Dynamical screening of charge potential in classical, quantum and ultrarelativistic plasmas

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Dense plasmas have recently gained growing interest due to their relevance for the interior of giant planets as well as for laser interaction with matter and inertial confinement fusion scenarios. Examples of recent experimental studies include the ultrafast thermalization of laser plasmas or free electron laser excited plasmas, inertial confinement fusion experiments at the National Ignition Facility, and magnetized Z-pinch experiments at Sandia. Questions of fundamental theoretical importance are the conductivity and heat conduction, the free energy loss of energetic particles (stopping power) in such a plasma, or the temperature equilibration of the electronic
and ionic components.

In the mentioned experiments the generated plasma is nonequilibrium. Therefore for adequate description of processes in plasmas the dynamical screened interaction potential has to be used instead of static screened potential [1].

On another hand, in recent years, wake effects have been extensively studied in nonequilibrium plasmas appearing in classical complex plasma experiments [2]. Therefore, it is very appealing to compare the features of plasma wakes observed in warm dense matter with those in classical plasmas, where the experimental investigation does not require sophisticated devices and is straightforward. Analogies, but also identified differences may be of direct importance for various fields, where a deviation from the static Yukawa potential due to streaming effects can be expected.

The first purpose of this work is to present dynamical screened potential for situations relevant to warm dense matter and obtain results that are quantitatively reliable allowing for predictions that can be tested in experiments. To this end we will use a dielectric function of quantum degenerate electrons streaming with a constant velocity relative to the ions that fully includes the effects of finite temperature T and collisions (correlations).

The second purpose of this work is outline the topological structure and characteristics of the dynamically screened potential for three representative systems in completely different physical regimes: (i) a classical complex plasma, (ii) a degenerate electron-ion plasma at high densities, and (iii) an ultrarelativistic quark-gluon plasma [3].

References

[1] Zh. A. Moldabekov *et al* 2015 *Physical Review E,* **91**, 023102
[2] P. Ludwig *et al* 2012 *New Journal of Physics,* **14**, 053016
[3] Chakraborty *et al* 2006 *Physical Review D,* **74**, 094002