Manifestation of the hexatic phase of charge particles confined in a lateral potential with circular symmetry

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Planar systems of charged particles interacting through the Coulomb potential and locked by external potentials with high symmetry play an important role in various fields of both experimental and theoretical physics and chemistry. Obviously, the functional efficiency of such systems depends on their structure, which can change during phase transitions under the influence of external conditions (e.g., temperature). Until now, the main attention has been focused on the search for signals of phase transitions in continuous two-dimensional systems. In finite quasi-two-dimensional systems, isotropic repulsion between charged particles leads to the formation of a hexagonal lattice in which six neighboring particles are located symmetrically relative to the selected particle [1]. This lattice is an analog of a three-dimensional Wigner crystal on the plane. Both practical and fundamental questions arise about the critical number of electrons at which the symmetry of the crystal lattice in the system under consideration will begin to break and, consequently the nucleation of defects will start.

The main objective of this work is to search for phase characteristics and order parameters, precursors of a phase transition of the hexagonal–hexatic phase type [2], depending on the number of particles in the system at zero temperature.

The dependences of the orientational order parameter and the correlation function, which characterize topological phase transitions, as functions of the number of particles at zero temperature have been studied [3]. The calculation results allow us to establish the precursors of the phase transition from the hexagonal phase to the hexatic one for $N = 92$, 136, and 187 considered as an example.
It is found that the boundary significantly influences the behavior of the system and the nature of the phase transition from the hexagonal phase to the hexatic phase and then to the isotropic “quasi-liquid state,” in contrast to infinite systems.

References

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