

Tutorial: Molecular dynamics simulations of dusty plasmas

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In the last decades numerical methods have become increasingly important due to the tremendously fast development of digital computers. In particular, particle-based bottom-up approaches such as Molecular Dynamics (MD) enable researchers to treat the interactions and strong correlations between classical charged particles without mathematical simplifications — from first principles.

Using MD we will focus on a relatively young field of plasma physics: the 3D Coulomb crystal formation observed in recent dusty plasma experiments [1]. The simulation results of the one-component static Yukawa model for the dust grains are found to be in very good agreement with the measurements [2,3]. Nevertheless, the multi-component plasma environment requires a systematic and careful analysis of collective many-particle effects. In particular in cases where the streaming velocity is close to or exceeds the sound speed, the effect of streaming ions can strongly influence the structural and dynamical properties of a strongly-coupled dusty plasma. Therefore these cases require the inclusion of dynamically screened pair potentials which are computed from a dynamic dielectric function [4].

[1] O. Arp et al., PRL **93**, 165004 (2004); [2] M. Bonitz et al, PRL **96**, 075001 (2006); [3] H. Kählert et al, Phys. Rev. E **78**, 036408 (2008); [4] M. Lampe et al., IEEE Trans. Plasma Sci. **33**, 57 (2005)