Essential changes of structural and dynamical properties in a Yukawa system caused by amplitude instability

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The majority of theoretical studies on stability of a non-ideal media are based on the analysis of linearized equations of motion and consideration of the dissipative or/and the dispersive instabilities due to small deviations of particles from their equilibrium positions. However, with the increase in particle kinetic temperature the amplitude instability can also develop.

Here we present the analysis of physical properties of a non-ideal particle system with a temperature growth. We propose to investigate the amplitude stability, i.e. the stability to any-size deviations (not just small ones) of particles from their equilibrium positions. The presented approach to the amplitude instability prediction is based on the determination of an inflection point for the potential energy of a system with an increase of its kinetic temperature. We consider the process of formation of amplitude instability in a two-particle Yukawa system for wide values range of screening parameter, friction coefficient, and gradients of external electric field.

Numerical simulations have shown that an increase in grain temperature leads to essential changes in the structural and dynamic properties of the system in the vicinity of the critical magnitude of the coupling parameter. The special features observed close to the critical point are caused by the formation of amplitude instability in the analyzed two-partical system (and are similar to those that causes the melting for extended systems).

The new analytical approach proposed here can also be an effective tool for studying amplitude instability in systems of interacting particles suspended in plasma with directed ion flow which adds to the interaction forces a wake-mediated attractive force.

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