Physical features of multicomponent Coulomb crystals

A. A. Kozhberov [1] *

[1]Ioffe Institute, Saint Petersburg, Russia

Coulomb crystals consist of fully ionized ions arranged in a crystal lattice and immersed into the uniform neutralizing electron background. It is thought that matter in white dwarf cores and neutron star crusts is arranged in the body-centered cubic (bcc) Coulomb lattice because this lattice have the lowest electrostatic energy among all lattices which were ever been studied. Most of these studies were devoted to one-component crystals with one type of the ion in the elementary cell. However, in the interior of degenerate stars the existence of crystallized mixtures is not excluded.

In this work we consider electrostatic and phonon properties of different multicomponent Coulomb crystal lattices. For instance, an analysis of the phonon spectra shows that binary bcc Coulomb crystal is stable if the ratio $\alpha \equiv Z_2/Z_1$ lies between $1/3.6$ and 3.6 (Z_i is i-th ion charge number) so the sufficiently different ions can not form the bcc lattice. On the other hand the binary "MgB_2 lattice" is stable if $\alpha \in [0.1; 0.375]$. And while the binary bcc lattice stay cubic at any possible α the binary hexagonal close-packed lattice changes its size. The distance between its hexagonal layers decreases with the growth of $|\alpha - 1|$.

Also for some lattices the energy of zero-point vibrations was calculated and the linear mixing rule was checked.

*E-mail: kozhberov@gmail.com