Coulomb crystals with polarized electron background

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The model of a Coulomb crystal: point like atomic nuclei and electrons background is used in astrophysics in theory of neutron stars and white dwarfs. Polarizability of electrons in a Coulomb crystal is usually described by the Thomas-Fermi formalism (ex., [1]). It is shown that in this approach the model of a Coulomb crystal is similar to the strongly-coupled Yukawa system which was described in [2]. The only difference is that in astrophysical applications electrons are thought to be degenerated while in Hamaguchi and Farouki model — nondegenerated (this only leads to $\kappa^2 \equiv 4\pi e^2 \partial n_e / \partial \mu_e$ changes while equations for electrostatic and total free energies as function of κ and Γ stay the same). Hence, far from the melting point structural transition between bcc and fcc Yukawa lattices could be described analytically by the simple harmonic approximation. Importance of corrections $\propto \kappa^4$ to the Yukawa potential in this approach is discussed. In particular, it is shown that these corrections could noticeably change the structural diagram of Yukawa systems and transition between fcc and hcp lattices could appears. Analytical equations also allows to consider low temperature effects (results received in [2] are valid at $T \ ? \ T_p$, where T_p is plasma temperature) and influence of the magnetic field.

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REFERENCES

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