STRONGLY COUPLED COULOMB SYSTEMS

Final Program
& Book of Abstracts

Kiel, July 30–August 4, 2017
Wissenschaftszentrum Kiel

Monday, July 31

08:30 Opening

Session I: Dense and astrophysical plasmas

10:15 Coffee break and informal discussions

Session II: Classical charged particle systems

12:30 Lunch and informal discussions

Session III: Dynamics of correlated quantum Coulomb systems

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

Session V: Confined and mesoscopic Coulomb systems

Session IV: Dynamics of correlated quantum Coulomb systems

Poster introductions and poster session II

16:30–18:00

Historical remarks

Wednesday, August 2

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

10:15 Coffee break and informal discussions

Session VIII: Confined and mesoscopic Coulomb systems

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

10:30 Coffee break and informal discussions

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

12:30 Lunch and informal discussions

Session XI: Electron liquids and complex plasmas

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

10:15 Coffee break and informal discussions

Session XIII: Transport properies of dense plasmas

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

12:30 Lunch and informal discussions

Session XIV: Thermodynamics of strongly coupled plasmas

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

15:00 Concluding discussion. Closing remarks

Monday

Poster Session I

Tuesday

Poster Session II

Thursday

Poster Session III

Direct determination of dynamic properties of strongly coupled plasmas

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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.

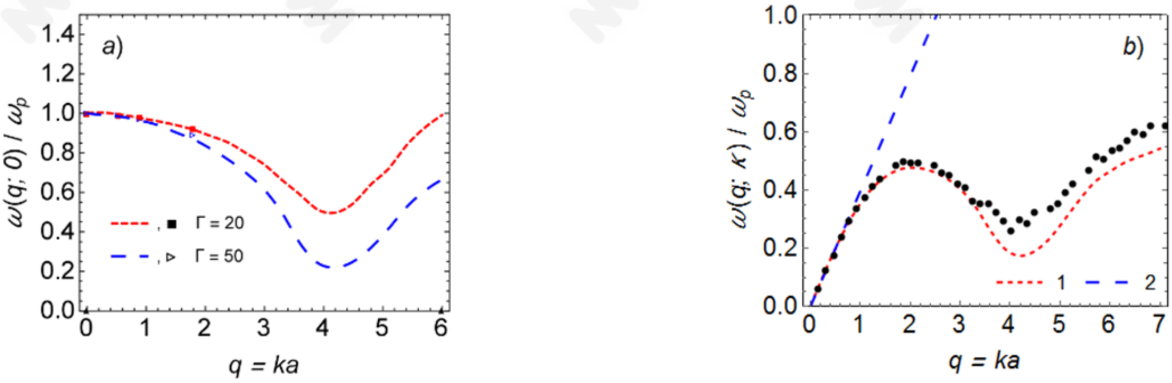

Figure: *Dispersion of plasma modes compared to MD data (figures): a) Coulomb OCP, b) Yukawa OCP at Γ=100 and κ=2. Line 2 stands for the sound mode. a is the Wigner-Seitz radius.*

[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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Friday

Two-component plasma stopping power directly from partial static structure factors

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Reliable knowledge of energy losses of heavy projectiles is of substantial significance for the progress of inertial fusion and other practical applications. Polarizational stopping power of hydrogen-like dense plasmas

$$\left[-\frac{dE}{dx}\right]^{pol} = \frac{2\left(Z_p e\right)^2}{\pi\, v^2}\int_0^{\infty}\frac{dk}{k}\int_0^{kv}\omega^2 L(k,\omega)d\omega,$$

($Z_p e$ and v are the projectile charge and velocity) is studied within the moment approach which constructs the system loss function , $\varepsilon(k,\omega)$being the system dielectric function, in terms of only the system partial static structure factors so that $L(k,\omega)$ satisfies all convergent sum rules and other exact relations [1,2]. Electron-ion correlations in the target plasma are also taken into account [3] without using the simulation data. Enhancement of the stopping power is observed with respect to that in electron fluids [4], where the asymptotic values are always higher than the calculated ones, see Figure, for example.

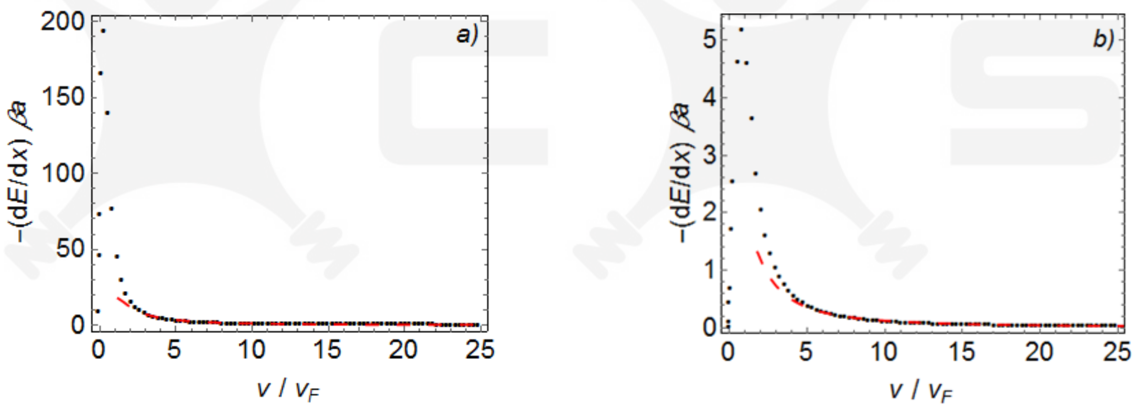

Figure: *Calculated stopping power (dots) and its asymptotic form (red dashed line) [3] at a) Γ= βe²/a = 10.77; b) Γ= 1.077, β^{-1}, a, and v_F are the plasma tempreature, electronic Wigner-Seitz radius and Fermi velocity, respectively. The structure factors were calculated in the hyper-netted chain approximation.*

[1] I. M. Tkachenko, Y. V. Arkhipov, and A. Askaruly, *The Method of Moments and its Applications in Plasma Physics* (Lambert, Saarbrücken, 2012) and references therein
[2] I. M. Tkachenko et al., To be presented at the SCCS 17 Conference
[3] D. Ballester, I. M. Tkachenko, Phys. Rev. Lett., **101**, 075002, (2008)
[4] M.D. Barriga-Carrasco, D. Casas, R.S. Morales, Phys. Rev. E, **93**, 033204, (2016) and references therein

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Calculating structural characteristics of one-component plasmas

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Practical application of research results on one-component plasma has found its reflection in various areas, such as astrophysics, lithography, dusty plasmas, ultracold plasmas, etc. Therefore, study of static and dynamic properties of OCP is of significant importance.
There is a number of theoretical methods of calculation of the static characteristics based on integral equations, fitting approximations and empirical formulas with the results of simulations often taken as reference. In this case, it is traditionally accepted that the theoretical results should be in a good agreement with the latter.
Not all of the above theoretical methods can be employed to calculate dynamic characteristics by the method of moments [1]. In the present work, we propose to qualify the static characteristics through the Hölder or Cauchy-Schwarz inequalities for the application of the above methods, $b>0$. The function b depends on the plasma thermodynamic characteristics via the static structure factor.
Precisely, we consider the hyper-netted chain (HNC) approximation with and without the empirical bridge function proposed by Ng [2], the modified HNC approximation (MHNC) [3], the variational modified HNC (VMHNC) [4], and other empirical and fitting formulas, e.g., [5]. For example, in Figure we present data for the HNC and the VMHNC, and show that in one case the inequality is violated.

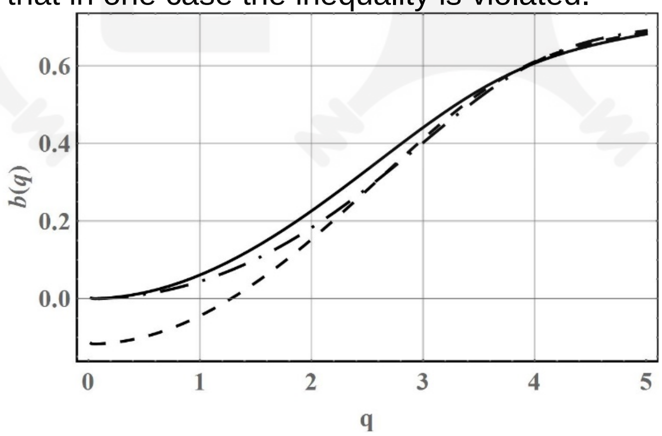

Figure: *Criterion of satisfaction of the Cauchy-Schwarz inequality, b>0, at Γ=16 for various theoretical methods: HNC (solid line); HNC with the bridge function [2] (dashed line); VMHNC [4] (dot dashed line).*

[1] I. M. Tkachenko et al., The present Conference
[2] K.–Ch. Ng, J. Chem. Phys. **61**, 2680 (1974)
[3] G. Faussurier. M. S. Murillo, Phys. Rev. E. **67**. 046404 (2003).
[4] G. Faussurier. Phys. Rev. E **69**, 066402 (2004)
[5] N. Desbiens. P. Arnault. J. Clérouin. Physics of Plasma. **23**. 092120 (2016).

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