P 12: Complex Plasmas and Dusty Plasmas I

Time: Wednesday 11:00–12:15 Location: ZHG006

Invited Talk P 12.1 Wed 11:00 ZHG006

Using dusty plasmas to measure low-electron sticking coefficients of dielectric materials — •Armin Mengel[1], Isabel König[1], Lorin S. Matthews[2], Franz X. Bronold[4], and Franko Greiner[1,3] — [1]Institute of Experimental and Applied Physics, Kiel University, Germany — [2]Center for Astrophysics, Space Physics, and Engineering Research, Baylor University, Waco, TX, USA — [3]Kiel Nano, Surface and Interface Science KiNSIS, Kiel University, Germany — [4]Institut für Physik, Universität Greifswald, Greifswald, Deutschland

Low-energy electron sticking coefficients are of high technological interest, even though their measurement proves challenging using conventional means. Precision measurements using single dust particles confined in a low-pressure plasma have now been utilized to quantitatively determine the low-energy electron sticking coefficient of silica. The results show that dielectric and metallic surfaces in a plasma differ in charge substantially. To apply this promising measurement scheme to a broader range of materials, charging models for non-spherical particles are needed in place of the spherical capacitor model used for spherical particles. Measurements and simulations of sphere aggregates are compared against the smallest enclosing sphere (SES) model and the orientation averaged equivalent sphere (OAES) model, as well as the numerically calculated capacitance, allowing to extend the sticking measurements to non-spherical grains of dielectrics.

P 12.2 Wed 11:30 ZHG006

Measuring Diffusion in Dusty Plasma Using Differential Dynamic Microscopy — •Yang Liu and Dietmar Block — IEAP, Christian-Albrechts-Universität, D-24098 Kiel, Germany

Differential Dynamic Microscopy (DDM) is an emerging Fourier-space-based measurement technique that extracts dynamic information similarly to light scattering, combining the sensitivity of scattering with the direct visualization advantages of microscopy [1]. In this study, we propose a new method for measuring diffusion in dusty plasma using DDM. We assume that particles interact via a screened Coulomb potential and generate a series of images that allow to extract the particle motion and to quantify the accuracy and effectiveness of DDM analysis. The particle dynamics are obtained from Langevin dynamic simulation [2, 3]. The results show that, due to the micro frictional damping arising from a neutral gas background, the effects of hydrodynamic interactions (HIs) between multiple particles can be neglected. This study extends the applicability of the DDM method to Yukawa systems, thereby enabling accurate characterization of the diffusion behavior of strongly interacting particles.

References [1] R. Cerbino and V. Trappe, Phys. Rev. Lett. 100, 188102 (2008). [2] M. Gu, Y. Luo, Y. He, M. E. Helgeson, and M. T. Valentine, Phys. Rev. E 104, 034610 (2021). [3] Y. Liu and D. Block, Phys. Plasmas 31, 103701 (2024).

P 12.3 Wed 11:45 ZHG006

Bow shock formation in a dusty plasma flowing around an obstacle under microgravity — •Stefan Schütt, Christina Knapek, Daniel Maier, Daniel Mohr, and André Melzer — University of Greifswald, Greifswald, Germany

Dust flows around an obstacle in three-dimensionally extended dust clouds have been investigated on parabolic flights. As the obstacle, a tungsten wire has been installed in the midplane between the electrodes of a parallel plate radio-frequency discharge. A periodic dust motion was generated by superimposing a low-frequency modulation on the electrodes, shifting the dust cloud between the electrodes. Due to the periodic nature of the dust motion, several shocks could be observed at varying dust densities. When the dust flow was transonic or supersonic, bow shocks were formed upstream of the wire and propagated away from it at a constant speed. However, at the dust densities needed for the shock formation, dust-density waves also occurred and the two phenomena often intermingled. The role of the streaming ions in driving the shock is therefore discussed. At carefully chosen parameters, it was possible to observe only the bow shock while suppressing the waves. It is reasoned that the shock is excited independently from dust-density waves by a density increase upstream of the obstacle.

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P 12.4 Wed 12:00 ZHG006

Investigation of dust density waves in binary systems — •Natascha Blosczyk and Dietmar Block — Institute of Experimental and Applied Physics, Kiel University, Kiel, Germany

The wave dynamics in monodisperse dusty plasmas are quite well understood. Theoretical predictions of dispersion relations have been verified in a number of experiments with self-excited or driven waves. For binary systems the situation is different. In general the wave properties will depend on the system properties like mixing ratio, charge ratios and local order. In this work an approach to evaluate the wave dynamics is presented for binary systems in experiments. The waves are driven with a laser manipulation system which launches plane wave fronts into the binary system. The measured system response in terms of particle trajectories is analyzed with the so-called Hilbert-transform which allows to measure with spatial resolution the wave frequency and wave number. This allows us to investigate the wave dispersion in these binary systems. Further, we are able to test whether the local particle arrangement affects the wave propagation. This contribution will show typical results and discuss prospects and limitations of this approach.