Effective potential of interactions between ions in dense quantum plasmas

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In this paper we consider the effective potential of interaction between ions in quantum plasmas. Effective interaction potential, taking into account the wave nature of ion at small interparticle distances can be obtained by the method of the dielectric response function in combination with so called quantum potential approach. AS the quantum potential for description of the semiclassical ions the Deutsch potential, which has a finite value at $r = 0$, was used [1]. Considered plasma density is $n > 10^{24}\, cm^{-3}$. In this case, electrons are quantum, ie should be described by Fermi-Dirac statistics. Next, we consider the case $\theta_i \geq 0.5$, where \theta is the ration of the thermal energy to the Fermi energy of protons. The degeneracy parameter of ions and electrons related as $\theta_e = \theta_i \times m_e / m_i << 1$, thus in the considered case the electronic subsystem is completely degenerate. As a result, the chemical potential of the electrons can be taken equal to the Fermi energy of the electrons. In the considered range of plasma parameters the effective coupling parameter $\Gamma^*_{ii} \leq 1$, here $\Gamma^*_{ii} = Q_i^2 / ak_BT \exp(-ak_Y)$ is defined as the ratio of the energy of interaction of two ions at an average interparticle distances to their thermal energy. This means that the ionic subsystem is weakly coupled and can be described by random phase approximation [2].

On the basis of the obtained effective interaction potential between ions, the thermodynamic properties of a dense plasma (warm dense matter) were investigated.

References

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