CRC 1227
Designed Quantum States of Matter

GUEST LECTURE

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(Guest of Prof. L. Santos and Prof. K. Hammerer)

Leibniz Universität Hannover
DQ-mat Colloquium
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Room 269, Appelstr. 2, building 3701

"Ab initio approach to static and dynamic properties of partially ionized plasmas and strongly coupled uniform liquids of charged fermions"

With the upcoming new experimental colliding planar shocks platform, in particular, at the NIF and the FAIR facility at GSI Darmstadt, high precision thermodynamic data for highly compressed matter will be needed. This poses new challenges to theory and simulations. However, even for such relatively simple elements like hydrogen, first principle equation of state (EOS) data free of systematic errors, are still absent.

In this content we have developed a novel first-principle fermionic path integral Monte Carlo (MC) approach for hydrogen (deuterium) plasma[1] which is free of the fixed-node approximation[2]. The revised EOS have been constructed for temperatures in the range 15 000K ≤ T ≤ 400 000K and wide range of densities. This provides new opportunities to improve alternative simulation methods as well as chemical models for the challenging conditions of warm dense matter.

As a next step we plan to analyze the dynamic properties of plasmas, cf. the dynamical structure factor and dielectric function, based on a novel non-perturbative self-consistent method of moments. We have recently successfully applied this approach to analyze the eigen-modes' explicit temperature/density dependence both in uniform electron fluids and in 3He, where for strong coupling we predicted a bimodal structure of the excitation spectrum with a lower-energy mode possessing a well pronounced roton-like feature[3]. The proposed approach, due to its rigorous mathematical foundation, can find numerous diverse applications in the physics of Fermi and Bose liquids.

[1] A.V. Filinov and M. Bonitz, PhysRevE.108.055212 (2023)
[2] S.X. Hu, B. Militzer, V.N. Goncharov, and S. Skupsky, PhysRevB.84.224109 (2011)
[3] A.V. Filinov, J. Ara, and I.M. Tkachenko, PhysRevB.107.195143 (2023) & Phil.Trans. of the Royal Society A: Mathematical, Physical and Engineering Sciences 381, 20220324 (2023)

All DQ-mat members and all interested are cordially invited to attend.