6th Asia-Pacific Conference on Plasma Physics, 9-14 Oct, 2022, Remote e-conference

Chaotic dynamics of small-sized charged Yukawa dust clusters

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Clusters of charged dust particles mutually interacting with screened Coulomb force and radially confined by an externally applied electric field in a two-dimensional configuration have been simulated using LAMMPS [1]. These charged microparticles have many applications in a variety of industrial processes [2,3]. It is observed that these clusters relax toward a minimum energy configuration. For small sized clusters, comprising up to few tens of particles, the particles organize themselves in various rings around the center. Depending on the number of particles, the relaxed state is observed to be either stationary or exhibits a dynamical rotating state in which the particles arranged in various shells show rotation. The rotation changes with time, and detailed analysis shows that the particle dynamics is chaotic. The correlation dimension and the largest Lyapunov index for the dynamical state have been evaluated to demonstrate that the dynamics is chaotic. It is also interesting to note that for systems comprising particles interacting with attractive forces, such as gravitational force, one observes periodic dynamical configurations, e.g., planetary motion, etc. Here, in contrast, charged particles interacting with repulsive forces have been considered (which are confined by an external potential), and it has been demonstrated that they show nonperiodic chaotic dynamics.

References

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