Simulation of strongly correlated and magnetized plasmas

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In plasmas with high densities, low temperatures, or highly charged particles, the strong Coulomb interactions between the constituents have a pronounced impact on the plasma state. Examples range from warm dense matter inside giant planets to ultra cold neutral plasmas and dusty plasmas created in the lab. Molecular dynamics simulations have become indispensable tools for the investigation of these so-called strongly correlated plasmas.
It is shown that the dynamic structure factor (DSF) [1], a key quantity for experiments, gives access to the thermodynamic and transport coefficients of strongly correlated plasmas. This is demonstrated explicitly for a one-component Yukawa plasma [2] by comparing simulation results for the DSF with extensions of the hydrodynamic model in the small wavenumber and low frequency limit. The thermodynamic and transport coefficients are found to be in good agreement with available data in the literature. Furthermore, the DSF allows one to study, in detail, the collective modes of strongly correlated plasmas and their dielectric properties. In magnetized plasmas, correlation effects profoundly modify the wave spectrum as one enters the strong coupling regime.

[1] H. Kählert, Phys. Plasmas **26**, 063703 (2019).
[2] H. Kählert, Phys. Rev. Research **2**, 033287 (2020).