverse problems in function space. The often used Gaussian processes prior often has difficulty in dealing with functions with discontinuities. In this work we present a non-Gaussian prior for such problems and we develop an efficient MCMC algorithm to sample the posteriors resulting from this non-Gaussian prior. Numerical examples are provided to demonstrate the effectiveness of the method.

▷ PP-A07-18

Joint MAP Estimation for Fractional Diffusion Inverse Problems

Yao, Zhewei — Shanghai Jiao Tong Univ.
Hu, Zixi — Shanghai Jiao Tong Univ.
Li, Jinglai — shanghai jiaotong univerisity

Abstract: We consider an inverse problem where the model is a time-fractional diffusion. In particular we consider the problem where the Caputo fractional derivative order α is not known. We present a joint MAP approach to estimate the unknown and α simultaneously. Numerical examples are provided to demonstrate the effectiveness of the proposed method.

▷ PP-A07-19

Cloud Computing Technology for Education and Research in Mathematics

Liu, Xuefeng — Niigata Univ., Japan
Tanaka, Tamaki — Niigata Univ.

Abstract: A system based on cloud computing technology is developed for the purpose of education and research in mathematics. The system can provide dynamic service (computing servers) corresponding to the needs of users. It is now very easy for one to set up an online demonstration site to reveal mathematics including various resource-consuming computing algorithms.

▷ PP-A07-20

Bounds on the Size of An Inclusion Using the Translation Method for Two-dimensional Complex Conductivity

Li, Xiaofei — Inha Univ.

Abstract: The size estimation problem in electrical impedance tomography is considered when the conductivity is a complex number and the body is two-dimensional. Upper and lower bounds on the volume fraction of the unknown inclusion embedded in the body are derived in terms of two pairs of voltage and current data measured on the boundary of the body. We also provide numerical examples to show that these bounds are quite tight and stable under measurement noise.

▷ PP-A08-1

Methods and Tools of Functional Programming for Supporting of Cloud Supercomputing

Kasyanov, Victor — Inst. of Informatics Sys.

Abstract: In the paper, the CSS project being under development at the Institute of Informatics Systems in Novosibirsk with support of the Russian Foundation for Basic Research (15-07-02029) is considered. The CSS system uses the Cloud Sisal language, is available on web via browser and includes interface, interpreter, graphic visualization/debugging subsystem, optimizing cross compiler, cluster runtime. It provides means to write and debug Cloud-Sisal-programs on low cost devices and to translate and execute Cloud-Sisal-programs in clouds.

▷ PP-A09-1

Detecting the Source of Failure in Distributed Data

Szajowski, Krzysztof — Wroclaw Univ. of Tech.

Abstract: The system generate events in random moments and with random effects. Any deviation from the regularity of events or results significantly different from the expected should be treated as a malfunction of the system. The mathematical model of such system is proposed. The change points could be in events appearance and the size. The detection of disorder moments is investigated in general case: known or unknown order.

▷ PP-A09-2

Eigenvalue Condition and Model Selection Consistency of Lasso

Yang, Yuehan — Central Univ. of Finance & Economics

Abstract: In this paper, we investigate a new train of thought to lead the model selection consistency of lasso. One important but more standard and much weaker condition, Eigenvalue Condition, is proposed. We can prove that the probability of lasso selecting wrong variables can decays at an exponential rate in ultra-high dimensional settings without other restrains except Eigenvalue Condition.

▷ PP-A09-3

An Efficient and Robust Variable Selection Method for Longitudinal Generalized Linear Models

Lv, Jing — Chongqing Univ.
Yang, Hu — Chongqing Univ.
Guo, Chaohui — Chongqing Univ.

Abstract: This paper presents a new efficient and robust smooth-threshold generalized estimating equations for generalized linear models (GLMs) with longitudinal data. The proposed method is based on a bounded exponential score function and leverage-based weights to achieve robustness against outliers both in the response and the covariate domain. Our motivation for the new variable selection procedure is that it enables us to achieve better robustness and efficiency by introducing an additional tuning parameter γ.

▷ PP-A09-4

Penalized Weighted Composite Quantile Estimators with Missing Covariates

Yang, Hu — Chongqing Univ.
Liu, Huilan — Chongqing Univ.

Abstract: In this paper, we propose the penalized weighted composite quantile regression estimation for linear model when the covariates are missing at

random. Under some mild conditions, the asymptotic normality, oracle property and Horvitz-Thompson property of the proposed estimators are established. Simulation results and a real data analysis are provided to examine the performance of our methods.

▷ PP-A09-5

The Adaptive L1-penalized LAD Regression for Partially Linear Single-index Models

Yang, Jing — Chongqing Univ.
Yang, Hu — Chongqing Univ.

Abstract: We propose a stepwise penalized LAD regression to generate robust estimators based on PLSIM. An iterative procedure is firstly presented to estimate the index parameters with the univariate link function is approximated by local linear LAD regression, then adaptive L1-penalized LAD procedure is introduced to do estimation and variable selection for the linear part parameters based on the index estimator. Compared with the penalized LS estimator, our proposed estimator is shown to be robust.

▷ PP-A09-6

A Robust and Efficient Estimation Method for Single-index Varying-coefficient Models

Yang, Hu — Chongqing Univ.
Guo, Chaohui — Chongqing Univ.
Lv, Jing — Chongqing Univ.

Abstract: A new estimation procedure based on modal regression is proposed for single-index varying-coefficient models. The proposed method achieves better robustness and efficiency than that of Xue and Pang (2013). We establish the asymptotic normalities of proposed estimators and evaluate the performance of the proposed method by a numerical simulation.

▷ PP-A09-7

The Pth Moment Asymptotic Stability and Exponential Stability of Stochastic Functional Differential Equations with Polynomial Growth Condition

Feng, Lichao — Beijing Univ. Of Tech.
Li, Shoumei — Beijing Univ. Of Tech.

Abstract: This paper mainly discusses the pth moment asymptotic stability and the exponential stability of nonlinear stochastic functional differential equations (SFDEs) satisfying the local Lipschitz condition but not the linear growth condition. These new conditions assume that the coefficients of SFDEs are polynomials or dominated by polynomials. We establish some sufficient conditions for the pth moment asymptotic stability and the exponential stability of nonlinear SFDEs by applying some novel techniques.

▷ PP-A09-8

Generalized Empirical Likelihood Inference for Longitudinal Data with Missing Response Variables and Error-Prone Covariates

Liu, Juanfang — Beijing Univ. of Tech.
Xue, Liugen — Beijing Univ. of Tech.

Abstract: Incomplete longitudinal data often arise in many areas. In this article, we consider longitudinal partial linear models when the response variable is missing probability depending on the covariate that is measured with error. A generalized empirical likelihood method is proposed by combining inverse probability-weighted generalized estimating equations and quadratic inference functions based on the working correlation matrix. Empirical studies demonstrate that the proposed method performs better than normal approximate method.

▷ PP-A09-9

Weak Approximation for Non-smooth Functionals of Stochastic Differential Equations with Irregular Drift and Application in Mathematical Finance

Ngo, Hoang Long — Department of Mathematics & Informatics

Abstract: We study the weak approximation for non-smooth functionals of (reflected) stochastic differential equations with irregular drift and constant diffusion coefficient, when their solution is approximated by a continuous Euler-Maruyama scheme. We also discuss some applications of your study to study the numerical pricing problem in mathematical finance.

▷ PP-A09-10

Semiparametric Estimation of the Single-index Varying-coefficient Model

Zhao, Yang — Beijing Univ. of Tech.
Xue, Liugen — Beijing Univ. of Tech.

Abstract: In this paper, we consider the choice of pilot estimators for the single-index varying- coefficient model, which may result in radically different estimators, and develop the method for estimating the unknown parameter in this model. Asymptotic properties for the proposed estimation procedure have been established. Simulation studies are carried out to assess the finite sample performance of the proposed estimators, and efficiency comparisons between the estimation methods

▷ PP-A09-11

Martingale Optimal Transport Dualities in Skorokhod Space

Gaoyue, GUO — CMAP, Ecole Polytechnique

Abstract: The problem consists in maximizing the expectation of some reward function among all martingale measures under some marginal constraints. We establish the dualities and give a geometric characterization of its optimizers.

▷ PP-A09-12

A Semiparametric Empirical Likelihood on the Linear Models with Covariates Parametrically Transformed

Zhang, Jing Hua — Beijing Univ. of Tech.
Xue, Liugen — Beijing Univ. of Tech.

Abstract: The linear assumption between the non-parametrically transformed response and the covariates in the traditional linear transformed models may not be satisfied in practice. With the covariates been parametrically transformed, the linearity may be recovered. Here we apply the empirical likelihood method to such a linear transformed model. We obtain the confidence region for the regression parameters via an U-statistics. Simulations and a real data analysis demonstrate that the proposed method substantially outperforms the normal approximationbasedmethod.

▷ PP-A09-13

Tests for High-dimensional Regression Coefficients in Linear Panel Models

Jing, Zhao — Beijing Univ. of Techonology

Abstract: To test regression coefficients of linear panel models, the FW-test based on within estimation of regression coefficients often is suggested. This paper investigates the performance of the FW-test for testing part of high dimensional regression coefficients in a panel data model under the case of p/N → ρ (0 ¡ ρ ¡ 1). The asymptotic normality of the FW-statistic is ob- tained, and then two asymptotic tests (UA-test,UB-test) are presented. The inference approach does not require any specification of the error distribu- tion. Some simulation results are presented which show that the UA-test and UB-test are more powerful than FW-test for moderately large dimension and sample sizes. A pharmacokinetics study on renal cancer data is illustrated using the proposed method.

▷ PP-A09-14

Gaussian Processes Accelerated Multi-canonical Monte Carlo for Rare Probability Estimation

Wu, Keyi — Shanghai Jiao Tong Univ.
Li, Jinglai — shanghai jiaotong univerisity

Abstract: Multi-canonical Monte Carlo (MMC) has been used to estimate small failure probabilities in various engineering problems. MMC often requires a rather large number (e.g. 1E5) of simulations to obtain a reliable estimate, which can be prohibitively expensive for computationally demanding models. We present a method to accelerate MMC with Gaussian processes, which can significantly reduce the computational cost of the standard MMC. Numerical examples are provided to demonstrate the efficiency of the proposed method.

▷ PP-A09-15

Analysis of High-Frequency Stock Data Based on Realized Power Variation

Shi, Xin — Peking Univ.

Abstract: Firstly I fitted a group of five-minute stock data with ARIMA+GARCH model as tool, after that I acquired daily volatility based on realized power variation theory and proved that there was a lot of jump behavior in stock data, and then I introduced an improved jump test statistic which can solve the problem caused by many zeros in return ratios in one day. This is also the main innovation and finding of this work.

▷ PP-A09-16

Formulas for Sizes of Markov Equivalence Classes

HE, Yangbo — School of Mathematecal Sci. , Peking Univ.

Abstract: The size of a Markov equivalence class is an important concept in graphical models and causal learning . In this paper, we introduce a concept of "core graph". Then, we show that the size is a polynomial of the number of dominating vertices given the core graph, and deduce the polynomial via a symbol computation.The proposed methods can improve dramatically the existing counting method for the Markov equivalence class represented by dense undirected graph.

▷ PP-A09-17

Empirical Likelihood in Generalized Linear Models for Longitudinal Data with Dropout

Guo, Donglin Beijing Univ. of Tech.
Xue, Liugen Beijing Univ. of Tech.

Abstract: In this article, the generalized linear model for longitudinal data with dropout is studied. An empirical likelihood method is proposed by combining generalized estimating equations and quadratic inference functions based on the working correlation matrix. It is proved that the proposed generalized empirical likelihood ratios are asymptotically chi-squared.This can construct the confidence regions of the parameters. An example of a real data is used for illustrating our methods.

▷ PP-A09-18

A Test of Linearity in Partial Functional Linear Regression

Yu, Ping Beijing Univ. of Tech.
Zhang, Zhongzhan Beijing Univ. of Tech.
Du, Jiang Beijing Univ. of Tech.

Abstract: This paper investigates the hypothesis test of the parametric component in partial functional linear regression. We propose a test procedure based on the residual sums of squares under the null and alternative hypothesis, and establish the asymptotic properties of the resulting test. A simulation study shows that the proposed test procedure has good size and power with finite sample sizes. Finally, we present an illustration through fitting the Berkeley growth data with a partial

▷ PP-A10-1

Stability Analysis and Reduction of A Class of Large-scale Supply Chain System by Co-semigroup Theory

Wang, Yuan Northeastern Univ.
Tang, Lixin Inst. of Industrial Engineering & Logistics Optimization, Northeastern Univ.

Abstract: From the actual production in iron and steel industry, we considered the inventory problem of the stability in the supply chain. In this paper, the complex dynamic behaviors which are produced by supply chain system under the uncertain conditions were studied, including stability, bifurcation and chaos. The distributed supply chain system model is conducted and qualitative theory will be analyzed by using group theory and convex optimization.

▷ PP-A10-2

Controllability of Nonlinear Fractional Delay Integrodifferential Systems

Joice Nirmala, Rajagopal Bharathiar Univ., Coimbatore

Abstract: Controllability is a qualitative property of control system. Controllability generally means, that it is possible to steer dynamical system from an arbitrary initial state to finial state using the control. In this poster controllability conditions for nonlinear fractional delay integrodifferential systems has been presented with suitable fractional order. The solution representation is obtained by Laplace transform technique and further the Schauder fixed point theorem is used to obtain the controllability result.

▷ PP-A10-3

Optimal Control Problem of Some Parabolic Hemivariational Inclusion - Galerkin Approximation

Just, Andrzej Lodz Univ. of Tech. Centre of Mathematics & Physics

Abstract: In this paper we shall consider nonlinear and nonmonotone optimal control problem governed by parabolic hemivariational inclusion in $W(0,T) = \{y \in L^2(0,t;V); y' \in L(0,T;V)\}$ where V is a real reflexive Banach space,

$$\begin{cases} y'(t) + A(t)y(t) + \chi(t) = (Bu)(t)\&\text{a.e. } t \in (0,T) \\ y(0) = y_0\& \\ \chi(x,t) \in \hat{\beta}(x,t,y(x,t))\&\text{a.e. } (x,t) \in Q. \end{cases}$$

We derive some results on the existence of optimal solutions. Then we introduced Galerkin approximation. These problems arise in many important real-life models of control. Finally, we give simple example.

▷ PP-A10-4

Non-fragile Adaptive Synchronization for Time-varying Complex Delayed Dynamical Networks

Li, Junmin Xidian Univ.

Abstract: In this paper, a non-fragile adaptive control scheme is proposed for a complex dynamical network with time-varying delay. Under the weakened assumptions that the weight matrix of the complex network is bounded and the norm of the perturbation of internal coupled matrix is bounded and the topological structure of the network is unknown, an adaptive feedback control is designed and the robustness is analysised. non-fragile adaptive control schemes are constructed with unknown gain perturbations.

▷ PP-A10-5

The Linear-Quadratic Optimal Control Problem for Differential-Algebraic Equations

Voigt, Matthias Technische Universität Berlin

Abstract: In this poster we will discuss a new general approach to solve the linear-quadratic optimal control problem for DAEs. We show how this problem can be solved by employing Lur'e matrix equations. We further discuss the construction of its solutions via the deflating subspaces of even matrix pencils. In contrast to previous work we do impose any of the common restrictive assumptions such as impulse controllability or non-negativity of the cost functional.

▷ PP-A10-6

Stabilization of A Cascaded Wave PDE-ODE Systems Subject to Boundary Control Matched Disturbance via Sliding Mode Control

Zhou, Hua-Cheng Acad. of Mathematics & Sys. Sci.,Chinese Acad. of Sci.
Bao-Zhu, Guo Acad. of Mathematics & Sys. Sci.,Academia Sinica
Wu, Zehao Acad. of Mathematics & Sys. Sci., Chinese Acad. of Sci.

Abstract: In this paper, we consider the stabilization of the wave PDE-ODE system with Dirichlet interconnection and with the external disturbance flowing the control end. Combining with backstepping approach, the SMC controller was designed to deal with target system subject to uncertain disturbance that is supposed to be bounded only. The existence and uniqueness of the solution for the closed-loop system are proved, and the monotonicity of the “reaching condition” is presented. Numerical simulations are given.

▷ PP-A10-7

Sensor Location in Feedback Stabilization of the Boussinesq Equations

Hu, Weiwei Univ. of Southern California

Abstract: We discuss the problem of sensor placement in feedback stabilization of a thermal fluid described by the Boussinesq equations. This problem is motivated by the design and operation of low energy consumption buildings. We apply the MinMax compensator design to obtain a reduced-order observer for state estimation based on the geometric structure of feedback functional gains. A two dimensional problem is employed to illustrate the theoretical and numerical results.

▷ PP-A10-8

Axially Symmetric Incompressible Flow of Three-Dimensional Magnetohydrodynamics

Wu, Jihui Beijing Univ. of Tech.

Abstract: We firstly give conditions on radial component of the velocity, swirl component of theviscosity and current density u^r,w^θ and j^θ are sufficient for proving the regularity of the weak solutionsto 3D axial symmetric MHD equations with none-zero angular component. Secondly, we propose atwo-dimensional model that can construct a family of exact solutions to the 3D MHD equations andobtain the regularity criteria for the solutions to the 2D MHD equations.

▷ PP-A11-1

Analysis of Zero-Norm-Regularized Least Absolute Deviation Regression Problem via Replica Method

Zhang, Jian-Zhou Sichuan Univ.

Abstract: In compressed sensing, the zero-norm-regularized least absolute deviation regression is used to reconstruct the compressive sensing signal from the measurements corrupted by noise. However, the optimization of an zero-norm -regularized least absolute deviation regression problem is NP-hard problem. Recently, the replica method from statistical physics is used in the asymptotic analysis of compressed sensing. In this paper, the analysis of the zero-norm -regularized least absolute deviation regression via the replica method is given.

▷ PP-A11-2

Multi- Echelon Inventory Control Based on Data Analytics

Cheng, Cong Inst. of Industrial Engineering & Logistics Optimization, Northeastern Univ.
Tang, Lixin Inst. of Industrial Engineering & Logistics Optimization, Northeastern Univ.

Abstract: In this paper, we consider the multi-echelon inventory problem based on the data analytics. The muiti-echelon inventory extracted from practice has many features, which are hard to represent by the traditional model, but one has plenty historical data. Based on the data analytics, the robust inventory model with gray box is built. A new trust region algorithm based on

data is proposed to handle this problem, where each subproblem is reduced to a conic program.

▷ PP-A11-3

Optimal Inventory Problem in Steel Slab Yard of Iron and Steel Enterprises

Jia, Yanhe — Northeastern Univ. of China, The Inst. of Industrial Engineering & Logistics Optimization
Tang, Lixin — Inst. of Industrial Engineering & Logistics Optimization, Northeastern Univ.

Abstract: In most of the production enterprises, commodity inventory plays a certain buffer action. Excessive inventory will make the inventory cost increase; if the inventory is too small, this will cause supply shortage. Therefore, determining the reasonable inventory is very important for enterprises. This paper uses the S curve analysis and combines with the actual historical data to determine the reasonable inventory level.

▷ PP-A11-4

The Analysis of Inventory with Submodularity.

Wu, Jing — Northeast Univ.
Tang, Lixin — Inst. of Industrial Engineering & Logistics Optimization, Northeastern Univ.
Jia, Yanhe — Northeastern Univ. of China, The Inst. of Industrial Engineering & Logistics Optimization

Abstract: This paper builds model about product-inventory which includes continuous or discrete variables. There are many factors affecting the quantity of inventory, such as the demand, the price, types of productions. The objective function which has the submodularity is to minimize the inventory costs. Through the analysis of submodularity, it can obtain the optimal quantity.

▷ PP-A11-5

Global Optimization for Multiperiod Blend Scheduling with Environmental Consideration

Su, Lijie — Northeastern Univ., China
Tang, Lixin — Inst. of Industrial Engineering & Logistics Optimization, Northeastern Univ.

Abstract: The multiperiod blend scheduling problem for refinery operations is addressed, in which environmental protection and product profit are simultaneously considered. A Mixed Integer Nonlinear Programming (MINLP) model based on continuous-time representation is formulated to describe the optimization problem. One efficient global optimization algorithm based on Outer Approximation is designed to solve the nonconvex MINLP problem. Through numerical experiments, advantages of the model are illustrated and performances of the proposed methods are compared with others.

▷ PP-A11-6

Optimal Control of the Hot Metal Ladle in Steel Production

Cao, Xueyun — The Inst. of Industrial Engineering & Logistics Optimization Northeastern Univ.
Tang, Lixin — Inst. of Industrial Engineering & Logistics Optimization, Northeastern Univ.
Lang, Jin — Inst. of Industrial Engineering & Logistics Optimization, Northeastern Univ.

Abstract: In this paper, the problem of determining the optimal policy for hot metal ladle the blast furnace(BF)—basic oxygen furnace(BOF)region in iron and steel factory is considered. The problem is formulated as a batch arrival, parallel servers closed queueing system. In addition, a dynamic programming is establishes, and the objective function is submodular with respect to the set of the number hot metal ladle and time.

▷ PP-A11-7

Batching Model and Solution for Stochastic Unit Commitment with Wind Power Generation

Lang, Jin — Inst. of Industrial Engineering & Logistics Optimization, Northeastern Univ.
Tang, Lixin — Inst. of Industrial Engineering & Logistics Optimization, Northeastern Univ.
Cao, Xueyun — The Inst. of Industrial Engineering & Logistics Optimization Northeastern Univ.

Abstract: This paper presents a stochastic unit commitment with volatility of wind power generation. By introducing scenario trees, the problem is formulated as MINLP model. As a large-scale wind power penetrate into power grid systems, we group wind turbines based on their physics locations to formulate the problem. Because the batching model is hard to solve with commercial optimizers, a Lagrangrian relaxation algorithm is developed. Computational results demonstrate the validity of the batching model and algorithm.

▷ PP-A11-8

A Hybrid Method to Compute Feasible Solutions of A Mathematical Programming Problem with Complementarity Constraints

Martini, Tiara — IMECC - State Univ. of Campinas
Martinez, Jose Mario — State Univ. of Campinas
Judice, Joaquim J. — Univ. of Coimbra
Andreani, Roberto — IMECC - State Univ. of Campinas

Abstract: A Projected-Gradient Underdetermined Newton type (PGUN) algorithm is introduced for finding a feasible solution of a Mathematical Programming Problem with Complementarity Constraints (MPCC). The method employs a combination of Newton and Projected-Gradient directions and a line-search procedure that guarantees global convergence. PGUN can also be applied to the computation of a feasible solution of MPCC with a target objective function value. Computational experience is reported illustrating the efficiency of the algorithm in practice.

▷ PP-A11-9

Batch Scheduling Coordinate with Energy in Iron and Steel Production via Submodular Optimization

Ren, Junfeng — Northeastern Univ.
Tang, Lixin — Inst. of Industrial Engineering & Logistics Optimization, Northeastern Univ.
Zhao, Xiaoli — Inst. of Industrial Engineering & Logistics Optimization, Northeastern Univ., Shenyang

Abstract: This paper considers the batch scheduling coordinate with energy in iron and steel production process. The objective of the batch scheduling problem is to minimize the total energy cost. Because the energy cost function can be simplified as submodular function, we formulate the problem as a submodular optimization problem which can be solved effectively.

▷ PP-A11-10

Modified Penalty Method for Solving Transportation Model

Tolentino, Rebecca — Pamantasan ng Lungsod ng Maynila (Univ. of the City of Manila)

Abstract: Transportation model is a special case of a linear programming problem. It generally involves shipping or transporting goods from multiple sources to multiple destinations. The proposed modified penalty method considers two measures: per unit cost/profit per shipment and the row and column penalty. The proposed method has reduced the number of iterations needed to get to the optimal solution and works best for unbalanced transportation problems.

▷ PP-A11-11

The Torpedo Car Scheduling Problem in Iron and Steel Industry

Yiyang, Liu — Inst. of Industrial Engineering & Logistics Optimization, Northeastern Univ.
Tang, Lixin — Inst. of Industrial Engineering & Logistics Optimization, Northeastern Univ.

Abstract: This paper presents a mixed integer programming model for torpedo car scheduling problem, given a set of identical torpedo car supplying customers with known demands. It was solved by commercial optimization software CPLEX to obtain the torpedo car scheduling scheme. Meanwhile, another scheduling scheme was obtained by nearest neighborhood based heuristics. Finally, to validate the efficiency and reasonability of the model, computational experiments are conducted to compare the results of CPLEX and the proposed heuristic.

▷ PP-A11-12

Branch-and-Cut Algorithm for the Crane Scheduling Problem

Zhao, Guodong — Inst. of Industrial Engineering & Logistics Optimization Northeastern Univ.
Tang, Lixin — Inst. of Industrial Engineering & Logistics Optimization, Northeastern Univ.
Wang, Yuan — Northeastern Univ.

Abstract: A crane scheduling problem for the hot-rolling slab yard is studied. With the purpose of improving the utilization of crane as well as lifting the efficiency of the whole slab yard minimizing the completion time of all tasks is selected as the objective of the problem. The crane scheduling problem is NP-hard, a Branch-and-Cut algorithm is adopted to solve this problem. The experimental results indicate that this algorithm is efficiency for the crane scheduling problem.

▷ PP-A11-13

Non Penalty Recurrent Neural Networks for Solving Nonlinear Programming

Problems.

Hosseini, Alireza — Univ. of tehran

Abstract: In this article a recurrent neural network model proposed for solving nonsmooth optimization problems.The model is designed by a differential inclusion. Under some assumptions,solution trajectory of designed differential inclusion converges to optimal set of the optimization problem. For differentiable problems, the model is implemented by circuit form. Some numerical example are solved by this model to confirm effectiveness of the new neural network.

▷ PP-A11-14

Identification of Scene Structures Using Affine Vector Fields

Shen, Ruobing — Heidelberg Univ.

Abstract: We consider an optimization problem arising in Image Segmentation, where a finite grid of points (i,j) and a function f(i,j) are given, and the problem consists of finding a piecewise linear function $f'(i,j)$ that approximates f, while minimizing at the same time the square error sum of $\sum_{i,j}(f-f')^2$ and the number of different affine functions. We investigate different variants of this problem, propose and compare alternative Mixed Integer Programming (MIP) formulations, and report computational resutls.

▷ PP-A11-15

A Remark on Binary Sensing Matrices

Randhi, RamuNaidu — IIT-Hyderbad

Challa, Subrahmanya Sastry — IIT-Hyderabad

Jampana, Phanindra Varma — IIT-Hyderabad

Abstract: Construction of the binary sensing matrices is one of the active directions in the emerging field of Compressed Sensing (CS). The present work attempts to relate the notion of extremal set theory to CS. In particular, we show that the extremal set theory is useful in bounding the column size of binary sensing matrices. We also prove the existence of binary sensing matrices possessing optimal column size asymptotically.

▷ PP-A11-16

Solving An Integration of Steel-grade Assignment and Order Batching Problem in Steel Industry

Wang, Gongshu — Inst. of Industrial Engineering & Logistics Optimization, Northeastern Univ.

Tang, Lixin — Inst. of Industrial Engineering & Logistics Optimization, Northeastern Univ.

Abstract: This paper studies an integration of steel-grade assignment and order batching problem arising in the steel industry. We formulate the problem as a novel MIP model. The MIP model is reformulated as a set-partitioning type model based on which a hybrid mathematical programming exact method that combines Lagrangian relaxation, column generation and dual ascent heuristics is proposed to solve the problem. The computational results demonstrate that the effectiveness of the proposed exact method.

▷ PP-A11-17

Stochastic Homogenization of Optimal Control Problem

Sun, Qi — Beijing Computational Sci. Research Center

Abstract: We study the homogenization of a stochastic optimal control problem whose objective functional is a velocity tracking type and constraint equation is a stochastic elliptic PDE with high oscillating coefficients. We prove the theorems of H-convergence for both the constraint problem and the optimal problem in stochastic Sobolev spaces. Also some numerical examples using stochastic Galerkin method are provided to elucidate the theoretical concepts and results.

▷ PP-A11-18

A Branch-and-price Algorithm for Solving the Batching Problem of Soaking Process

Meng, Ying — Northeastern Univ.

Tang, Lixin — Inst. of Industrial Engineering & Logistics Optimization, Northeastern Univ.

Abstract: Batching problem for soaking process is to select ingots from N ingots to form M batches each for an empty soaking furnace. We formulate the problem as a set-packing model. A column generation based branch-and-price-and-cut algorithm is developed to solve the problem. A variable reduction strategy is also proposed to speedup the algorithm. The computational experiment show that our algorithm can obtain the optimal solutions for the middle scale problems in a reasonable CPU time.

▷ PP-A11-19

Discussion on Kriging Algorithm with A Matrix Form

Zhang, Guohua — Northwestern Polytechnical Univ.

Lu, Yuquan — Northwestern Polytechnical Univ.

Xiao, Manyu — Northwestern Polytechnical Univ.

Liu, Zefang — Northwestern Polytechnical Univ.

Abstract: Managing computational effort (CPU time, memory, and interfacing) is a major issue in engineering design optimization problems, due to the cost of the high fidelity numerical simulations (finite elements, finite volumes, etc.) involved. In order to decrease the overall cost of the optimization process, parallel algorithm, reduced-order models or their combinations are an economical and efficient option. In this work, a model reduction with Kriging based is discussed to discover its properties more clearly.

▷ PP-A13-1

Numerically Certifying the Completeness of Real Solution Sets

Liddell, Alan — Univ. of Notre Dame

Abstract: The computation of real solutions to a system of polynomial equations presents unique challenges. Since real solutions are often the solutions sought after in applications, one may wish to know if one has computed the complete set of solutions for a given system. In this work, we develop an algorithm certifying that a given set of solutions, including real isolated and positive-dimensional solution components, constitutes a complete real solution set.

▷ PP-A13-2

Loop Motion Planning Algorithms

Mamouni, My Ismail — CRMEF Rabat, Morocco

Abstract: The topological study of Robots motion planning algorithms emerged in the 2003-2004 with the works of M. Farber. His main tool was the concept of *Topological Complexity* denoted TC. Our aim in this talk is to introduce a similar one, the so-called *Loop Topological Complexity* denoted TC^{LP}. We prove that $TC = TC^{LP}$ and that it leads to a *loop motion product* wich can be extended to a string product similar than that of Chas-Sullivan

▷ PP-A13-3

Better Certificate of Positivity in Bernstein Basis

Boudaoud, Fatima — Oran Univ.

Abstract: Let $P \in Z[X]$ be a polynomial of degree p with coefficients in the monomial basis of bit-size bounded by τ. If P is positive on [-1, 1], we obtain a certificate of positivity (i.e. a description of P making obvious that is positive) of bit-size $O(p^3(\tau+\log_2))$, using recent progress on real root isolation. Previous comparable results had a bit-size complexity $O(p^4(\tau+\log_2))$, while more classical certificate of positivity based on Polya's theorem were of exponential

▷ PP-A13-4

Symmetries and Curvature Structure in Riemannian Geometry

Saifullah, Khalid — Quaid-i-Azam Univ., Islamabad

Abstract: Motions and collineations of a tensor are the vectors along which the tensor remains invariant under the Lie transport relative to that vector. The Ricci and energy-momentum tensors are mathematically very similar and have a kind of 'dulaity' in their role by virtue of the Einstein equations. Symmetries of the metric are Killing vectors. We investigate the relationship between different symmetries of tensors used in Riemannian geometry, and their applications.

▷ PP-A14-1

Convergent Finite Difference Scheme Based Anisotropic Huber Image Restoration

Prasath, Surya — Univ. of Missouri-Columbia

Moreno Briceno, Juan Carlos — Univ. of Beira Interior

Abstract: We consider adaptive Huber type regularization function based image restoration scheme. By using discrete split Bregman scheme we prove the convergence to continuous formulation. Experimental results on real images are given to illustrate the results presented. Compared with other schemes such as additive operator splitting, dual fixed point, and projected gradient schemes our method provides faster convergence rate as well as good numerical restoration results.

▷ PP-A14-2

Recognition Method for Abnormal Water Surface Based on SOM

Zuo, Jianjun — Guizhou Univ. of Engineering Sci.

Abstract: Abnormal Water Surface monitoring and recognition technique still is the research focus at present. In this paper, we first establish a background model with Gaussian Mixture Model, achieve the abnormal region quickly using background difference method, then, a improve algorithm of color moment calculation is used to extract the abnormal features, finally the SOM model is used to cluster the characteristics of the data, the data classifier is estab-

lished.

▷ PP-A14-3

Reconstructing the Conductivity and CGO Solutions from Partial Neumann-to-Dirichlet EIT Data: A Computational Approach in 2D

Hauptmann, Andreas — Univ. of Helsinki
Siltanen, Samuli — Univ. of Helsinki

Abstract: We present a realistic direct computational approach to recover the CGO solutions and conductivity from partial Neumann-to-Dirichlet data for electrical impedance tomography. The basic idea is to derive an integral equation involving the ND-map for full boundary data. Instead of solving the integral equations we apply Born approximation for stable and fast computations. Extensions of partial data are computed based on smooth diffusive interpolation of the measurement traces. Computational results from simulated data are presented.

▷ PP-A14-4

IMAGE RESTORATION AND TEXTURE PRESERVATION UNDER DATA-DEPENDANT MULTIPLICATIVE NOISE AND LINEAR SHIFT-INVARIANT BLUR USING LOCAL CONSTRIANTS

PACHEERI PADIKKAL, JIDESH — NATIONAL Inst. OF Tech., KARNATAKA, SURATHKAL, INDIA
ANATTU, BINI — NATIONAL Inst. OF Tech., KARNATAKA, SURATHKAL, INDIA

Abstract: IN THIS STUDY WE PROPOSE TO RESTORE IMAGES CORRUPTED BY DATA-DEPENDENT MULTIPLICATIVE NOISE (OF GAMMA OR GAUSSIAN DISTRIBUTION AND LINEAR SHIFT-INVARIANT BLUR) USING A VARIATIONAL FRAMEWORK. WE INCORPORATE NOISE (DISTRIBUTION) ADAPTIVE FIDELITY OR REACTIVE TERM ALONG WITH AN IMAGE FEATURE DEPENDENT REGULARIZATION TERM TO RESTORE IMAGES. FURTHER A PIXEL DEPENDENT REGULARIZATION PARAMETER IS USED TO CONTROL THE EXTEND OF REGULARIZATION AT VARIOUS PIXEL VALUES. THIS STRATEGY HELPS TO RESTORE IMAGES WHILE PRESERVING THE TEXTURE INFORMATION.

▷ PP-A14-5

A Family of Local Edge Detectors Enhanced by A Threshold Function

Yun, Beong in — Kunsan National Univ.

Abstract: We develop enhanced edge detectors based on the existing edge detectors and a threshold function composed of the sigmoidal transformation. It is proved that the proposed edge detectors can eliminate inevitable oscillations of the original edge detectors near discontinuities and improve the resolution far from the discontinuities. Several examples are included to demonstrate efficiency of the presented method.

▷ PP-A14-6

MR Image Reconstruction with Analysis Sparse by Split Bregman Method

Yonggui, Zhu — School of Sci., Communication Univeristy of China
Xiaoman, Liu — School of Sci., Communication Univ. of China
Hao, Li — School of Sci., Communication Univ. of China
Xiang, Bi — School of Sci., Communication Univ. of China
Xiuxiu, Niu — School of Sci., Communication Univ. of China

Abstract: Compressive Sensing (CS) is able to reconstruct accurately magnetic resonance (MR) images from undersampled k-space data. Analysis dictionary is a sparsifying transform and can reconstruct images from more highly undersampled k-space data than other analytical sparsifying transforms such as wavelets, curvelets and total variation. MR image reconstruction model based on compressive sensing with analysis sparse regularization is developed in this paper. The split Bregman method is employed to solve the proposed MR reconstruction model over learned analysis dictionary. Some MR images and real MR data of several anatomies with a variety of sampling schemes are used to do numerical experiments. The results demonstrate the proposed model and its algorithm are very efficient in MR image reconstruction.

▷ PP-A14-7

A Method for Removing Streaking Artifacts in Quantitative Susceptibility Mapping (QSM)

Choi, Jae Kyu — Yonsei Univ.

Abstract: QSM is a recent medical imaging modality that visualizes a susceptibility distribution of the human body inside an MRI scanner. The corresponding inverse problem, a deconvolution problem, is ill-posed due to its integral kernel being zero on a cone. This ill-posedness produces streaking artifacts in the reconstructed image. We provides the first theoretical discussion of removing streaking artifacts by decomposing measured data.

▷ PP-A14-8

Landmark Constrained Genus-one Surface Teichmuller Map Applied to Surface Registration in Medical Imaging

Lam, Ka Chun — The Chinese Univ. of Hong Kong
LUI, Lok Ming Ronald — The Chinese Univ. of Hong Kong
Gu, Xianfeng — Stony Brook Univ.

Abstract: We address the registration problem of genus-one surfaces with prescribed landmark constraints using a special class of Quasi-conformal maps called Teichmuller maps (T-Maps). Existence and uniqueness of the landmark constrained T-Map are theoretically guaranteed. This work presents an iterative algorithm to compute the T-Map. Numerical experiments demonstrate the effectiveness of our proposed algorithm. The method has also been applied to register vertebrae bones with prescribed landmark points and curves, which gives accurate surface registrations.

▷ PP-A14-9

Applications of Materm Functions in Landmark-based Image Registration

Qiao, Hanli — Univ. of Turin

Abstract: Matern functions are quite common in statistics literatures and they have recently received a great deal of attention. In our work, we apply Matern functions to landmark-based image registration and the numerical results show us they have good properties. However, Matern functions have global support, a single landmark pair change may influence the whole registration result. Therefore, we construct novel compactly support functions based on Matern ones and we analyze their properties in image

▷ PP-A14-10

Proximal Iterative Hard Thresholding Methods for Wavelet Frame Based Image Restoration

Zhang, Xue — Shanghai Jiao Tong Univ.
Hou, Likun — Shanghai Jiao Tong Univ.
Zhang, Xiaoqun — Shanghai Jiao Tong Univ.

Abstract: Iterative hard thresholding methods are less understood due to its non-convexity and discontinuity. We consider the l0 regularized wavelet frame balanced approach for image restoration. Then we study the convergence rate of proximal iterative hard thresholding algorithm and propose an extrapolated proximal iterative hard thresholding algorithm. Finally, we conduct numerical experiments on compressive sensing, CT reconstruction, image reconstruction, to demonstrate the improvement of l0 regularization models as well as the effectiveness of proposed algorithm.

▷ PP-A14-11

Dynamic SPECT Reconstruction from Few Projections: A Sparsity Enforced Matrix Factorization Approach

Ding, Qiaoqiao — Shanghai Jiao Tong Univ.
Zhang, Xiaoqun — Shanghai Jiao Tong Univ.

Abstract: The reconstruction of dynamic images from few projection data is a challenging problem, especially when noise is present and images are vary fast. We propose a variational model, sparsity enforced matrix factorization(SEMF), based on low-rank matrix factorization of images and enforced sparsity constraints both coefficients and bases. The convergence of proposed model relies upon the Kurdyka - Lojasiewicz property. We show the advantage of proposed model compared to conventional methods.(Joint work with Yunlong Zan and Qiu Huang).

▷ PP-A15-1

Effects of Hall Current on Unsteady MHD Convective Couette Flow of Heat Absorbing Fluid Due to Accelerated Movement of One of the Plates of the Channel in A Porous Medium

Sharma, Rohit — Indian School of Mines Dhanbad

Abstract: An investigation of unsteady MHD convective Couette flow of a viscous, incompressible, electrically conducting and temperature dependent heat generating/absorbing fluid within a rotating vertical channel embedded in a fluid saturated porous medium taking Hall current into account is carried out. Asymptotic behavior of the solution for fluid temperature and fluid velocity are analyzed for small and large values of time to gain some physical insight in to the flow pattern.

▷ PP-A15-2

An Optimal Dispersion for A Dispersive Waves with Non-hydrostatic Model

Magdalena, Ikha — Institut Teknologi Bandung

Abstract: In fluid dynamics, dispersion means that waves of different wavelengths travel with different wave speeds. In this research, we propose a numerical two-layer non-hydrostatic model. Based on it, we derive the numerical dispersion relation which is tuned to approximate well the exact linear dispersion relation. We will compare our result with two other approachs by

using different type model, Nwogu[1993] and Y.Bai and K.F.Cheung[2012]. Moreover our result have achived linear dispersive accuracy up to kd=10.

▷ PP-A15-3

Pressure Drop Evaluation During Filling Process of Blind Backfilling Technique

Panda, Susmita — IIT Kharagpur
Pal, Samir — IIT Kharagpur
Murthy, P V S N — IIT Kharagpur

Abstract: Blind Backfilling in mine voids is used to avoid the effects of surface subsidence of abandoned mine. Very little amount of theoretical work have been done on blind backfilling in mining industry by others researchers worldwide. Therefore the present work aims in development of mathematical models in the area of simple gravity blind backfilling. Theoretical pressure drop has been evaluated of blind backfilling technique assuming different layer formation during filling process.

▷ PP-A15-4

Similarity Solution for the Flow Behind An Exponential Shock in A Rotational Axisymmetric Perfect Gas in the Presence of Magnetic Field

Sahu, P. K. — Motilal Nehru National Inst. of Tech. Allahabad
Nath, G. — Motilal Nehru National Inst. of Tech. Allahabad

Abstract: We study the propagation of an exponential shock wave in rotating medium under the influence of magnetic field by taking into account the components of vorticity vector. The gas is assumed to be perfect with infinite electrical conductivity. Solutions are obtained under isothermal and adiabatic flow conditions. It is shown that the magnetic field have decaying effects on the shock wave. A comparison is also made between the solutions of isothermal and adiabatic flows.

▷ PP-A15-5

Effect of Variable Permeability on Free Convection Boundary Layer over A Vertical Cone in Non-Newtonian Fluid Saturated Porous Medium with Internal Heat Generation

Bagai, Shobha — Cluster Innovation Centre, Univ. of Delhi
Nishad, Chandrashekhar — Department of Mathematics, Univ. of Delhi

Abstract: The analysis is carried out for free convection boundary layer over a vertical cone imbedded in a porous media filled with non-Newtonian fluid incorporating the variation in permeability. An exponentially decaying model is assumed for permeability whereas the well-known power law model is assumed for the non-Newtonian fluid. Similarity solutions are obtained, for two cases - variable wall temperature and variable heat flux). Similarity equations obtained are solved numerically.

▷ PP-A15-6

Bi-Critical States in Temperature Modulated Rayleigh Benard Convection

Singh, Jitender — Guru Nanak Dev Univ., Amritsar

Abstract: We investigate the Rayleigh-Bénard convection under sinusoidally varying temperatures of the horizontal rigid-planes bounding a laterally infinite fluid-layer for the bicritical states. The problem is analogous to the well studied Faraday-instability and Rayleigh-Bénard convection under gravity modulation. Under modulation, the neutral instability-curve is found to alternate between the conventional harmonic and subharmonic tongues in the space of the dimensionless wave number of disturbance and the control parameter. The transition between harmonic and subharmonic critical instability

▷ PP-A15-7

On the Development of A Nonprimitive Navier-Stokes Formulation Subject to A Rigorous Implementation of Integral Vorticity Boundary Condition

Sen, Shuvam — Tezpur Univ.
Sheu, Tony — National Taiwan Univ.

Abstract: A new integral vorticity boundary condition has been developed and implemented to compute solution of Navier-Stokes equation. This procedure is a limiting case of physically correct global integral boundary condition and keeps all merits of the original equation. Here we design and realize a method which is easy to implement and explicit. This algorithm captures accurate vorticity distribution on the boundary of computational flow field and can be used for both wall-bounded and open flows.

▷ PP-A15-8

Solvability of One Thermo-viscoelastic Model of Non-Newtonian Hydrodynamics

Zviagin, Andrei — Voronezh State Univ.

Abstract: The solvability of initial-boundary value problem for mathematical Voigt model which describes the motion of weakly concentrated aqueous polymers solutions in respect of temperature changes will be considered. The existence of solutions is established by a suitable approximation method applied to regularized system in a suitable functional space, proof of solvability of which is based on appropriately chosen approximations, global a priori estimates, application of a fixed point theorem, and pass to the limit.

▷ PP-A15-9

A MODEL FOR DISCRETE HEATER DRIVEN CONVECTION WITH SURFACE RADIATION

Shanmugam, Saravanan — Bharathiar Univ.

Abstract: We investigate the changes experienced by a convective flow in a closed square enclosure when surface radiation is taken into account. The flow is driven by a centrally placed discrete heater in an air filled two dimensional enclosure. Symmetrically cooled isothermal vertical walls and insulated horizontal walls are considered. The governing coupled differential equations were solved using a finite volume method. The resulting augmentation of fluid velocities and the factors causing them are discussed.

▷ PP-A15-10

Uncertainty Propagation in Airway Liquid

Xu, Feng — The Univ. of Manchester

Abstract: Mucus in the lung acts as a barrier that protects the lung from disease and irritations. To quantify the uncertainties arising from imprecise knowledge of mucus rheology, we simulate the flow of a thin liquid film with spatially non-uniform viscosity and track the evolution under flow of a solute that has an initial stochastic spatial distribution, assuming that the solute field determines the local viscosity. We initially examine a drop-spreading flow.

▷ PP-A15-11

Heat Transfer of Weakly Compressible Power-law Flows

Li, Botong — Beijing Univ. of Tech.

Abstract: A numerical research on steady momentum and heat transfer in power-law non-Newtonian fluids in a channel is finished. Weakly compressible, laminar fluids are to be studied with no slip at the walls and a uniform wall temperature. The full governing equations are solved by using the continuous finite element method. Three thermal conductivity models are adopted in this paper.The results are compared with each other and the physical characteristics for values of parameters are discussed.

▷ PP-A15-12

Thin Films on Spheres: Statics, Dynamics and Instability

Kang, Di — Claremont Graduate Univ.

Abstract: We model the dynamics of a thin viscous film on a rotating sphere, under the influence of gravity and surface tension, using lubrication theory with no-slip at the solid surface and kinematic and stress conditions at liquid-air interface. We identify three types of energy-minimizing steady states: one having a uniformly positive thickness, or states with one or two dry zones. A stability analysis including Marangoni effects provides the parameter thresholds and modes of instability.

▷ PP-A15-13

Analytical Study for Steady Flow Past An Encapsulated Particle

Zhao, Longhua — Case Western Reserve Univ.

Abstract: This work presents an analytic study about a highly viscous, incompressible flow past an encapsulated spherical particle in the Stokes regime. Taking advantage of the symmetry properties, we derive the explicit formulae of stream functions by considering the no-slip boundary condition for the rigid core and the no interfacial mass transfer and force equilibrium conditions at the fluid interface. Moreover, we investigate the flow properties, drag experienced by the particle and its terminal velocity.

▷ PP-A15-14

Mathematical and Experimental Investigation of Ultrasound Wave in Fluid System

Ahobilam, Gayathri — scsvmv Univ., dept. of mathematics
Thothatri, Venugopal — scsvmv Univ.

Abstract: The calculation of the speed of ultrasound in the given medium is the fundamental requirement for investigating the transport properties of liquid and solid systems. The speed of ultrasound in the sample can be computed through various mathematical techniques like Jungie equation method, Rao's specific sound velocity method, Impedance relation and Nomoto's method. The theoretical values are compared with experimental values. Various elastic properties of Vibhuti, an ash like powder is studied and analysed.

▷ PP-A15-15

High-order Accurate Physical-constraints-preserving Finite Difference WENO Schemes for Special Relativistic Hydrodynamics

Wu, Kailiang — Peking Univ.

Tang, Huazhong Peking Univ.

Abstract: This work develops high-order physical-constraints-preserving scheme for special relativistic hydrodynamical equations by extending the positivity-preserving techniques for classic Euler equations. The features due to strong nonlinearity, e.g. no explicit expressions of the conservative vector for the primitive variables and the flux vectors, make related theoretical analysis of the admissible state set and the construction of physical-constraints-preserving limiter challenging. The accuracy, robustness and effectiveness of the proposed scheme are demonstrated by several ultra-relativistic numerical experiments.

▷ PP-A15-16

Pseudo-spectral Simulations of Two-dimensional Free Decaying Flows on Infinite Domain

Yin, Zhaohua Inst. of Mechanics, Chinese Acad. of Sci.

Abstract: The fluid motion on unbounded domain is a popular and difficult problem in fluid mechanics. Its main difficulty is the treatment of boundary effect which cannot be fully removed by any existing numerical schemes since finite computing grids can never cover an infinite domain. The adoption of the Hermite function can partly resolve the above dilemma. In this paper, the two-dimensional unbounded free decaying flow, which eventually leads to the Oseen vortex, is studied by two different strategies: 1) the new Hermite spectral scheme on the infinite domains; 2) the traditional Fourier spectral scheme on finite but very large extended domain. When there are only same-signed vortices at the beginning of simulations, both methods can give the correct results. On the other hand, when both positive and negative vortices co-exist initially, the Hermite method can still solve the problem efficiently until very late stage, but the Fourier method cannot generate correct results even with an extremely large computing domain and a one-hundred-larger resolution. It is concluded that the Hermite spectral solver has obvious advantages in such simulations on the infinite domains, and some efforts to parallel the code will also be discussed.

▷ PP-A15-17

Mixed Finite Element Method for A Pressure Poisson Equations Reformulation of the Incompressible Navier-Stokes Equations

Zhou, Dong Temple Univ.
Seibold, Benjamin Temple Univ.
Shirokoff, David New Jersey Inst. of Tech.
Chidyagwai, Prince Loyola Univ. Maryland

Abstract: Pressure Poisson equation (PPE) reformulations of the incompressible Navier-Stokes equations represent a class of methods that replace the incompressibility constraint by a Poisson equation for the pressure, with a suitable choice of the boundary condition so that the incompressibility is maintained. We present a mixed finite element method of the Shirokoff-Rosales PPE reformulation with electric boundary conditions, and demonstrate that this approach allows for arbitrary order of accuracy both in space and in time.

▷ PP-A15-18

EFFECTS OF CURVATURE OF STENOSES AND DAUGHTER TUBE ON FLOW PROFILE AND HEMODYNAMIC INDICATORS IN A BIFURCATING ARTERY HAVING MULTIPLE STENOSES

SHARMA, MUKESH KUMAR Guru Jambheshwar Univ. of Sci. & Tech., Hisar

Abstract: The bifurcation is composed of the daughter vessels, the parent tube and the flow divider. The calibrating parameters to define flow divider are parent tube diameter D, daughter tube diameter d, radius of curvature of the daughter tube R, length of flow divider L, and branching angle 2α. Parent and daughter vessels are suffered with the stenoses in the proximity of bifurcation. The flow profiles and hemodynamic indicators WSS, WSSG, OSI, RRT are numerically simulated.

▷ PP-A15-19

Numerical Solutions of Unsteady Mixed Convection Flow at A Three-dimensional Stagnation Point

Nazar, Roslinda Universiti Kebangsaan Malaysia

Abstract: This paper presents a numerical analysis of an unsteady mixed convection flow at a three-dimensional stagnation point. The governing nonlinear partial differential equations are transformed into a system of ordinary differential equations by a similarity transformation, which are then solved numerically by a Runge-Kutta Fehlberg method with shooting technique. The dual solutions obtained and the effects of the governing parameters on the fluid flow and heat transfer characteristics are analyzed and discussed.

▷ PP-A16-1

Consequences of QCD Ghost F(T) Gravity

Chattopadhyay, Surajit Pailan College of Management & Tech., Kolkata

Abstract: The present paper reports a reconstruction scheme for f(T) gravity based on QCD ghost-dark energy. Two models of f(T) have been generated and the pressure and density contributions due to torsion have been reconstructed. Two realistic models have been obtained and the effective equations of state have been studied. Also, the squared speed of sound has been studied to examine the stability of the models.

▷ PP-A16-2

MATHEMATICAL STUDY OF THE FREE ENERGY OF MIXING FOR THE LEAD-BASED BINARY LIQUID ALLOYS OF ALKALI METALS

Chakrabarti, Swapankumar Tribhuvan Univ.

Abstract: Binary liquid alloys, especially the complex-forming ones, often show anomalous thermodynamic behaviour. There is no unique theory which can explain the thermodynamic properties of mixing for all the alloys. Here we have considered three lead-based alloys of different alkali metals—lithium-lead, sodium-lead and potassium-lead—and used Flory’s model. Accordingly, the method of successive approximations has been applied. Our results explain the variation of the free energy of mixing with concentration for the present molten alloys.

▷ PP-A16-3

IMPACT OF EIGENVALUES ON THE SUPERCONDUCTING STATE PARAMETER FOR MAGNESIUM AND ITS BINARY ALLOYS

Yadav, Rajnarayan mahendra morang adarsh multiple campus TU

Abstract: Here we have dealt with the impact of eigenvalues on the electron-phonon coupling strength of magnesium and its two binary alloys—magnesium-aluminium and magnesium-indium. For this purpose the form factors for all of them have been computed considering, initially, the orthogonalised plane wave parameter as unity. Then the Vashishta-Singwi form of exchange and correlation is employed. Finally, the results have been compared with the theoretical values derived by other researchers and found to be more satisfactory.

▷ PP-A16-4

Linear Response Theory of Time-dependent Time Fractional Fokker-Planck Equation Systems

Kang, Yanmei Xi’an Jiaotong Univ.

Abstract: There are two types of time-dependent time fractional Fokker-Planck equations for modeling subdiffusion modulated by a time-varying external field. Our work proves that the dissipation-fluctuation theorem holds in both cases, but the long time linear response dies out in the one case. Moreover, with the dissipation-fluctuation relation as a bridge, we access the fluctuation spectral density for the time-independent time fractional Fokker-Planck equation systems based on method of weighted series expansion.

▷ PP-A17-1

Data Assimilation Unit for the General Curvilinear Environmental Model

Garcia, Mariangel San Diego state Univ.
Castillo, Jose San Diego State Univ.

Abstract: Existing numerical models of water systems are based on assumptions and simplifications that can result in predictive errors. Data Assimilation can significantly improve the success rate of predictions and operational forecasts; however, implementation is difficult, as physical ocean models are highly nonlinear and require dense spatial discretization to correctly reproduce the dynamics. Our General Curvilinear Environmental Model incorporates measured observation into the dynamical system, and so accurately forecast estimates of variable states in less time.

▷ PP-A17-2

Sensitivity to Cumulus Convection in Simulating Indian Summer Monsoon Using RegCM4

Maity, Suman Indian Inst. of Tech. Kharagpur
Mandal, Manobattam Indian Inst. of Tech. Kharagpur

Abstract: Indian summer monsoon (ISM) is originated and accelerated by large scale convection and hence its simulation is expected to depend on appropriate representation of cumulus convection in climate models. Numerical experiments are conducted in simulating ISM for three consecutive years 2007, 2008 and 2009. RegCM4 at 30 km resolution and 23 vertical levels is integrated for the period 1st May to 30th September in these three years using five convection schemes available in RegCM4.

▷ PP-A17-3

Consistent Approximation of the Water Velocity Including the Wet-dry Front

Chen, Guoxian Wuhan Univ.

Abstract: In finite volume schemes, the flow velocity is computed as m/h.

This becomes singular at the wet-dry front, and may lead to oscillations. Sophisticated cut-off functions may suppress the oscillations, but may loose consistency with the physics. We study this problem for HLL-type schemes using continuous bottom topography. We prove that the water height is positive and the velocity posses a natural physical upper bound, which is only increased due to gravitational acceleration.

▷ PP-A17-4

ON PARAMETER ESTIMATION IN HIGH DIMENSIONAL OCEANIC MODEL BY STOCHASTIC SIMULTANEOUS PERTURBATION METHOD

Hoang, Hong Son — SHOM, Toulouse
BARAILLE, Remy — SHOM

Abstract: Simple and efficient Stochastic Simultaneus Perturbation (SSP) method applied for solving the problem of estimation of the friction coefficient in the high dimensional ocean model HYCOM.
Estimation of the friction coefficient is an important task to improve capacity of the ocean model to produce precise forecasts. The results presented here are obtained on the basis of the HYCOM model configured in the Bay of Biscay, actually used for forcasting extreme sea level rise scenarios.

▷ PP-A17-5

The Wasserstein Distance Applied to Seismic Inversion and Registration

Engquist, Bjorn — Univ. of Texas-Austin
Yang, Yunan — Univ. of Texas at Austin

Abstract: In seismic imaging and inversion, popular misfit functions include the travel time difference and the L2 norm. Here we propose the Wasserstein distance as a measure of misfit between signals. We have proved the distance is convex with respect to vector shift, partial amplitude change and dilation. This makes the metric more suitable for minimization problems that arise in FWI. Simple numerical examples have demonstrated the feasibility of the approach.

▷ PP-A18-1

A View of Surface Volume Reactions: Modeling and Analysis

Evans, Ryan — Univ. of Delaware

Abstract: A surface-volume reaction is a one in which a fluid containing chemical reactants (free ligand molecules) is convected through a channel, over a surface to which receptors are confined. Applications are found in blood platelet adhesion, drug absorption, and antigen-antibody reactions. We develop and analyze a non-linear model. In particular, have found an analytic approximation to the solution of the resulting non-linear system that is valid for a wide parameter range.

▷ PP-A19-1

Pressure Difference and Pumping Action of the Peristaltic Flow of A Multi-layered Fluid: An Application of Arterial Blood Flow

Sharma, Rashmi — Dr. B.R. Ambedkar Univ., Agra
Kumar, Sanjeev — Dr. B.R. Ambedkar Univ., Agra

Abstract: The flow of a fluid through a cylindrical tube in the presence of peripheral layer of a Newtonian fluid with different viscosity is having an application in the area of blood flow in artery. The relationship between flow rate and pressure is very important, therefore it is calculated along with the trapping and reflux limits. The relation between flow rate and pressure difference and efficiency of pumping are calculated. The problem is solved numerically.

▷ PP-A19-2

Novel Oscillatory Behavior in Competitive Biological Networks

Rabajante, Jomar — Univ. of the Philippines

Abstract: We present special patterns of oscillation arising from the network of antagonistic interaction involving three or more nodes. First, we briefly discuss the mathematical properties of the basic “concurrent decision-making model (CDM)”. The CDM represents various biological systems, such as species competition, gene interaction, mental cognition and social repression. Second, we show different structures of the CDM that induce special types of oscillations, such as the repressilator, predator-prey type and interaction with delay.

▷ PP-A19-3

Quantifying the Effect of Acetylation on Histone H1 Dynamics

Carrero, Gustavo — Athabasca Univ.
Contreras, Carlos — Univ. of Alberta

Abstract: Histones H1 are mobile nuclear proteins that limit DNA accessibility by binding to the chromatin structure (DNA and associated proteins). This binding process, driven by slow and rapid interactions, is modulated by core histone acetylation. In this work, we use a reaction-diffusion model to quantify the effect of acetylation on the binding interactions of histone H1. We propose a procedure to quantify, in general, the effect of post-translational modifications on histone H1 binding dynamics.

▷ PP-A19-4

Branching and Oscillations in the Epigenetic Landscape of Cell-fate Determination

Babierra, Ariel — Univ. of the Philippines

Abstract: The well-known Waddington’s epigenetic landscape of cell-fate determination is not static but varies because of the dynamic gene regulation during development. However, existing mathematical models with few state variables and fixed parameters are inadequate in characterizing the temporal transformation of the landscape. Here we simulate a decision-switch model of gene regulation with more than two state variables and with time-varying repression among regulatory factors.

▷ PP-A19-5

RUPTURE MODEL OF INTRACRANIAL SACCULAR ANEURYSMS DUE TO HYPERTENSION

Nabong, Jennica Rica — Univ. of the Philippines Diliman

Abstract: The risk of rupture of intracranial saccular aneurysms is one of the leading dilemmas for patients and neurologists. An idealized model of saccular aneurysms with assumed Fung material behavior is investigated for rupture potential when the wall stresses exceed the maximum wall strength of the aneurysm wall. Various levels of blood pressure, from normal to hypertensive, are numerically applied, in order to identify which aneurysms of given sizes and thickness are at risk of rupture.

▷ PP-A19-6

Soft Computing Diagnostic Model for Coronary Heart Disease

Srivastava, Pankaj — M.N.N.I.T. ALLAHABAD

Abstract: Heart disease involves various aspects of vagueness in information and uncertainty due to that diagnosis process becomes more complex. Medical experts consider coronary heart disease has key factor for cardiogenic sudden death. The present paper deals with design and development of soft computing model for the risk assessment of coronary heart disease.

▷ PP-A19-7

An Extended Model-free Model Analysis for Protein Motions in Crowded Environment.

Wang, Po-hung — RIKEN
Sugita, Yuji — RIKEN

Abstract: Combining NMR and computational tools we investigated the rotational motion of proteins in a crowded environment. A series of different concentrations of chicken villin headpiece was prepared and the spin-spin and spin-lattice relaxation time scales were measured. We developed an extended Model-free analysis as the motional model and discovered two distinct rotational time scales. The same model was applied to the trajectories from molecular dynamics simulations and the results agreed well with experiment.

▷ PP-A20-1

A Mathematical Approach to the Modelling of Complex Systems on Networks with Application to Opinion Formation.

Knopoff, Damian — Universidad Nacional de Cordoba

Abstract: This poster presents a development of the kinetic theory for active particles to the modelling of complex living systems in networks. The system is constituted by a large number of individuals localized in a network of interacting nodes, mathematical equations describe the dynamics in each node and in the whole network. Interactions are nonlinearly additive, modelled by stochastic games. An application to opinion formation is shown, where social interactions modify the opinion of individuals.

▷ PP-A21-1

Counterparty Credit Risk in A New Reduced-form Model with Default Contation

Li, Wang — The Univ. of Manchester

Abstract: We propose a new reduced-form model with default dependence. Our model includes both exogenous economic-wide events and interaction between companies’ credit events. And it generates considerable default dependence level and allows for recovery from credit events. The model is applied to compute Credit Value Adjustment for a CDS contract with wrong-way risk. We also proposed a finite-difference scheme for numerical valuation of default probability, swap spread and CVA, which will be discussed.

▷ PP-A21-2

Mathematical Modeling of Risk Preferences with Application to Portfolio Selection Problem

Fulga, Cristinca Bucharest Univ. of Economic Studies

Abstract: We consider the portfolio problem in the Mean-Risk framework and propose a risk measure calculated only with the downside part of the portfolio return distribution. We establish the properties of the proposed risk measure, study the link with stochastic dominance criteria, point out the relations with Conditional Value at Risk and Lower Partial Moment of first order, and give the explicit formula for the case of scenario-based portfolio optimization.

▷ PP-A21-3

Stability of ADI Schemes with Applications in FX Options Pricing

MISHRA, Chittaranjan IIT Ropar

Abstract: Alternating direction implicit (ADI) schemes are popular among practitioners for numerically solving financial option pricing equations. The Modified Craig-Sneyd scheme is one such ADI scheme that is very efficient in handling the task at hand. We analyze the scheme for its stability with its applications to FX option pricing PDEs in the Heston frame-work.

▷ PP-A21-4

Different Solution of Option Pricing: Black-Scholes Model

Yermukanova, Binur Nazarbayev Univ.
Karjanto, Natanael Nazarbayev Univ.

Abstract: One of the outstanding applications of mathematics in finance is the theoretical model of option pricing developed by Fischer Black and Myron Scholes in 1973. The objective of the paper is to offer a rather different method of solution of Black-Scholes equation and find out how well the theory fits the actual data. For the achievement of the goal, through a transformation of the Black-Scholes equation, Euler's equation is investigated and exact solutions are presented.

▷ PP-A21-5

Cooperative Strategies for Sustainability in A Decentralized Supply Chain with Competing Suppliers

Gang, Xie Acad. of Mathematics & Sys. Sci., Chinese Acad. of Sci. (CAS)

Abstract: In this study, firstly, the mechanism on the selection of cooperative strategies is described. Also, the decisions of the supply chain with noncooperation are investigated. Then, two cooperative strategies and their possible combinations are proposed, and the decisions of the supply chain are analyzed. Lump sum transfer contracts are designed for supply chain coordination. The results suggest that cooperative strategies are critically important in terms of enhancing sustainability.

▷ PP-A22-1

Interdisciplinary Teaching: the Mathematical Component of Ecology of Homelessness

Ma, Yanping Loyola Marymount Univ.

Abstract: Students were exposed to the diversity of the homeless population in America in an attempt to educate beyond the stereotypes of homelessness, and were engaged in computational laboratory and fieldwork experiences that simulated research in community health science and urban ecology. Mathematical sessions prepared students in modeling. Group projects used math/stat tools and created solutions for local services facilities, such as food and service map (Voronoi tessellation), data for volunteer program (regression analysis) and epidemiology.

▷ PP-A23-1

Lattice Differential Equation analysis of Schloegl’ s second model for particle creation and annihilation

Wang, Chi-Jen Georgia Inst. of Tech.

Abstract: Schloegl’ s stochastic models for autocatalysis on a lattice of dimension d⩾2 involves: (i) spontaneous annihilation of particles at lattice sites; and (ii) autocatalytic creation of particles at vacant sites. We analyze the dynamics of interfaces between populated and empty regions via discrete reaction-diffusion equations (dRDE’ s) obtained from approximations to the exact master equations. These dRDE can display artificial propagation failure (APF) absent due to fluctuations. Higher-dimension analysis avoiding APF captures behavior in the stochastic model.

▷ PP-A23-2

Bayesian Inference on Mixed-effects Varying-coefficient Joint Models with Skew-t Distribution for Longitudinal Data with Multiple Features

Lu, Tao SUNY Albany

Abstract: We study the relationship between viral load and CD4 counts in AIDS studies by developing a joint model taking into account multiple data features. A Bayesian inference procedure is developed to estimate the parameters in the joint model. The proposed model and method are applied to a real AIDS clinical study and various comparisons of a few models are performed.

▷ PP-A23-3

Two-sex Mosquito Model for the Persistence of Wolbachia

Xue, Ling Tulane Univ.

Abstract: We present an ordinary differential equation model to investigate the dynamics of releasing Wolbachia-infected mosquitoes to establish an endemic infection in a population of wild uninfected mosquitoes. The transmission model for the adult and aquatic-stage mosquitoes takes into account Wolbachia-induced fitness change and cytoplasmic incompatibility. We analyzed the impact of reducing the wild mosquito population before introducing the infected mosquitoes. We found that the most effective approach of reducing the number of infected mosquitoes needed to establish a wild Wolbachia-infected population requires reducing wild mosquito populations in both the adult and aquatic stages before the release. This could be accomplished by recursive spraying, or a combination of spraying and larvae control.

▷ PP-A23-4

A Computational Framework for the Simulation of Atherosclerotic Plaques

Joshi, Sunnie temple Univ.

Abstract: Atherosclerosis is a chronic inflammatory process in which the arterial wall develops a plaque as a result of the build up of cholesterol and other fatty materials in the interior surface of the wall, and is the most common disease of the arterial system. This study focuses on the implementation of a coupled reaction diffusion model in two dimensions with a cross–sectional geometry of the artery which reveals the interaction between various factors that affect

▷ PP-A23-5

Evaluation of Salinity by Using Wavelet Modelling

DÖKMEN, FUNDA Kocaeli Univ., Food & Agricultural Vocational School
ASLAN, ZAFER ISTANBUL AYDIN Univ.

Abstract: Approximately, 10 billion ha of agricultural lands/soils cannot be use due to salinity every year because of wrong irrigation applications in the world.Main elements (cations) are potassium (K+), sodium (Na+), calcium (Ca+2) and magnesium (Mg+’ 2) for salinity in dry and semi-dry climatic regions. Methods of wrong irrigation and quality of irrigation water are so important for salinity of agricultural soils/lands.In this study, ground water resources were analysed in the laboratory conditions in terms of salinity parameters in Yalova Province (regions of Taşk
"Oprü, Çiftlikk
"Oy and Altınova). Results of analyses were explained with variations and effects based on quantity of salinity and also defining role of small, meso and large scale factors by using wavelet model.Results of this study would be helpful for estimation of salinity contents on soils by using irrigation of groundwater at agricultural areas.

▷ PP-A23-6

Modelling of TESLA Cavities' Eccentricity with Isogeometric Analysis

Corno, Jacopo Graduate School CE, TU Darmstadt
Schöps, Sebastian TU Darmstadt

Abstract: Measurements of cell eccentricity for the TESLA cavities obtained at the German Electron Synchrotron DESY are analyzed by using discrete Karhunen-Loève decomposition to create a smaller set of independent parameters. The deformation of the cavity is propagated in an Isogeometric framework to maintain the regularity properties of the CAD parametrization. Simulations on a grid of collocation points allow for the evaluation of sensitivities and other quantities of interest.

▷ PP-A23-7

RESEARCH ON KEY TECHNOLOGY OF UNIVERSAL SIMULATION PLATFORM MOLTEN IRON IN THE RAILWAY SCHEDULING SYSTEM

Xingli, Zhong CISDI.R&D.Co.ltd
Linwei, Xu CISDI.R&D.Co.ltd
Mingming, Qi CISDI.R&D.Co.ltd

Abstract: In this paper, an example was given to show the result of applying molten iron railway scheduling system by the logistics simulation technology, some parameters were computed from the simulation system such as the efficiency of every locomotive, the occupancy rate of key lines and fluctuation curve of molten iron in process, through simulation method, the engineers can improve the design system constantly by knowing the condition of all key facilities under different dispatch system.

▷ PP-A23-8

An Improved Strategy for Solving Sudoku by Sparse Optimization Methods

Yuchao, Tang — Nanchang Univ.

Abstract: We proposed several strategies to improve the sparse optimization methods for solving Sudoku puzzles. Further, we define a new difficult level for Sudoku. We tested our proposed methods on Sudoku puzzles dataset. Numerical results showed that we can improve the accurate recovery rate from 84.89 percent to 99.02 percent by the L1 sparse optimization method.

▷ PP-A23-9

Model Reduction of Kinetic Equations by Operator Projection

Fan, Yuwei — School of Mathematical Sci., Peking Univ.
Li, Jun — Peking Univ.
Ruo, Li — Peking Univ.

Abstract: Designing optimal hyperbolic regularized method for moment system of kinetic equations is a challenging problem, which has been studied in different reduction models for many years. Developing from NRxx method, we present a uniform framework to derive globally hyperbolic models using an operator projection method. Like simple algorithm, the framework is concise with only four inputs and almost cover all existing globally hyperbolic models, while can also derived some new ones as well.

▷ PP-A23-10

Mathematical Models for Environmental Decision-making under Uncertainty

Zhang, Xiaodong — Los Alamos National Laboratory
Velimir, Vesselinov — Los Alamos National Laboratory

Abstract: Environmental decision-making processes are very complicated, involving numerous economic, environmental, societal, technical, and political factors, parameters, and objectives coupled with complex uncertainties such as probabilistic and non-probabilistic (i.e. fuzzy and/or interval) ones. This necessitates effective methods and techniques. Mathematical models are valuable tools for addressing and quantifying the uncertainties. This study will investigate mathematical models and their applications in environmental decision-making with a representative case study.

▷ PP-A23-11

Approximate Second Order Maximum Entropy Model in Radiative Transfer

Li, Weiming — Peking Univ.
Ruo, Li — Peking Univ.

Abstract: The maximum entropy closure is widely regarded as the most reasonable candidate for modelling radiative transfer, but its implementation suffers huge numerical difficulties. We discovered an approximation of M2 in slab geometry. Its closure is given analytically to ensure an easy implementation, while to one's surprise, it closely resembles that of M2. Moreover, it shares the major advantages of maximal entropy closure, providing us a positive distribution and a globally hyperbolic model.

▷ PP-A23-12

Simulations of Hydrogen-added Gasoline Engine Combustion

Lin, Kuang C. — Department of Mechanical & Electro-Mechanical Engineering, National Sun Yat-Sen Univ.
Chen, Kang-Shin — Inst. of Environmental Engineering, National Sun Yat-Sen Univ.
Lin, Yuan-Chung — Inst. of Environmental Engineering, National Sun Yat-Sen Univ.
Zhou-Hung, Cun-Yan — Department of Mechanical & Electro-Mechanical Engineering, National Sun Yat-Sen Univ.
Jhang, Syu-Ruei — Inst. of Environmental Engineering, National Sun Yat-Sen Univ.

Abstract: Using addition of hydrogen in gasoline fuels, this study aims at reducing heavy air pollution and carbon emissions produced by international combustion engines. Good agreement between experiments and 3-D engine simulations is obtained in terms of formation of CO, NOx and PAHs.

▷ PP-A23-13

New Developments in Mesh Generation with Applications to Image Registration

Liao, Guojun — univ of texas at arlington

Abstract: Despite remarkable progress achieved in past decades, mesh generation and adaptation remain significant bottle necks of large scale simulations on complex geometries. In this poster, we illustrate our group's recent developments in this area: (1) Triangular meshes with prescribed boundary nodes (2) Higher order triangular meshes (3) Multi-block structured grids (4) Mesh deformations with prescribed Jacobian determinant and prescribe curl (5) Optimal control approach to medical image registration based on the divergence and curl

▷ PP-A23-14

Numerical Simulation of Nematic Liquid Crystals under An Electric Field

Ridder, Johanna — Univ. of Oslo

Abstract: We use finite difference methods to investigate the dynamics of the director field of a one-dimensional nematic cell without flow. Simulations of the Fréedericksz transition that include the rotational inertia of the director show that inertia can become significant under strong electric fields. For the dissipation dominated model, we include weak anchoring boundary conditions to simulate the transition to excited equilibrium states of odd parity, which have been observed in experiments.

▷ PP-A23-15

Computing Band Structures of Two-dimensional Honeycomb Photonic Crystals by Dirichlet-to-Neumann Maps

Hu, Zhen — Hohai Univ.

Abstract: An efficient numerical method is developed for computing the band structures of two-dimensional photonic crystals which are honeycomb lattices of circular cylinders. Using the Dirichlet-to-Neumann (DtN) map of the unit cell which consists of three hexagons, the problem can be formulated as a linear eigenvalue problem for relatively small matrices, where the eigenvalue is a function of the Bloch wave vector and the frequency is a given parameter.

▷ PP-A23-16

Detecting the Growth of Groups Based on Social Network

Guan, Yuanpan — Hangzhou Normal Univ.
You, Zhiqiang — hang zhou normal Univ.
Han, Xiao-Pu — Hangzhou Normal Univ.

Abstract: Focusing on the group structures of social networks and utilizing the dataset of QQ friendship network, we propose a model considering that users in the network join a group with a probability exponentially proportional to the influence of their friends within their own interest to detect the mechanism how groups grow based on social network; the statistical characteristics of hypergraph generated from our model are consistent with the empirical results.

▷ PP-A23-17

Positivity Preserving High-order Local Discontinuous Galerkin Method for Parabolic Equations with Blow-up Solutions

Guo, Li — Univ. of Sci. & Tech. of China

Abstract: We apply positivity-preserving high order local discontinuous Galerkin methods to solve parabolic equations with blow-up solutions. This model is commonly used in combustion problems. The positivity-preserving property can hardly be satisfied for high-order methods, leading to incorrect blow-up time and blow-up sets. Therfore, we construct special limiters to keep the positivity of the numerical approximations. Due to the Dirichlet boundary conditions, we have to modify the numerical fluxes and the limiters used in the schemes.

▷ PP-A23-18

Using Polar Auxin Transport Model and Cell Lineage Model to Explain Feedback Regulation of Organs on Shoot Apical Meristem

Guo, Xiaolu — Peking Univ.
Lei, Jinzhi — Tsinghua Univ.
Zhang, Lei — Peking Univ.

Abstract: The population of shoot apical stem cells are negatively feedback regulated by lateral organs through the auxin regulation. We modified the flux-based polar auxin transport model by changing the auxin production rate term to a Hill equation term, which captures the bi-stable state of distribution of auxin. Then cell lineage model is used to simulate the stem cell population variation. The simulation results are according with the experimental results and well explain the negative regulation.

▷ PP-A24-1

Computation and Visualization of Local Deformation for Multiphase Metallic Materials by Infimal Convolution of TV-type Functionals

Fitschen, Jan Henrik — Univ. of Kaiserslautern

Abstract: Estimating the local strain tensor from a sequence of microstructural images, realized during a tensile test, is a challenging problem. Here we propose to compute the strain tensor by a variational optical flow model. To separate the global displacement during insitu tensile testing from the local displacement we use an infimal convolution regularization consisting of first and second order terms. Numerical examples with simulated and experimental data demonstrate the advantageous performance of our algorithm.

▷ PP-A24-2

Violent Elastoplastic Wave Interactions

Ockendon, Hilary Univ. of Oxford
Ockendon, John Univ. of Oxford
Howell, Peter Univ. of Oxford
Thomson, Stuart Univ. of Oxford

Abstract: At very high stresses metals can be modelled as barotropic compressible fluids in which the strength, measured by the ratio of the yield stress to the imposed stress, is negligible. This work considers the elastic/plastic waves that can propagate in violent uniaxial compression of a finite bar and shows 1) how shock waves are formed which may be either overdriven or underdriven and 2) the effect of strength on waves reflected from the stress-free end.

▷ PP-A24-3

Efficient Methods for Homogenization of Random Heterogeneous Materials

Nie, Yufeng Northwestern Polytechnical Univ.

Abstract: Homogenization has been widely used for predicting effective coefficients of random heterogeneous materials. Under common Dirichlet boundary condition and Neumann boundary condition, Richardson extrapolation method is introduced to improve the convergence rate of effective coefficients.For random heterogeneous materials with a high contrast of constituent properties, above two boundary conditions cannot provide accurate effective coefficients. A new Robin boundary condition is proposed for the auxiliary problem.

▷ PP-A24-4

Reflection/refraction of A Dilatational Wave at Elastic/porous Interface

Goyal, Suraj DAV Univ. Jalandhar

Abstract: Reflection and refraction phenomena of a plane dilatational wave striking obliquely at a plane interface between a uniform elastic half-space and a swelling porous elastic half-space has been studies. The swelling porous half-space consists of solid, liquid (viscous) and gas (inviscid) constituents. The equations giving the amplitude ratios and the expressions for the partition of incident energy among various reflected/refracted waves have been presented. Numerical computations have been performed for a specific model.

▷ PP-A24-5

Directional Decomposition of the Acoustic Wave Equation for Fluids And metafluids in Spherical Geometries

Olsson, Peter Chalmers Univ. of Tech.

Abstract: A new directional decomposition of the acoustic 3D wave equation is derived for spherically symmetric geometries, where the wave fields do not need to possess such a symmetry. The wave equation considered incorporates effects from radially varying compressibility and density, but also from an anisotropic compressibility, making the equation applicable for certain so called metafluids. Contrary to previous results on such wave splittings, the new decomposition can be given a very explicit form.

▷ PP-A24-6

Three Dimensional Coupling Model with Potential Function Vanishing Ghost Forces.

Fang, Lidong Shanghai Jiao Tong Univ.

Abstract: In three dimensional atomistic to continuum coupling model, we construct potential functions for atomistic region, continuum region and interface elements, so that the ghost forces vanish in the uniform deformation. The potential functions are the same in the formula, but they are different from the parameters.

▷ PP-A24-7

Simulation and Analysis of 2D Granular System

WANG, HAOLEI Shanghai Jiao Tong Univ.

Abstract: The study of physical and mechanical properties of granular materials is of great importance. We use a discrete element method (DEM) to simulate a 2D bi-disperse granular systems under pure shear. We study the formation and evolution of force chain in this simulation. Moreover, a continuum model can be constructed by random homogenization methods. Both discrete model and continuum model can be compared with experimental data.

▷ PP-A25-1

Quantifying Changes Exhibited During Ecological Rehabilitation with Wearable Inertial Sensors

Sprint, Gina Washington State Univ.
Borisov, Vladimir Washington State Univ.
Cook, Diane Washington State Univ.
Weeks, Douglas St. Luke's Rehabilitation Inst.

Abstract: Rehabilitation after injury or stroke is a long process towards regaining function and independence. Changes exhibited in these areas tend to be subtle and highly dependent on several variables. We utilized wearable inertial sensors to investigate changes in movement of participants at an inpatient rehabilitation facility on a sequence of ambulatory tasks. We developed algorithms to process the sensor signals, compute mobility features, statistically quantify improvements, and predict clinical assessment scores using machine learning techniques.

▷ PP-A25-2

Derivative Free Optimization and Its Application in the Basic Oxygen Furnace

Liu, Yongxia Inst. of Industrial Engineering & Logistics Optimization, Northeastern Univ.
Tang, Lixin Inst. of Industrial Engineering & Logistics Optimization, Northeastern Univ.
Cheng, Cong Inst. of Industrial Engineering & Logistics Optimization, Northeastern Univ.

Abstract: This paper is to solve the operation optimization problem refined from the basic oxygen furnace process based on the derivative free optimization. In the process, data have been collected adequate. Then the relationship function between the input variables and output variable can be found based on these historical data. The objective of this paper is to find the value of the input variables to minimize the least-square of the relationship function and expected temperature value.

▷ PP-A25-3

Coil Scheduling Problem with Consideration of Energy Consumption in Iron & Steel Industry

Yang, Yang Inst. of Industrial Engineering & Logistics Optimization
Tang, Lixin Inst. of Industrial Engineering & Logistics Optimization, Northeastern Univ.
Wang, Gongshu Inst. of Industrial Engineering & Logistics Optimization, Northeastern Univ.

Abstract: This paper derives the coil scheduling problem with consideration of energy consumption from production in continuous annealing line. The problem is characterized by uncertain energy and technical parameters. Firstly, it is formulated as an optimization via simulation model, in which the uncertain parts are considered as black box. Then, it is solved by sample approximation algorithm combined with column generation. Finally, computational experiments are carried out to verify the performance of the proposed method.

▷ PP-A25-4

Parameters Identification for Abrasive WaterJet Milling Process

Groza, Vladimir UNice

Abstract: This work is part of STEEP Marie-Curie ITN project, and it focuses on the identification of unknown parameters for AWJM process, represented by PDE model. In this framework, we propose the identification of model parameters by minimizing a cost function, measuring the difference between experimental and numerical solutions. We use automatic differentiation (Tapenade) for the adjoint computation. Regularization terms have a high influence on footprints formation and play a key-role in direct and inverse problems.

▷ PP-A25-5

Reconstructing Gas Distribution and Localization Maps via Adaptive Sparse Regularization Algorithm

Ye, Zhang Örebro Univ.

Abstract: In this work we present an inspection robot to produce a gas distribution map and localize gas sources in a large complex environment. The robot equipped with a remote gas sensor measures the total absorption of a tuned laser beam and returns integral gas concentrations. This is an ill-posed problem and we will solve it by a new regularization method, which is based on the sparsity of gas sources and adaptive finite element method.

▷ PP-A25-6

Computation of Electromagnetic Fields Scattered from Dielectric Objects of Uncertain Shapes Using MLMC

Litvinenko, Alexander KAUST, UQ & ECRC Centers

Abstract: Simulators capable of computing scattered fields from objects of uncertain shapes are highly useful in electromagnetics and photonics, where device designs are typically subject to fabrication tolerances. Knowledge of statistical variations in scattered fields is useful in ensuring error-free functioning of devices. Multilevel MC scheme is used together with a deterministic surface integral equation solver.

▷ PP-A25-7

EFFECTS OF NANO-FLUID AND DISCREAT SURFACE HEAT SOURCES ON MHD MIXED CONVECTION FROM AN UNSTEADILY STRETCHING INCLINED PLATE

SHARMA, PUSHKAR RAJ — Univ. of Rajasthan, Jaipur

Abstract: The behaviors of convective enhancement due to types of nano-fluid and location of the discrete heat sources on an unsteadily stretching plate embedded in a porous medium are investigated. The governing equations are solved numerically and effects of various physical parameters on flow are shown through graphs. The Skin-friction, Nusselt number and Sherwood number are computed for analyzing stress on the plat, heat convection and mass diffusion in the medium.

▷ PP-A26-1

Application of A Perturbation Result on A Model for HBV with Differential Susceptibility

Yannick, Kouakep Tchaptchie — Univ. of Ngaoundere

Abstract: In this poster we consider an age structured epidemic system modeling the dynamics of transmission of Hepatitis B virus. Our model takes into account age speciﬁc differential susceptibility as well as two classes of infected individuals: the chronic carriers and the acute infected human. Based on the low infectivity of chronic carriers, we study the asymptotic behavior of the system and, under some suitable assumptions, we prove the global stability of the endemic equilibrium point using perturbation arguments. An application is done on data for a «Baka» pygmy group in the East of Cameroon. We see numerically the fact that ignoring the vertical transmission and vaccination doesn' t lead to a good approximation of reality in a region with endemic HBV

▷ PP-A26-2

Dynamical Behaviour of Parametrically Driven Duffing and Externally Driven Helmholtz Duffing Oscillators under Nonlinear Dissipation

PATIDAR, Vinod — Sir Padampat Singhania Univ.

Abstract: We mainly focus our attention on the global dynamical behaviour of some ubiquitous nonlinear oscillators with nonlinear dissipation. We particularly consider the parametrically driven Duffing oscillator and externally driven Helmholtz Duffing oscillators with nonlinear damping term proportional to the power of velocity . We obtain the threshold condition for the occurrence of chaos analytically and also analyze the 2D parameter space consists of external forcing amplitude and damping coefficient corresponding to various asymptotic dynamics.

▷ PP-A26-3

Modelling the Synchronization of Malaysian Fireflies.

Abdul Razak, Fatimah — Universiti Kebangsaan Malaysia

Abstract: A small number of Ptreproptyx teners from the riverbank of Sungai Selangor (Malaysia) are observed in captivity with the aim of understanding. We analyse the data sets and compare them with simulation of mathematical models of synchronization. We utilize these models to describe the advent of synchronization and what happens during synchronization. We compare simulations of the Mirollo-Storgatz oscillators, the Kuramoto model of coupled oscillators as well as synchronization by time delay.

▷ PP-A26-4

Stability Calculations for A Basic Delayed Model of Electroacoustics

Zhang, Li — Nanjing Univ. of Aeronautics & Astronautics
Stepan, Gabor — Budapest Univ. of Tech. & Economics

Abstract: The simplified mechanical model of a basic problem of electroacoustics is considered. The corresponding governing equation is the 1D wave equation with delayed boundary conditions.By means of the D' Alembert solution, the system can be transformed into a delay differential equation of neutral type that includes two time delays. The intricate stability chart is constructed analytically in the parameter plane of the gain parameter and the ratio of the time delays.

▷ PP-A26-5

Transition Classes on Infinite-to-one Factor Codes

Allahbakhshi, Mahsa — Univ. of Santiago

Abstract: One source of inspiration in symbolic dynamics comes from storage systems and transmission in computer science. For example sofic shifts are analogous to regular languages in automata theory, so a sofic shift and its cover are natural models for information storage and transmission. We present some of the properties on a cover of a sofic shift analogous to the rare cases where information is not lost as a result of applying the channel code.

▷ PP-A26-6

Permanence of A Food-chain System with Stage Structure and Time Delay

Zhihui, Ma — Lanzhou Univ.

Abstract: A non-autonomous food-chain system incorporating discrete time delay and stage-structure for each species has been presented in this paper. The sufficient conditions are derived for permanence and non-permanence of the considered system by applying the lemma and standard comparison theorem.

▷ PP-A26-7

Dynamics of A Network-based SIS Epidemic Model with Nonmonotone Incidence Rate

Li, Chun-Hsien — National Kaohsiung Normal Univ.

Abstract: We study the dynamics of a network-based SIS epidemic model with nonmonotone incidence rate. A threshold value for the transmission rate is obtained. This value completely determines the dynamics of the model and interestingly, the threshold is not dependent on the functional form of the nonlinear incidence rate. Numerical experiments are given to illustrate the theoretical results.

▷ PP-A26-8

Heterogeneity and Oscillations in Small Predator Prey Swarms

Jeffrey, Dunworth — Univ. of Pittsburgh

Abstract: We examined a dynamical systems model of predator-prey interactions, governed by isometric interaction kernels incorporating classical swarming for the prey. Since many parameter values lead to the predator splitting the swarm into smaller, unevenly-sized groups, we investigate the effects of heterogeneity among predator-prey interactions in small swarms. We show that a variety of behaviors, including oscillations, are possible in the small swarm case. Joint work with Bard Ermentrout.

▷ PP-A26-9

Dynamics of Traveling Spots with Oscillatory Tails for the Generalized Three-component FitzHugh-Nagumo Equations

Gao, Zhijun — Tohoku Univ.
Nishiura, Yasumasa — Tohoku Univ., WPI-AIMR

Abstract: The research is concerned with the dynamics of traveling spots with oscillatory tails arising in the generalized three-component FitzHugh-Nagumo equations. The main aim is to show numerically that such solution display a wave-particle duality, quantum-like behavior. Moreover by center manifold reduction theory, the dynamics of single spot dynamics can be reduced to a 4D system of ODEs. This is a joint work with Yasumasa Nishiura. The research is supported by KAKENHI A 26247015.

▷ PP-A26-10

Projective Lag Synchronization in A Drive-Response Dynamical Network with Time Varying Delay Coupling

Md Noorani, Mohd Salmi — Universiti Kebangsaan Malaysia
Abu Bakar, Sakhinah — Universiti Kebangsaan Malaysia
Al-Mahbashi, Ghada — Universiti Kebangsaan Malaysia

Abstract: The problem of projective lag synchronization (PLS) behaviour with delayed coupling in drive-response dynamical networks model is investigated. Based on Lyapunov stability theory, a hybrid feedback control method is designed to achieve the PLS with time-varying delay coupling. Finally analytical results show that the states of the dynamical network with delayed coupling can be asymptotically synchronized onto a desired scaling factor under the designed controller.

▷ PP-A26-11

A Novel Synchronization Approach of Coupled Systems and Its Applications

Shih, Chih-Wen — National Chiao Tung Univ.
Tseng, Jui-Pin — National Chengchi Univ.

Abstract: The investigation presents a novel approach to establish the global synchronization of coupled systems of differential equations. Under this approach, the problem of synchronizing coupled systems is transformed into one of solving corresponding linear systems of algebraic equations; moreover, the coupling configuration of the coupled systems can be quite general. The framework established in this investigation can accommodate a wide range of coupled systems, such as chaotic oscillators, neuronal models, and neural networks.

▷ PP-A26-12

Formulate the Average Infection Period When Treatments Are Density-Dependent

Song, Baojun — Montclair State Univ.

Abstract: If a linear treatment rate is adopted in an epidemiological model,

the expected infection period can be formulated by an exponentially distributed variable. We formulate the mean infection period when the treatment rates are density-dependent. The results are applied to the transmission of gonorrhea in China. We conclude that Chinese gonorrhea patients may not seek medical treatments in a timely manner.

▷ PP-A26-13

Travelling Waves in A Continuum Coupled Hindmarsh-Rose Type Model

Chen, Shyanshiou — National Taiwan Normal Univ., Department of Mathematics

Abstract: IIn the poster, we propose a continuum coupled Hindmarsh-Rose type model (CCHRTM), which possesses a diffusion term for the conduction process of action potentials with two nerves where one nerve is small and the other is large. Due to the huge difference of size for the two nerves, a delay structure is also deduced in CCHRTM. We study the existence of travelling waves for CCHRTM.

▷ PP-A26-14

Analysis of A Standard Incidence Model for HIV/AIDS with Case Detection and Treatment

Singaram, Athithan — VIT Univ., Chennai Campus
Ghosh, Mini — VIT Univ., Chennai Campus, Chennai-600127, India

Abstract: In this paper a simple non-linear mathematical model for HIV/AIDS is formulated and analyzed by assuming that only some fraction of total HIV and AIDS infected are detected and are subjected to proper counseling. The existence and stability of different equilibria of this model are discussed. Next we formulated the optimal control problem which is analyzed using Pontryagin's maximum principle. It is observed that optimal control strategy gives a better result in minimizing the infectives.

▷ PP-A26-15

Common Fixed Point Theorems for Two Hybrid Pairs of Mappings in Menger PM-spaces

Zhaoqi, Wu — Nanchang Univ.
Chuanxi, Zhu — Nanchang Univ.

Abstract: In this paper, a new concept of the common property (E.A) for two hybrid pairs of mappings is introduced in Menger PM-spaces. Utilizing this concept, some common fixed point theorems are obtained under strict contractive conditions, which shed some new light on the study of fixed point results for hybrid pairs in Menger PM-spaces. The corresponding results in metric spaces are also obtained, which generalize many known results.

▷ PP-A27-1

Certain Families of Generalized Mittag-Leffler Functions and Their Integral Representation

Menaria, Naresh — Mewar Univ.

Abstract: In this paper integral representations and some other results are established for some families of Mittag-Leffler function .which are introduced by Shukla et al. and Saxena et al. respectively. The results are expressed in form of six theorems.

▷ PP-A27-2

On Minimal Geodetic Domination in Graphs

Nuenay, Hearty — Mindanao State Univ.- Iligan Inst. of Tech.

Abstract: Let G be a connected graph. For two vertices u and v in G, a u-v geodesic is any shortest path joining u and v. The closed geodetic interval IG[u,v] consists of all vertices of G lying on any u-v geodesic. For S⊆V(G), S is a geodetic set in G if ∪u,v∈SIG[u,v]=V(G).
Vertices u and v of G are neighbors if u and v are adjacent. The closed neighborhood NG[v] of vertex v consists of v and all neighbors of v. For S⊆V(G), S is a dominating set in G if ∪u∈SNG[u]=V(G). A geodetic dominating set in G is any geodetic set in G which is at the same time a dominating set in G. A geodetic dominating set in G is a minimal geodetic dominating set if it does not have a proper subset which is itself a geodetic dominating set in G. The maximum cardinality of a minimal geodetic dominating set in G is the upper geodetic domination number of G. This paper initiates the study of minimal geodetic dominating sets and upper geodetic domination numbers of connected graphs.

▷ PP-A27-3

Convergence of Wavelet Expansions

Sheikh, Neyaz — National Inst. of Tech.

Abstract: In this paper we will show the convergence rate of wavelet series on different function spaces like FL2(S), where FL2(S) is a subspace of a Hilbert space L2(R). The convergence properties have been studied by various authors particularly by Kon & Raphael.

▷ PP-A27-4

SOME WEAKER FORMS OF FUZZY FAINTLY OPEN MAPPINGS

ALI, Hakeem Ahmed Othman — Univ. College of Al-Qunfudah, Umm Alqura Univ.

Abstract: This paper is devoted to introduce and investigate some weak forms of fuzzy open mappings, namely fuzzy faintly semi open (fuzzy faintly semi closed), fuzzy faintly preopen (fuzzy faintly preclosed), fuzzy faintly alpha-open (fuzzy faintly alpha-closed), fuzzy faintly semi preopen (fuzzy faintly semi preclosed) and fuzzy faintly sp- open (fuzzy faintly sp- closed) mappings and their fundamental properties are obtained. Moreover, their relationship with other types of fuzzy open (closed) mappings are discussed.

▷ PP-A27-5

Realized Laplace Transform of Volatility with Microstructure Noise

Xiaochao, Xia — College of Mathematics & Statistics, Chongqing Univ.

Abstract: In this paper, we consider the problem of estimating the Laplace transform of volatility in Todorov and Tauchen (2012b) by allowing the presence of microstructure noise, within a fixed time interval [0,T] and under high frequency sampling. We use the pre-averaging approach to remove the effect of microstructure noise, and under the high frequency scenario, we obtain a consistent estimator with convergence rate $n^{1/6}$. The simulation studies justify the finite sample performance of our methods.

▷ PP-A27-6

Bio-heat Transfer Problem for One-Dimensional Spherical Biological Tissues

Kengne, Emmanuel — Univ. of Quebec at Outaouais
Lakhssassi, Ahmed — Univ. of Quebec at Outaouais

Abstract: Based on the Pennes bio-heat transfer equation with constant blood perfusion, we set up a simplified one-dimensional bio-heat transfer model of the spherical living biological tissues for application in bio-heat transfer problems.We present in a simple way the analytical solution of the problem which is used to investigate the effects of tissue properties, the cooling medium temperature, and the point-heating on the temperature distribution in living bodies.

▷ PP-A27-7

Behavior Pattern Discovery Using Behavior Matrices and Behavior Prediction Relationships

Ventura, Jade — Univ. of the Philippines

Abstract: Let $B_1, \ldots, B_m$ be behaviors observed over n consecutive time units. Set $o_{ij} = 1$ if B_i is present at time j and $o_{ij} = 0$ otherwise. Then $O = [o_{ij}]$ is an *observed behavior matrix*. Let the data set $\mathcal{D}$ be a finite collection of observed behavior matrices. We present a behavior pattern discovery algorithm which takes $\mathcal{D}$ as an input and outputs a collection of *expected behavior matrices*. We then apply it to Philippine eagle prey delivery instances.

▷ PP-A27-8

Effect of Non-uniform Heating on Thermal Instability in A Horizontal Porous Layer

MATTA, ANJANNA — IIT Hyderabad

Abstract: In this study deals with the effect of non-uniform heating on the onset of Hadley-Prats flow in a horizontal fluid-saturated porous medium. In this study the non-linear stability analysis carried out for a large number of parameter values. The horizontal components of these gradients induce a Hadley circulation, which becomes unstable when vertical components are sufficiently large and this instability is analyzed by using three dimensional normal modes. The system that constitutes an eigenvalue problem.

▷ PP-A27-9

On Relationship between Fractal Complexities of Built and Natural Landscapes

Naoumova, Natalia — Pelotas State Univ.
Bourchtein, Andrei — Pelotas State Univ.

Abstract: Problematic points associated with the application of the box-counting method for the evaluation of the visual complexity of historic buildings and their surrounding environments are analyzed. Different options for the choice of the box sizes and locations are considered and tested in the case of classical fractals. The proposed optimized algorithm applied to evaluation of the factual material shows that there is a strong similarity between the fractal measures of built and natural landscapes.

▷ PP-A27-10

A New Kind of Fibonacci-like Sequence of Composite Numbers

Son, Jaesung — Ridgewood High School
Ismailescu, Dan — Hofstra Univ.

Abstract: An integer sequence is said to be Fibonacci-like if it satisfies the binary recurrence relation: Xn=Xn􀀀1+Xn􀀀2. Graham proved that there exist two relatively prime positive integers such that the Fibonacci-like sequence contains no primes. The common feature of all the above constructions is the existence of a finite covering set of primes such that every term is divisible by a prime in the set. In this paper we construct a Fibonacci-like sequence of composite numbers_for_which_such_a_covering_set_does_not_appear_to_exist.

▷ PP-A27-11

Study of Estimation and Selection of Variables in Semi-parametric Model

Jingwen, Tu — Chongqing Univ.

Abstract: The paper will combine theoretical research work in mathematics and actual needs in finance, and systematically study various estimation methods in semi-parametric model and its application in financial data processing. First, this paper briefly describes the development and present research situation of semi-parametric regression model. This paper combines various models and present research situations of the semi-parametric regression ,on this basis, it specificly introduces semi-parametric linear regression model and semi-parametric autoregressive models. Secondly, this paper

▷ PP-A27-12

Convergence of An Iterative Scheme for Contractive Type Mappings in Nonlinear Domain

KUMARI, MANDEEP — Maharshi Dayanand Univ., Rohtak

Abstract: The subject of this paper is to obtain the convergence results for an iteration process for contractive type mappings in CAT(0) spaces. In this paper, we analyze the Ishikawa type iteration scheme for a finite family of demi-contractive mappings in CAT(0) space. Our results are the generalization of several recent results in the current literature.

▷ PP-A27-13

On Stability of Fixed Point Iterative Schemes in Convex Metric Spaces

Malik, Preety — Maharshi Dayanand Univ., Rohtak

Abstract: In 1970, Takahashi introduced the notion of convexity in metric space and studied some fixed point theorems for nonexpansive mappings in such spaces. The aim of this paper is to prove the stability results for fixed point iterative schemes for a pair of nonself mappings using iterative schemes and a certain contractive condition in Convex metric spaces. These results extend and improve the existing results in current literature.

▷ PP-A27-14

Anti-dark and Mexican-hat Solitons in the Sasa-Satsuma Equation on the Continuous Wave Background

Xu, Tao — China Univ. of Petroleum-Beijing
Li, Min — North China Electric Power Univ.
Li, Lu — Shanxi Univ.

Abstract: We use the Darboux transformation to construct new analytic soliton solutions for the Sasa-Satsuma equation. We reveal the anti-dark and Mexican-hat solitons on a continuous wave background, and examine their stability under small initial perturbations. Such two types of solitons can exhibit both the resonant and elastic interactions, as well as various partially/completely inelastic interactions. We also show that the soliton shape change may take place due to the energy exchange with the background.

▷ PP-A27-15

A Recursive Formula for the Circumradius of the N-Simplex

Kobayashi, Kenta — Hitotsubashi Univ.

Abstract: We present a recursive formula which gives the circumradius of the n-simplex in terms of the circumradius of its facets. Our formula shows that the circumradius of the nsimplex is closely related to the distances from each vertex to the circumcenter of the opposite facet. We could only prove the formula for n¡=5 by the aid of computer algebra system, but numerical results strongly suggest that our formula holds true for any n.

▷ PP-A27-16

A Note on Special Functions and Integrable Systems of Lotka-Volterra Type

Fujiwara, Takashi — higashi yodo technical high school

Abstract: There are many investigations of the relationships between special functions and integrable systems. For example, there are the relationships between Toda molecule equations and orthogonal polynomials, and so on. In this poster we consider the relationships between special function satisfying three term recurrences and integrable systems of Lotka-Volterra type.

▷ PP-A28-1

On An Arithmetic Convolution

Singh, Jitender — Guru Nanak Dev Univ., Amritsar

Abstract: The Cauchy-type product of two arithmetic functions f and g on nonnegative integers is defined by $(f \bullet g)(k) := \sum_{m=0}^{k} \binom{k}{m} f(m)g(k-m)$. We explore some algebraic properties of the aforementioned convolution, which is a fundamental characteristic of the identities involving the Bernoulli numbers, the Bernoulli polynomials, the power sums, the sums of products, and so forth.

▷ PP-A28-2

Contiguous Functions Relations: A Combinatorial Approach

Harsh, Harsh Vardhan — Amity Univ. Rajasthan

Abstract: Contiguous function relation play an important role in the theory of hypergeometric funtion and q-hypergeometric function theory. Recently few development has done by Wei. C. et.el. in this present note we apply some combinatorial techniques to evaluate the countability of contiguous function relations. we also evaluate some new contiguous function relations for hypergeometric function and q-hypergeometric funtion.

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