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Using dusty plasmas to study deformations of crystalline solids

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Laboratory dusty plasmas are complex systems consisting of micrometer sized solid grains immersed in an electrical gas discharge. The dust grains charge up negatively and levitate between the electrodes due to the interaction with the background plasma and the electric field within. Often the strong electrostatic repulsion between the grains dominates the dynamics over the random thermal motion. Using mono-disperse powder and plane-parallel electrode radio frequency discharge, one can easily form stable single layer (2D) crystalline structures (triangular lattices) that consist of thousands of grains and have characteristic distance and time scales easily observable by video microscopy or even by the unaided eye. These strongly coupled many-particle systems are ideal experimental model systems to study collective processes (deformations, phase transitions, wave propagations, transport processes, etc.) in situ on the level of individual particles. Recently we have realized a slow shearing creep deformation experiment and have measured the exponents of the shear stress - shear rate and the shear stress - dislocation density relations, and have demonstrated, that the creation of dislocation pairs, the rapid (partly supersonic) glide and annihilation of dislocations are the dominant microscopic processes, in consistence with the Harper-Dorn creep model. As a long-term consequence, the shape of the crystalline domains become elongated parallel with the shear. The main purpose of this talk is to convince the material science community that dusty plasmas can be useful tools to uncover the microscopic details of macroscopic processes in condensed matter, and to build interdisciplinary bridges to the benefit of both communities.

Biography

Peter Hartmann has completed his PhD in 2004 from the Roland Eotvos Science University in Budapest, Hungary. He started his research in the field of gas discharge physics in the Research Institute for Solid State Physics and Optics of the Hungarian Academy of Sciences (now part of the Wigner Research Centre). He is the leader of the Gas Discharge Physics research group. Since 2008 he is conducting dusty plasma experiments and related numerical simulations. He has published more than 70 papers in reputed journals his h-index is 16.

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