

# International Conference **Strongly Coupled Coulomb Systems** 30 July – 4 August 2017, Kiel

## Keynote Speakers

Gordon Baym (Illinois, USA)  
Siegfried H. Glenzer (Stanford, USA)  
Stefan Kuhr (Strathclyde, UK)  
Stephane Mazevet (Paris, France)  
Carlo Pierleoni (L'Acquila, Italy)  
Andrea Tomadin (Genoa, Italy)

## Invited Speakers

Bernard Bernu (Paris, France)  
Ben van Duppen (Antwerp, Belgium)  
Tobias Dornheim (Kiel, Germany)  
Yan Feng (Soochow, China)  
V.E. Fortov (Moscow, Russia)  
Martin French (Rostock, Germany)  
Fabian Heirich-Meisner (Munich, Germany)  
Y.E. Lozovik (Moscow, Russia)  
Manoel Manghi (Toulouse, France)  
Andrea Perali (Camerino, Italy)  
Alessandro Principi (Nijmegen, Netherlands)  
Niclas Schlünzen (Kiel, Germany)  
Luciano Silvestri (Boston, USA)  
Jan Vorberger (Dresden, Germany)  
Ulf Zastrau (Hamburg, Germany)



## **Local Organizing Committee SCCS 2017**

Michael Bonitz, Patrick Ludwig & Zhandos Moldabekov  
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<http://www.uni-kiel.de/sccs2017>

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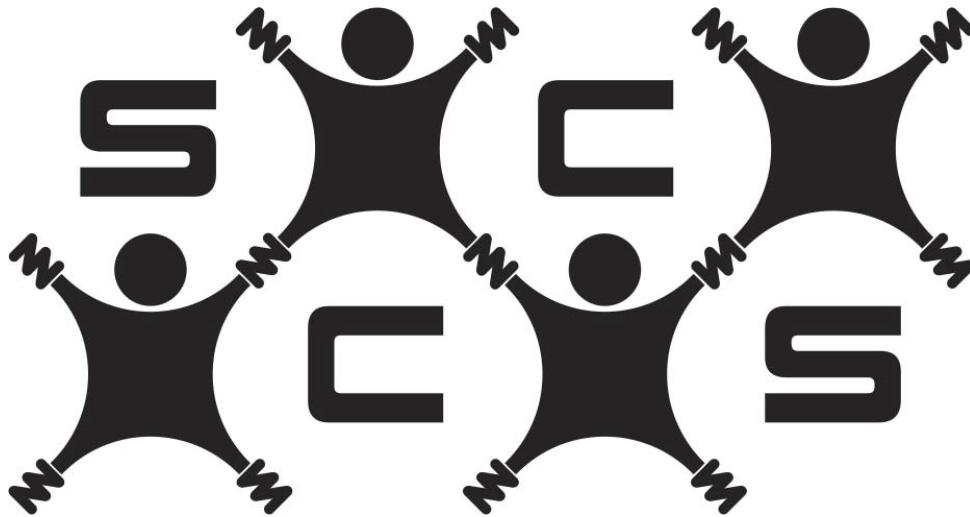
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STRONGLY COUPLED COULOMB SYSTEMS

FINAL PROGRAM  
& BOOK OF ABSTRACTS

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Kiel, July 30–August 4, 2017  
Wissenschaftszentrum Kiel

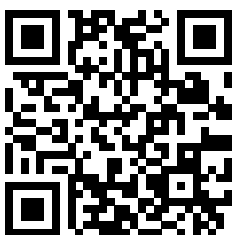
**TOPICS OF SCCS 2017**

1. DENSE AND ASTROPHYSICAL PLASMAS
2. PLASMAS IN CONDENSED MATTER
3. CONFINED AND MESOSCOPIC COULOMB SYSTEMS
4. HIGH-ENERGY-DENSITY PLASMAS IN THE LABORATORY
5. CLASSICAL CHARGED SYSTEMS
6. DEVELOPMENTS IN THEORETICAL METHODS AND NUMERICAL TECHNIQUES
7. DYNAMICS OF CORRELATED QUANTUM COULOMB SYSTEMS



**Conference website**

<http://www.uni-kiel.de/sccs2017>



## *Welcome to SCCS 2017*

'Strongly Coupled Coulomb Systems' (SCCS) is a major series of international conferences for scientists drawn from a large variety of fields including plasma physics, astrophysics and condensed matter physics. In all these fields the behavior of charged many-particle systems and the role of their correlations play a central role, and many results from one area have been found useful in other areas as well. The idea of a conference bringing together experts from such diverse fields is due to Gabor Kalman who organized the first meeting in 1977. 40 years back it was not foreseeable that this would become such a successful conference series.

In the mean time the SCCS conferences have become an important event held in 3 years intervals in locations all over the world. The goal is to provide a regular international forum for the presentation and discussion of research achievements and ideas relating to a variety of plasma, liquid and condensed matter systems that are dominated by strong Coulomb interactions between their constituents. Each meeting has seen an evolution of topics that have followed in the steps of new discoveries and new methods. In recent years the field has seen the emergence of new experimental tools and access to new strongly coupled conditions including e.g. dusty plasma, ultracold neutral plasmas. Each time novel topics emerge. This time these are the topics of dynamics of correlated quantum systems, including cold fermionic atoms and plasma-surface interaction.

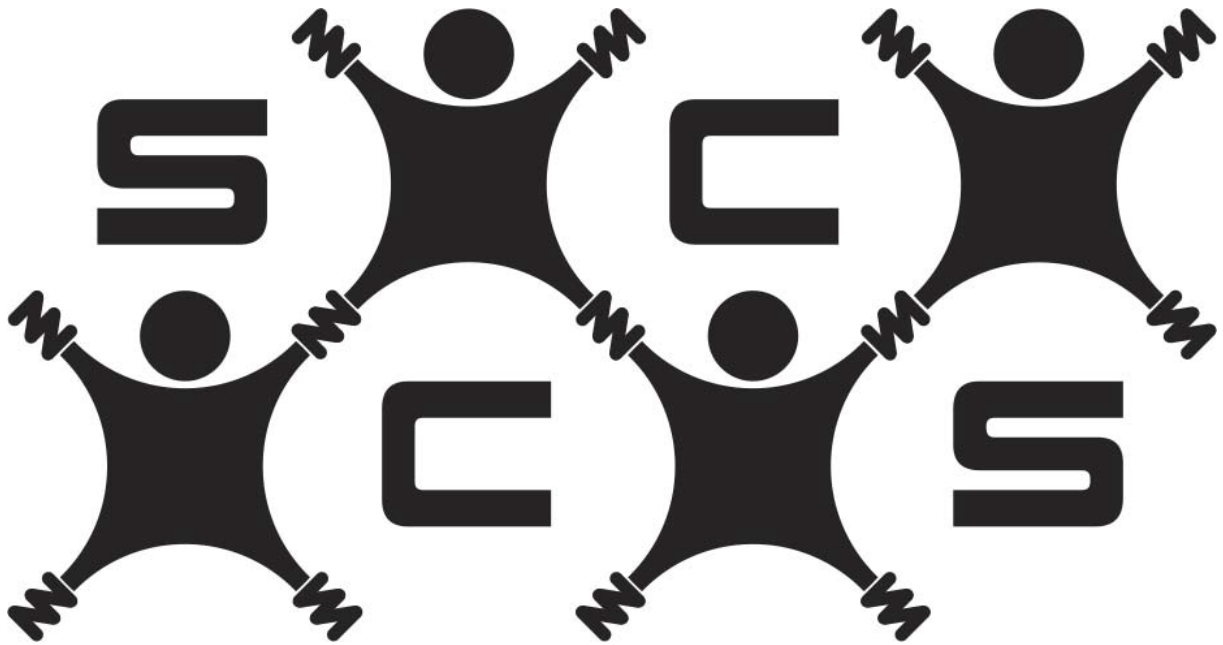
The program committee and the local organizers have managed to form an excellent and exciting collection of talks and posters, and we have created best possible conditions for a stimulating exchange of ideas. The conference has attracted a very diverse international group of researchers – from leading experts with long research experience – to the next generation: young scientists and students. To support participants financially, the organizers have obtained substantial funds from the German Science Foundation (DFG) and Kiel University (KiNSIS). But we are equally grateful to our keynote and invited speakers who have returned part of our travel support in order to make participation of young researchers possible.

We wish all participants a successful SCCS conference and a memorable stay in Kiel.

*Michael Bonitz, Patrick Ludwig & Zhandos Moldabekov*  
Local organizing committee



# SCCS 2017 Conference Schedule







**Monday, July 31****08:30 Opening****Session I: Dense and astrophysical plasmas**

08:45	S. Mazevet	
[keynote]	<i>Ab initio equation of states for planetary and exoplanetary modeling</i>	24
09:30	V.K. Gryaznov	
	<i>Thermodynamics of deuterium at terapascal pressure range</i>	25
09:45	M. Schöttler	
	<i>Miscibility gap of hydrogen-helium mixtures</i>	26
10:00	V. Mintsev	
	<i>The possibilities of proton radiography for the strongly coupled plasma EOS measurements</i>	27

**10:15 Coffee break and informal discussions****Session II: Classical charged particle systems**

10:45	M. Manghi	
[invited]	<i>Ionic transport through hydrophobic nanopores: theory and experiments</i>	28
11:15	E. Allahyarov	
	<i>The role of Coulomb correlations in nano-composite materials with high-k inclusions</i>	29
11:30	Y. Feng	
[invited]	<i>Experiments and simulations on dusty plasmas</i>	30
12:00	E. Kostadinova	
	<i>Transport properties of a disordered 2D complex plasma crystal</i>	31
12:15	W. Schröer	
	<i>Critical and non-critical fluctuations in mixtures of ionic liquids with alcohols in the vicinity of the liquid-liquid phase transition</i>	32

**12:30 Lunch and informal discussions****Session III: Dynamics of correlated quantum Coulomb systems**

14:30	S. Kuhr	
[keynote]	<i>Quantum-gas microscopes-quantum simulation with single-particle access</i>	33
15:15	N. Schlünzen	
[invited]	<i>Ab initio simulations of the transport of strongly correlated fermions</i>	34
15:45	B. He	
	<i>Simulation of stopping power and evolution of ion temperature in plasmas</i>	35
16:00	S. Tanaka	
	<i>Constructing the free energy of finite-temperature spin-polarized electron liquids from quantum many-body theories</i>	36

**16:15 Coffee break and informal discussions****Poster introductions and poster session I****16:30–18:00**

**Tuesday, August 1****Session IV: Dense and astrophysical plasmas**

08:45	J. Vorberger	
[invited]	<i>Energy relaxation in warm dense matter</i> . . . . .	37
09:15	J. Dai	
	<i>Interplay between quantum electrons and coupled ions: ion-electron temperature relaxation in dense hydrogen</i> . . . . .	38
09:30	C. Lin	
	<i>Ionization potential depression in terms of the dynamical structure factor</i> . . . . .	39
09:45	A.S. Shumikhin	
	<i>Equation of state and transport properties of metals in warm dense matter regime</i> . . . . .	40
10:00	Y. Hou	
	<i>Influence of the ionization on ionic transport properties in the warm dense regime</i> . . . . .	41

**10:15 Coffee break and informal discussions****Session V: Confined and mesoscopic Coulomb systems**

10:45	G. Baym	
[keynote]	<i>Phase transitions in spin-orbit coupled systems</i> . . . . .	42
11:30	G. Senatore	
	<i>Excitonic condensation and quadriexcitons in a symmetric electron-hole bilayer with valley degeneracy: QMC simulations</i> . . . . .	43
11:45	Yu.E. Lozovik	
[invited]	<i>Strongly correlated electron-hole 2D systems: current status and perspectives</i> . . . . .	44
12:15	I.Ya. Polishchuk	
	<i>Charge density waves in the electron-hole liquid in the coupled quantum wells</i> . . . . .	45

**12:30 Lunch and informal discussions, IAB meeting****Session IV: Dynamics of correlated quantum Coulomb systems**

14:45	V.N. Valmispild	
	<i>Time-dependent calculation methods for studying the electronic dynamics of correlated systems</i> . . . . .	46
15:00	Z. Jurek	
	<i>Simulations of high intensity x-ray generated plasmas</i> . . . . .	47
15:15	C. Dharma-wardana	
	<i>Phase transitions in low-Z warm-dense-matter Carbon systems; NPA-DFT predictions of EOS, conductivity and XRTS spectra</i> . . . . .	48
15:30	B.L. Witte	
	<i>Warm dense matter demonstrating non-Drude conductivity from observation of non-linear plasmon damping</i> . . . . .	49
15:45	H. Ruhl	
	<i>Quantum MD simulations in strong EM fields</i> . . . . .	50
16:00	T. Bornath	
	<i>Thomson scattering from dense non-equilibrium plasmas</i> . . . . .	51

**16:15 Coffee break and informal discussions**

**Poster introductions and poster session II**

**16:30–18:00**

**Historical remarks**

17:45 W. Ebeling

*What is the correct choice of the plasma partition function and the lowering of the ionization energy—on contributions by Planck and Unsöld . . . . .*

52



## Wednesday, August 2

### Session VII: High-energy-density plasmas in the laboratory

08:45	S.H. Glenzer	
[keynote]	<i>Ultrafast probing of dense plasmas—visualizing dynamics of Strongly Coupled Coulomb Systems</i>	53
09:30	D.H.H. Hoffmann	
	<i>Accelerator driven high energy density science: status of HED physics at FAIR and GSI</i>	54
09:45	T. Döppner	
	<i>Ionization measurements in 30-fold compressed, near-degenerate plasmas</i>	55
10:00	G. Norman	
	<i>Ionization of molecules at the fluid-fluid phase transition in warm dense hydrogen</i>	56

#### 10:15 Coffee break and informal discussions

### Session VIII: Confined and mesoscopic Coulomb systems

10:45	A. Perali	
[invited]	<i>Strong electron correlations in graphene and related materials</i>	57
11:15	E.H. Hwang	
	<i>Coupled plasmon modes in vertically stacked 2D nanomaterials</i>	58
11:30	H. Totsuji	
	<i>Strongly coupled fine particle clouds in fine particle plasmas</i>	59
11:45	H. Pan	
	<i>Strongly coupled dusty plasma in a 2D harmonic trap</i>	60
12:00	P. Hartmann	
	<i>Diffusion in two-dimensional quasi-magnetized rotating dusty plasmas</i>	61
12:15	K. Müller-Dethlefs	
	<i>Observation of a periodic many-body system</i>	62

#### 12:30 Lunch and informal discussions

### Conference excursion to Lübeck

14:00–20:00

## Thursday, August 3

### Session IX: Developments in theoretical methods and numerical techniques

08:45	C. Pierleoni	
[keynote]	<i>Coupled electron-ion Monte-Carlo methods for warm dense hydrogen</i>	63
09:30	T. Dornheim	
[invited]	<i>Ab initio Quantum Monte Carlo results for the warm dense electron gas</i>	64
10:00	F. Heidrich-Meisner	
[invited]	<i>Nonequilibrium dynamics in the Hubbard model</i>	65

#### 10:30 Coffee break and informal discussions

### Session X: High-energy-density plasmas in the laboratory

11:00	V.E. Fortov	
[invited]	<i>Quasi-adiabatic multi-shock compression of strongly coupled plasmas: correlations and degeneracy</i>	66
11:30	D.N. Nikolaev	
	<i>Brightness temperature and specific conductivity of multiple shocked initially gaseous protium and deuterium up to 0.4 TPa</i>	67
11:45	U. Zastra	
[invited]	<i>High energy density plasmas diagnosed with X-ray free electron lasers</i>	68
12:15	P. Sperling	
	<i>Exploring the physical properties of warm dense water by using Free-Electron-Laser</i>	69

#### 12:30 Lunch and informal discussions

### Session XI: Electron liquids and complex plasmas

14:30	A. Principi	
[invited]	<i>Viscosity, thermal conductivity and violation of the Wiedemann-Franz law in hydrodynamic electron liquids</i>	70
15:00	A. Bataller	
	<i>2D plasma condensation in monolayer semiconductors</i>	71
15:15	L. Silvestri	
[invited]	<i>Collective behavior of Yukawa systems</i>	72
15:45	T.S. Ramazanov	
	<i>Structural and dynamic properties of strongly coupled dusty plasma of RF discharges</i>	73
16:00	H. Charan	
	<i>Bow shock formation by supersonic flows in the presence of an obstacle in a two dimensional strongly coupled complex plasma</i>	74

#### 16:15 Coffee break and informal discussions

### Poster introductions and poster session III

16:30–18:00

### Conference dinner

19:30–23:00

**Friday, August 4****Session XII: Plasmas in condensed matter**

08:45	A. Tomadin	
[keynote]	<i>Corbino-disk and other viscometers for 2D quantum electron liquids</i>	75
09:30	D. Kreil	
	<i>Plasmon properties in dilute, two-dimensional electron liquids</i>	76
09:45	Ben Van Duppen	
[invited]	<i>Graphene plasmonics</i>	77

**10:15 Coffee break and informal discussions****Session XIII: Transport properties of dense plasmas**

10:45	M. French	
[invited]	<i>Superionic phases in C-N-O-H mixtures and the interior of Neptune-like planets</i>	78
11:15	J. Dufty	
	<i>Electrical conductivity for warm dense matter</i>	79
11:30	Yu. K. Kurilenkov	
	<i>Oscillating ions: from strong coupling to fusion temperatures</i>	80
11:45	I. Tkachenko	
	<i>Direct determination of dynamic properties of strongly coupled plasmas</i>	81
12:00	J. Clerouin	
	<i>Enhancement of nuclear fusion reactions in asymmetric binary ionic mixtures</i>	82
12:15	S. Ferri	
	<i>Statistical properties of microfields in multicomponent coupled plasmas</i>	83

**12:30 Lunch and informal discussions****Session XIV: Thermodynamics of strongly coupled plasmas**

13:45	B. Bernu	
[invited]	<i>Periodic states in the homogeneous two dimensional electron gas at all densities</i>	84
14:15	I. Martynova	
	<i>Non-linear screening effect on parameters of phase transitions and boundaries of complex plasma thermodynamic stability (on the phase diagram)</i>	85
14:30	I. Iosilevskiy	
	<i>Enthalpic and entropic phase transitions in strongly coupled plasmas</i>	86
14:45	V. Ballenegger	
	<i>Screened cluster equation of state for the hydrogen-helium mixture</i>	87

**15:00 Concluding discussion. Closing remarks**

# Direct determination of dynamic properties of strongly coupled plasmas

**I.M. Tkachenko**<sup>\*1</sup>, Yu.V. Arkhipov<sup>2</sup>, A.B. Ashikbayeva<sup>2</sup>, A. Askaruly<sup>2</sup>, L. Conde<sup>3</sup>, A.E. Davletov<sup>2</sup>, Z. Donkó<sup>4</sup>, D.Yu. Dubovtsev<sup>2</sup>, P. Hartmann<sup>4</sup>, I. Korolov<sup>4</sup>, S. Syzganbayeva<sup>2</sup>

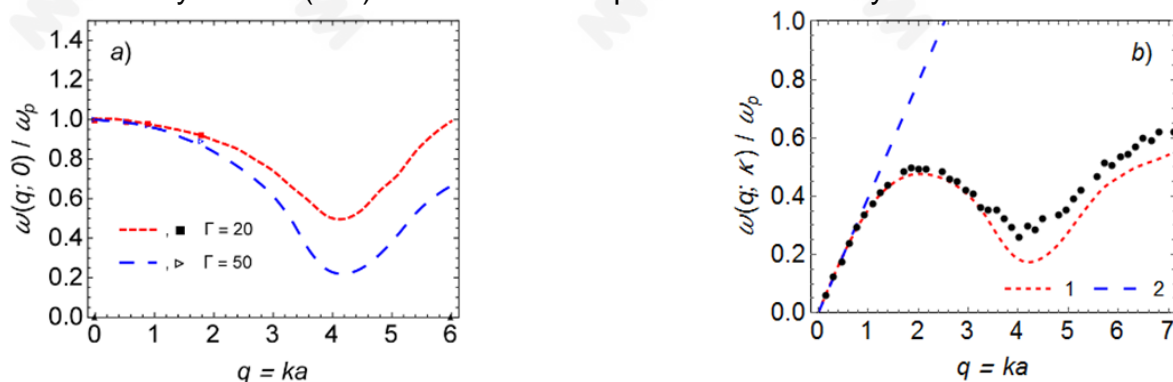
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A closed algorithm is suggested which allows the determination of dynamic characteristics of various strongly coupled plasmas (one- and two-component plasmas, electron gas, etc.) within the non-perturbative model-free moment approach without any data input from simulations or direct experiments. The standard Nevanlinna formula (see [1,2] and references therein) for the loss function (LF) which incorporates its independently calculated power frequency moments or the sum rules is complemented with an observation with respect to the LF low-frequency behavior [2]. Thus, the constructed LF satisfies all involved sum rules automatically and permits to determine the system's dynamic structure factor (DSF), the dispersion, the decay, and other characteristics of the collective modes using only the (partial) static structure factors obtained numerically or theoretically. For one-component plasmas it also provides a model for the dynamic local-field correction [3]. Simplified interpolation formulas for the LF moments, which do not need the external static data, are also suggested whose validity confirms the robustness of the present approach. A good quantitative agreement with molecular dynamics simulation data is achieved in a wide realm of variation of the system parameters, see, for example, the following figures where our results computed on the basis of static characteristics obtained by the molecular-dynamics (MD) method are compared to the MD dynamic data.



**Figure:** Dispersion of plasma modes compared to MD data (figures): a) Coulomb OCP, b) Yukawa OCP at  $\Gamma=100$  and  $\kappa=2$ . Line 2 stands for the sound mode. *a* is the Wigner-Seitz radius.

[1] I. M. Tkachenko, Y. V. Arkhipov, and A. Askaruly, *The Method of Moments and its Applications in Plasma Physics* (Lambert, Saarbrücken, 2012)

[2] Yu. V. Arkhipov et al., *Phys. Rev. E* **90**, 053102 (2014), *ibid*, **91**, 019903 (2015)

[3] Yu.V. Arkhipov et al., *Phys. Rev. E* **81**, 026402 (2010)

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