P 18: Complex plasma and Low-temperature plasma and applications 2

Time: Thursday 11:00–13:10 Location: b302

Invited Talk P 18.1 Thu 11:00 b302

Experiments on Binary Dust Mixtures — •Frank Wieben and Dietmar Block — Institute of Experimental and Applied Physics, Kiel University, Germany

A solid or fluid can drastically change its properties if an additional species of atoms or molecules is added. In the field of strongly coupled systems, colloidal dispersions were the first using polydisperse mixtures and observed phenomena like e.g. highly ordered alternating lattices. Naturally, the presence of a second species was expected to also impact closely related complex (dusty) plasmas, where solid as well as fluid states are accessible. The charged dust particles form two- or three-dimensional systems which are virtually undamped and allow for dynamical processes to emerge. Monodisperse systems proved to follow a One Component Plasma (OCP) description very well, thus serving as an ideal model experiment. Early microgravity experiments using two particle sizes revealed a demixing of the species, but recently the transition from demixed to mixed or even highly ordered binary complex plasmas was reported. This opened a completely new field and granted access to structural as well as (thermo-) dynamical properties of these systems. In this contribution an overview of the recent progresses in binary complex plasmas is given.

Invited Talk P 18.2 Thu 11:30 b302

Structure and transport in magnetized gas discharges related to dusty plasmas — •Peter Hartmann[1] and Marlene Rosenberg[2] — [1]Wigner Research Centre for Physics, Budapest, Hungary — [2]University of California San Diego, La Jolla, California, USA

Motivated by recent magnetized dusty plasma experiments at Auburn University and the University of Greifswald we have applied our GPU accelerated electrostatic cylindrical 2D Particle-in-Cell with Monte Carlo Collision simulations to describe charged particle transport in capacitively coupled RF discharges in an axisymmetric homogeneous magnetic field of up to a few Tesla magnitude. Microscopic details of the observed phenomena, like filamentation, imposed dust structure formation and light emission profiles have been computed and compared to the experiments.

P 18.3 Thu 12:00 b302

Experimental Studies of Phase Separation in Binary Dusty Plasmas under Microgravity — •Stefan Schütt and André Melzer — University Greifswald, Germany

Dusty plasma experiments under microgravity conditions allow to study the dynamics of individual particles in three-dimensionally extended systems. Such dusty plasmas typically contain one species of monodisperse dust particles. Adding a second species of monodisperse particles of different size allows to study phase separation processes. Those binary systems exhibit phase separation even for small relative size disparities of about 3%. Particles marked with a fluorecscent dye are used for one of the species. This makes it possible to distinguish between the species despite their small size disparity using a two-camera video microscopy setup and appropriate filters. The availability of high-resolution, high-speed cameras allows to track single particles during the separation process. As the particle number density as well as the flux are available, diffusion coefficients can be determined. Additionally, a method is presented that does not rely on particle tracking and therefore is much faster. A systematic study of phase separation at different size disparities made possible by this method is shown. This work was supported by DLR under grant no. 50WM1638.

P 18.4 Thu 12:25 b302

FTIR monitoring of nanoparticles synthesized in a capacitively coupled low-pressure plasma — •Oguz Han Asnaz, Franko Greiner, and Jan Benedikt — Institute of Experimental and Applied Physics, Kiel University, Germany

Due to their unique physical, mechanical, electrical, and optical properties, in the last decades, nanoparticles have found a wide range of applications ranging from drug carriers in biomedicine over catalysts to batteries and solar cells. In all of these, fine control of the particle's surface properties as well as the bulk crystallinity is required.

Here, we present results of in situ analysis of Ar/C2H2-plasma-generated a-C:H nanoparticles by means of time-resolved multi-pass FTIR spectroscopy in parallel to optical light scattering techniques during operation. While the scattering techniques work well for larger particles, the absorption spectroscopy can be operated with particles with sizes even in the nanometer range, depending only on the density of absorbing features (chemical bonds on or in particles), i.e., independent of particle size. The a-C:H particles serve as a first model system to compare both measurement methods. In the future, surface modifications of silicon, metal or metal-oxide nanoparticles generated in external plasma sources will be studied, which will allow insight into the dynamics of surface oxidation, passivation, and thin-film deposition.

P 18.5 Thu 12:40 b302

Complex plasma experiments in microgravity with the Zyflex chamber — •Christina A. Knapek, Daniel P. Mohr, Peter Huber, and Mierk Schwabe — Deutsches Zentrum für Luft- und Raumfahrt (DLR), Institut für Materialphysik im Weltraum, Wessling, Germany

Complex plasmas consist of highly charged micrometer-sized grains injected into a low temperature noble gas discharge. The particles interact with each other via a screened Coulomb potential, and can form gaseous, liquid or solid states. On ground, gravity compresses the system and prevents the generation of larger, three-dimensional particle clouds. To study those systems, research in microgravity conditions, e.g. on parabolic flights, sounding rockets or the International Space Station (ISS), is essential.

In this talk, some of the latest results of experiments performed during parabolic flights with the Zyflex plasma chamber – a large, cylindrical radio-frequency (rf) discharge with adaptive internal geometry and a special electrode system – will be presented.

In microgravity, complex plasmas generated in a parallel-plate rf discharge usually exhibit a void in the central region of the plasma chamber, due to the ion drag force pushing particles out of the bulk plasma. The performed experiments include the successful generation of large, homogeneous 3D particle clouds without central void, and the observation of fluid phenomena at the void boundary.

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P 18.6 Thu 12:55 b302

Correlation of the void dynamics with transition events of the growth chain of nanodust in a reactive argon-acetylene plasma — Sebastian Groth[1], Nancy Fassheber[2], Gernot Friedrichs[2], and •Franko Greiner[1] — [1]Institut für Experimentelle und Angewandte Physik, Christian-Albrechts-Universität zu Kiel — [2]Institut für Physikalische Chemie, Christian-Albrechts-Universität zu Kiel

Using imaging Mie ellipsometry in combination with 1D extinction measurements we have fully characterized the spatio-temporal size and density evolution of nanoparticles grown in a reactive argon acetylene plasma [Groth et al. PSST 2019, DOI: 10.1088/1361-6595/ab5412]. The growth process is usually divided into four phases: (i) creation of precursors from acetylene, (ii) nucleation of nanometer-sized a:C-H clusters (nucleation phase), (iii) coagulation of the clusters to 50 nm nanoparticles (coagulation phase), and finally (iv) further growth of negatively charged particles by sticking of molecules and molecular ions (accretion phase).

The analysis of the dynamical behavior of a nanodust cloud completely embedded in another cloud, consisting of larger particles, can link events in the spatio-temporal evolution of the nanodust cloud to events along the growth chain of the nanoparticles. This permits the verification of theoretical predictions about the occurrence of specific plasma chemical events along the growth chain by means of laser spectroscopy.