CRYSTAL–LIQUID TRANSITION IN THE ONE-COMPONENT PLASMA CLUSTERS

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The object of investigation is the massive charged particles on the compensating uniform background confined to a spherical surface. Such objects extend considerably the limits of the model of an infinite system [1] because the state of a system is defined not only by the Coulomb coupling parameter Γ but by the number of particles N as well. Since the size effects are of interest, N is not too great. This makes it possible to include the Coulomb interaction forces directly and, at the same time, to avoid bulky calculations associated with the molecular dynamics (MD) simulation of such systems.

We performed MD simulation of the one-component plasma clusters. The temperature was controlled by the Langevin thermostat, which was modified to conserve the total momentum of the particles. This excludes the dipole surface oscillations that can have a notable effect on the cluster crystallization. The simulation was performed for N ranging from 140 to 1200 and Γ, from 50 to 500 and revealed that at the crystal–liquid transition point, Γ is increased with N, the mean value being not much different from that for the bulk system [1]. The structure of a crystallized cluster is represented by a set of embedded spherical shells.

We discuss the methods of experimental determination of Γ based on the Wigner–Seitz cell model. The estimation based on the mean-square deviation of a particle from the center of its cell commonly used in the experimental data analysis (e.g., in [2]) is demonstrated to be not reliable because of the shift of the cell center due to the particle thermal jumps. A new method based on the determination of the particle acceleration is proposed, which proved to ensure sufficient accuracy not only for the crystal but for the liquid state as well. This method can be applied for the complex plasma.

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