P 3: Dusty Plasmas I

Zeit: Montag 14:00–15:55 Raum: HS 1010

Hauptvortrag P 3.1 Mo 14:00 HS 1010
Numerical studies of plasma-object interactions — •Wojciech Miloch — Department of Physics, University of Oslo, Norway

Interaction of plasma with finite-sized objects is one of main problems in plasma physics. Objects immersed in plasma will be charged by plasma and other currents, a sheath will form in their vicinity, and plasma parameters will be modified locally. Detailed understanding of the plasma-object interactions is important for a number of problems, including plasma diagnostics by probes, spacecraft performance, plasma processing, or dynamics of dust grains in complex (dusty) plasmas.

The relative motion of an object and plasma breaks the symmetry of charging, and gives rise to the wake in plasma density and potential. The object charging and wake formation are often nonlinear processes, and to study them, first principle kinetic numerical simulations should be considered. Such simulations can be carried out with the particle-in-cell (PIC) method, where trajectories of a large number of plasma particles are followed in self-consistent force fields. In this work, I focus on the object charging in flowing plasmas and wakefield effects, and present recent results from self-consistent PIC simulations. Problems that are addressed include spacecraft-plasma interaction, the role of wakes in data acquisition and instrument performance, charging of several dust grains, and the role of magnetic field in the wake formation.

Fachvortrag P 3.2 Mo 14:30 HS 1010
Structure and properties of two-dimensional binary mixtures — •Frank Wieben and Dietmar Block — Institute of Experimental and Applied Physics, Kiel University, Germany

Binary mixtures can occur in various systems, e.g. fluids, colloidal suspensions and strongly coupled complex plasmas. The primary characteristic of binary systems is the decomposition of the species under certain conditions. Complex plasmas, compared to fluids or colloidal suspensions, feature a low damping of the particles which allows for the investigation of dynamical processes. Under microgravity conditions dust particles in a complex plasma form three-dimensional clouds. If a second species is injected, a fast decomposition of the species is observed, even for small size disparities. In ground based experiments two species can form a two-dimensional binary monolayer if the charge-to-mass ratios are equal. However, there are no experiments on 2D binary mixtures yet and numerical simulations on binary Yukawa systems in parabolic traps predict no decomposition of the species. In this contribution first experiments on two-dimensional binary mixtures in complex plasmas are presented. Special attention is paid to the demanding experimental generation of these systems. The experiments are compared to molecular dynamics simulations that include imperfections of real complex plasmas.

This work was supported by the Deutsche Forschungsgemeinschaft DFG in the framework of the SFB TR24 Greifswald Kiel, Project A3b.

P 3.3 Mo 14:55 HS 1010
Fine structure of a Mach cone in a zero gravity, 3d complex plasma system — •Erich Zaehringer, Mierk Schwabe, Sergey Zhdanov, Christina A. Knapek, Daniel P. Mohr, Peter Huber, and Hubertus M. Thomas — DLR German Aerospace Center, Research Group Complex Plasmas, Wessling, Germany

For a Complex Plasma, small micrometer sized particles are injected into a low temperature plasma, consisting of electrons, ions and neutral gas. Particles are getting charged by electrons and ion fluxes on their surfaces. These particles form a system with gaseous, liquid and solid properties out of several thousand charged particles. The single particle dynamics can be recorded in direct measurements due to the large size of 1 - 10 μm. Additional to measurements on plasma conditions and the particle system itself, extra particles can generate a lot of extra information about the complex plasma system.
A probe particle with supersonic speed was observed during a zero gravity experiment in the Zyflex chamber of the PlasmaLab / Eko-Plasma project, generating a fine structured Mach cone in the 3D complex plasma system. Based on that, a profile of the acoustic velocity across the cloud could be generated and perturbations were analysed. The high resolution of the data offers the application of PTV and PIV methods to measure densities, velocities and displacements, and to characterize the super-sonic motion.
This work and some of the authors are funded by DLR/BMWi (FKZ 50WM1441).

P 3.4 Mo 15:10 HS 1010
A Machine-Learning Method for Plasma Crystal Analysis — •Christopher Dietz, Tobias Kretz, and Markus Thoma — I. Physikalisches Institut, JLU Gießen

Machine-Learning is one of the most popular fields in computer science and has a vast amount of applications. We propose a method, that will use a Machine-Learning algorithm to identify crystal structures in a simulated plasma crystal. This data consists of fcc, hcp, bcc and disordered particles, which is difficult to identify using conventional methods.

The new approach works very well for highly disturbed lattices and mixed phase systems. Thus, it enables us to retrieve a more complete picture of plasma crystals.

P 3.5 Mo 15:25 HS 1010
In Operando Size Measurements of Single Microparticles in Plasmas — •Oguz Han Asnaz, Hendrik Jung, Franko Greiner, and Alexander Piel — Institute of Experimental and Applied Physics, Kiel University, Germany

In recent years ever more precise measurements of single dust particles in a plasma environment became possible. The goal of these experiments is the usage of particles as small probes for determining several plasma properties. With the gain in precision, the accuracy of manufacturer's data about the particles dimensions became a limiting factor. Therefore, in operando measurements of the microparticles are needed. In this contribution two such methods are demonstrated. Using a long distance microscope, single particles are imaged from outside the plasma chamber. In combination with phase-resolved resonance measurements [1] it is possible to determine the particle mass. Since this method can be used in operando, it is possible to analyze the long-term evolution of spherical and non-spherical particles during plasma exposure over several hours. For smaller spherical particles interferometric techniques based on Mie-scattering offer finer resolution by resolving the angular scattering pattern of the particle.
This work was funded by the DFG within the SFB-TR24, project A2.
[1] H. Jung *et al.*, J. Plasma Phys. **82** (2016)

P 3.6 Mo 15:40 HS 1010
Single Dust Particles in a Magnetized Plasma: Stability, Charging and Interaction — •Hendrik Jung, Franko Greiner, and Alexander Piel — Institute of Experimental and Applied Physics, Kiel University, Germany

Dust in plasmas with high magnetic fields ($B > 1.0\,\mathrm{T}$) is a major topic in dusty plasma physics. The magnetization of the plasma leads to fundamental changes of the discharge properties. The limited cross field motion of the plasma constutuents has a substantial impact not only on the plasma itself but also on the charging and interaction of dust grains. The formation of filaments – structures of higher density or temperature that propagate through the magnetized discharge – play a significant role since they impede a stable confinement of the micrometer-sized dust grains and make high-precision studies of the particle system difficult.
In this contribution we show how filaments induce instabilities and heat particles. Pulsing the rf discharge suppresses filament-induced instabilities what can be utilized to get a single particle or a specific particle system to high magnetic fields where stable parameter regimes even in the continuous wave mode can be found and reliable studies of the dust system are performed. By using the well-established phase-resolved resonance method [Jung et al., JPP 82, 615820301 (2016)] the influence of the plasma magnetization on the dust charging and wake formation is investigated.
This work was funded by DFG under contract SFB TR-24/A2.