# NEW APPROACH TO CALCULATING THE GROUND-STATE ENERGY OF SYSTEMS OF LIKE-CHARGED PARTICLES ON A DISK WITH A CONFINING POTENTIAL AT THE BOUNDARY

**Lavrov G.K.[1,2], Nikonov E.G.[1,2]**

[1]Joint Institute for Nuclear Research, Russian Federation,
141980, Dubna, Moscow Region, Joliot-Curie str., 6, +74962163307, lavrov@jinr.ru;
[2]Dubna State University, Russian Federation,
141980, Dubna, Moscow Region, Universitetskaya str., 19, lavrov@uni-dubna.ru.

In this work, we present a new approach developed by the authors for calculating the ground-state energy of classical systems of like-charged particles distributed in a circular domain with an infinite confining potential at the boundary. The relevance of this problem is due to its fundamental nature and its applications in plasma physics, nanoelectronics, and condensed matter theory [1,2].

The main idea of the proposed approach is a systematic comparison of the energetic properties of the same particle system in two different thermodynamic states. In the first case, the system is modeled in a geometry with a fixed radius of the confining potential. In the second case, the radius of the confining potential is varied so as to maintain a constant average particle density, i.e., the system is scaled. Numerical experiments were carried out using the molecular dynamics (MD) method with an energy-minimization (quenching) relaxation algorithm [1]. As a result, for each system considered, two quantities were obtained: the minimum configuration energy in a domain of fixed size and the minimum configuration energy at fixed density. The central result of the work is the discovery of a direct quantitative relationship between these two quantities. It turned out that the ratio of the energy of the system in the geometry with a constant radius of the circular domain to the energy of the system with constant density is, with high accuracy, equal to the dimensionless radius of the domain in the latter case.

The revealed regularity is a qualitatively new result and makes it possible to obtain the ground-state energy for a given number of particles without performing extremely resource-intensive MD simulations. In addition, this dependence provides a criterion for how close the global minimum obtained in MD calculations is to the true ground-state energy for a given number of particles.

## References

1. *Nazmitdinov R.G., Puente A., Cerkaski M. and Pons M.* Self-organization of charged particles in circular geometry // *Phys. Rev. E* **95**, 2017, 042603;
2. *Amore P., Zarate U.* Thomson problem in the disk // *Phys. Rev. E* **108**, 2023, 055302.