P 17: Dusty Plasmas II

Zeit: Mittwoch 8:30–10:25 Raum: HS 2010

Hauptvortrag P 17.1 Mi 8:30 HS 2010

PK-4 - Complex Plasmas under Microgravity — •Markus Thoma — I. Physikalisches Institut, Universität Giessen

Complex plasmas are created in low-temperature and low-pressure discharges by injecting micron size particles into the plasma. By electron collection the micro-particles get highly charged, building a strongly coupled component of the plasma. Complex plasmas can be used as a model for the dynamics (e.g. phase transitions, non-equlibrium physics) of strongly interacting many-body systems.

Experiments with complex plasmas in the laboratory are often strongly disturbed by gravity, restricting the micro-particle clouds to the plasma sheath. Therefore experiments in microgravity conditions are performed in parabolic flights and on board the ISS since almost 20 years. The experiment facility PK-4 (”Plasmakristallexperiment 4”) was launched to the ISS in 2014 and used in ten parabolic flight campaigns since 2003.

After an introduction to complex plasmas the PK-4 experiment and its first results from ISS and latest parabolic flights will be discussed.

Fachvortrag P 17.2 Mi 9:00 HS 2010

Multiple Camera Diagnostics of 3D Particle Motion in Dusty Plasmas — •Michael Himpel and André Melzer — Institute of Physics, University Greifswald

Stereoscopic camera systems are a standard diagnostic tool in dusty plasmas since many years. There, a small volume of a particle-containing plasma is observed with two or more cameras under different angles. The evolving imaging hardware makes it possible to achieve continuously higher framerates and higher spatial resolutions. This leads to the possibility to observe and track dust clouds with higher particle number densities. Such stereoscopic systems have been used in laboratory experiments and on parabolic flights to study waves and vortices. In a future plasma experiment (*EKoPlasma*) onboard the ISS, a four-camera system is planned to be implemented. This would be one of the first three-dimensional dusty plasma diagnostics to be used under space conditions.

This contribution gives an insight into the capabilities of such multi-camera systems and a brief presentation of all neccessary steps ranging from calibration to triangulation. Preliminary measurements of clusters with more than 1000 particles are shown demonstrating that single-particle reconstruction in volume-filling dust-clouds is possible.

P 17.3 Mi 9:25 HS 2010

Plasma Parameter Control for Complex Plasma Experiments — •Christina A. Knapek, Peter Huber, Daniel P. Mohr, Erich Zähringer, and Hubertus M. Thomas — DLR German Aerospace Center, Research Group Complex Plasmas, Wessling, Germany

Complex plasmas are generated by injecting micrometer-sized grains into a low temperature noble gas discharge. The particles acquire high negative charges of up to several thousand elementary charges, interact with each other via a screened Coulomb potential, and can form gaseous, liquid or solid states. Since the particles are individually visible, complex plasmas provide an experimental approach for fundamental studies of strong coupling phenomena with fully resolved dynamics at the individual particle level. Electron temperature and plasma density play an important role for the charging and interaction potential of the particles. The Zyflex plasma chamber, which has been developed within the PlasmaLab/EkoPlasma project as the future laboratory for complex plasma research in microgravity on the International Space Station (ISS), offers several possibilities for manipulation of plasma parameters, either by variable rf operation modes, or by using special grid electrodes for electron temperature control. In the latter case, the region of plasma production is separated from the working volume containing the particles, and the electron temperature can be controlled by the grid parameters. Results of first experiments – performed during parabolic flights and in the laboratory – with complex plasmas in such a “controllable” plasma environment are presented.

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P 17.4 Mi 9:40 HS 2010

In situ analysis of optically thick nanoparticle clouds — •Florian Kirchschlager[1], Sebastian Groth[2], Sebastian Wolf[1], and Franko Greiner[2] — [1]Institute of Theoretical Physics and Astrophysics, Kiel, Germany — [2]Institute of Experimental and Applied Physics, Kiel, Germany

In an argon-acetylene plasma nano-particles are grown. Kinetic single-wavelength Mie ellipsometry allows one to constrain the size of these particles.

We find deviations between experimental measurements and numerical simulations based on single Mie-scattering. These deviations were previously assumed to result from multiple scattering in the plasma clouds.

We present 3D Monte-Carlo polarized radiative transfer simulations which allow us to calculate normalized Stokes vectors for dusty systems with arbitrary optical depth. With this approach it was possible for the first time to reproduce the experimental data. This technique has the potential to extend the existing diagnostic method for the in-situ analysis of the properties of nano-particles to systems where multiple scattering can not be neglected anymore.

P 17.5 Mi 9:55 HS 2010

Investigations of size dynamics of nanodust clouds by means of imaging Mie diagnostics — •Sebastian Groth, Franko Greiner, Benjamin Tadsen, and Alexander Piel — Institute of Experimental and Applied Physics, Kiel University, Germany

The long term behavior of plasma-grown nanodust clouds in an argon plasma shows various interesting phenomena once the initial growth process is stopped and the particles remain confined within the plasma discharge.

The investigation of such nanodust clouds with kinetic single-wavelength ellipsometry and extinction measurements at a fixed position show the loss of particles caused by an imperfect confinement and a decrease of the particle size via etching. In addition, a strong variation of the line-integrated dust density is observed. These measurements indicate a dynamic size sorting process due to spatially inhomogeneous etching. Here, this cannot be fully understood using diagnostics at a fixed position. To gain more detailed insight into the dynamics of the entire nanodust clouds a new diagnostic setup with a 2D-imaging rotating-compensator ellipsometer (I-RCE) using a CCD camera has been developed. In this way the spatially resolved in situ determination of all dust properties is possible.

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P 17.6 Mi 10:10 HS 2010

Characterization of Dusty Plasmas in a Magnetic Field — •Benjamin Tadsen, Franko Greiner, and Alexander Piel — Institute of Experimental and Applied Physics, Kiel University, Germany

If a dusty plasma is exposed to a magnetic field, it’s topological structure changes. As the electrons get magnetized, the plasma is confined with a cylindrical shape [1] due to the low cross-field mobility of the electrons. In such a situation a variety of instabilities like dust-density waves (DDWs) and plasma filamentation can be observed. In this contribution, an experimental setup is presented that is used to characterize the dust cloud of submicron particles in an rf plasma. The particle size is determined using Mie-scattering of polarized light and the dust particle density is calculated from extinction images of the dust cloud with an Abel inversion algorithm. The DDWs are observed at a frame rate well above the dust plasma frequency. Information about ion density and dust charge can be extracted from the data [2]. Using these diagnostics, the transition from an unmagnetized to a magnetized plasma will be examined.

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[1] B. Tadsen et al., Phys. Plasmas **21**, 103704 (2014)
[2] B. Tadsen et al., Phys. Plasmas **22**, 113701 (2015)