DPP19-2019-000344

Abstract for an Invited Paper
for the DPP19 Meeting of
the American Physical Society

Towards *ab initio*simulation of warm dense matter[1]

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Warm dense matter (WDM) – an exotic state where electrons are quantum degenerate and ions may be strongly correlated – is ubiquitous in astrophysics and highly compressed laboratory plasmas. We have recently obtained *ab initio*thermodynamic results for the electron component in WDM based on novel quantum Monte Carlo (QMC) simulations [1-3] including the first *ab initio*parametrization of the exchange-correlation free energy F_xc [3, 4], and here we present applications using finite temperature DFT simulations. In addition, also inhomogeneous systems have been studied giving rise to *ab initio*results for the static structure factor. Moreover, recently the first exact QMC result for the dynamic structure factor could be obtained [5]. An interesting result is the prediction of a negative plasmon dispersion in the range of strong electronic correlations – an effect that should be observable in dense hydrogen. Finally, an outlook is presented on how to accurately treat degenerate electrons in WDM out of equilibrium. Here we discuss two approaches: quantum hydrodynamics for which a microscopic derivation is given [6]. The second is nonequilibrium Green functions which allow for a rigorous extension of kinetic equations to ultrafast relaxation processes [7]. [1] T. Schoof, S. Groth, J. Vorberger, and M. Bonitz, Phys. Rev. Lett. , 130402 (2015) [2] T. Dornheim, S. Groth, T. Sjostrom, F.D. Malone, W.M.C. Foulkes, and M. Bonitz, Phys. Rev. Lett. , 156403 (2016) [3]S. Groth, T. Dornheim, T. Sjostrom, F.D. Malone, W.M.C. Foulkes, and M. Bonitz, Phys. Rev. Lett. , 135001 (2017) [4] T. Dornheim, S. Groth, and M. Bonitz, Phys. Reports , 1-86 (2018) [5] T. Dornheim, S. Groth, J. Vorberger, and M. Bonitz, Phys. Rev. Lett. , 255001 (2018) [6] M. Bonitz, Zh. Moldabekov, and T. Ramazanov, Phys. Plasmas, submitted [7] M. Bonitz, "Quantum Kinetic Theory", 2nded., Springer 2016

[1]Supported by Deutsche Forschungsgemeinschaft via grant BO1366/13