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Microscopic and Dynamical Properties of Partially Ionized Plasma

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We consider the partially ionized dense semiclassical weakly degenerated plasma of different elements (hydrogen, argon, copper, aluminum, beryllium) with the wide values of number density and temperature.
It is well known that the study of the properties of strongly coupled complex plasmas is of great interest related to the fundamental investigations of astrophysical objects and inertial confinement fusion plasmas. In such strongly coupled systems, the collective (or screening) and quantum-mechanical effects play an important role in the studies of thermodynamic and kinetic properties of strongly coupled plasmas.

The quantum mechanical diffraction and symmetry effects can be taken into account by using different micropotentials which are obtained from quantum mechanical consideration of interparticle interaction. In order to describe the interactions between particles several effective potentials are proposed. These potentials take into account quantum mechanical, screening and polarizations effects in dense plasmas. The effective potentials between particles in dense plasmas are derived on the basis of the method of dielectric response functions and multipole expansion. The effective dynamically screened potential of a classical ion in a stationary flowing quantum plasma at finite temperature is investigated. For consideration of electron-atom interaction we use optical model consisting of two parts: Hartree-Fock potential of non-perturbed atom and the polarization potential. Polarization potential describes the contribution of atomic dipole moment inducted by projectile charged particle. The screening effect is taken into account in long-wave limit due to quantum electron and correlation corrections using by local field correction method.

The Coulomb logarithm for dense semiclassical fully and partially ionized plasmas has been derived. Stopping power and dynamical processes of dense plasma have been studied by the Coulomb logarithm. We compare our results with data of RPA, the Born first-order approximation, T-matrix, PIC-method and so called combined scheme. It should be noted that our results have a reasonable agreement with results of PIC-simulation and combined scheme at small and near critical velocities.

Using the obtained effective potential we have calculated the elastic total and transport cross sections by solving the Calodgero equation. The important role of quantum and correlation effects is observed at low collision energies: it is clearly shown from behavior of transport cross sections. As a result the transport cross section decreases at low collision energies due to the taking into account of screening effects.

The effect of the ionic core on the microscopic and dynamic properties of dense plasma was analyzed. The screened potential of the electron-ion interaction was used to compute the quantum scattering transport cross section for the electron-ion collisions in dense plasmas. The ion-core effect is taken into account using the pseudopotential approach suggested by authors in the previous works.

Thermodynamic and transport properties of dense plasma have been studied on the basis of proposed effective potentials. The comparison with data of other theoretical and experimental works has been done.

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