We plan to link an MD simulation of the Particle Kinetics and a Fluid Simulation of the Plasma to understand the process better.

Experiments reveal an Apparent Surface Tension despite a Purely Repulsive Interaction of the Microparticles

The PK-3 Plus setup makes highly resolved studies of microparticles in the plasma bulk possible

When gravity is negligible, a central void appears. The cause are the ions that stream outwards and push the particles away.

Bubbles and droplets appear in complex plasmas with thermophoresis and low radio-frequency power

The droplets are self-contained and possess many similarities to water droplets

A related phenomenon: Often, the microparticle density increases near the void boundary

Possible explanation: a reverse of the flow of ions towards the microparticle cloud from both sides Gozadonis et al., New J. Phys. 5, 32 (2003)

We plan to link an MD simulation of the Particle Kinetics and a Fluid Simulation of the Plasma to understand the process better.

The freely available MD code LAMMPS is well suited for the particle part of the simulation

The microparticles will be input as stationary charge distribution in the plasma simulation

The freely available MD code LAMMPS is well suited for the particle part of the simulation

Particles with charge of -2000e interact via a Yukawa potential in a box of $96 \times 96 \times 96 \mu m^3$ with $\lambda_0 = 100 \mu m$. They are subject to drag by the background gas (pressure 20 Pa) and to random kicks from the neutral background particles to set the temperature to 300 K. A central drag force of $10^{-6} N$ compresses the particle cloud to a sphere. The two images correspond to times $t_0 = 0$ s and $t_1 = 5$ s. The color coding indicates the kinetic energy of each particle.

We will use an ambipolar fluid model to simulate the plasma


ambipolar fluid model for the plasma solves ion continuity and electron energy balance

coupled to analytical sheath model

The microparticles will be input as stationary charge distribution in the plasma simulation

get the distribution of microparticles $n_d$ from the MD simulation

use as stationary sinks in the fluid code

influence the plasma particles via ambipolar electric field

after the plasma simulation: use particle densities $n_i$ and $n_e$, electron temperature $T_e$ and ion flux $j_i$ to calculate the microparticle charge $Q_d$ and the forces on the microparticles

Acknowledgements

M. S. is funded by the European Research Council under the European Union’s Seventh Framework Programme (FP7/2007-2013) via a Marie Curie IOF fellowship. The PK-3 Plus project is funded by the space agency of the Deutsches Zentrum für Luft- und Raumfahrt e.V. with funds from the federal ministry for economy and technology according to a resolution of the Deutscher Bundestag under grant number 50 WP 0203.

contact: mierk@berkeley.edu

Mierk Schwabe$^b$ and David Graves$^a$

$^a$Department of Chemical Engineering, University of California, Berkeley, USA $^b$Max Planck Institute for Extraterrestrial Physics, Garching, Germany

Complex plasmas allow observations of the dynamics of individual particles

The freely available MD code LAMMPS is well suited for the particle part of the simulation

The microparticles will be input as stationary charge distribution in the plasma simulation

We will use an ambipolar fluid model to simulate the plasma


ambipolar fluid model for the plasma solves ion continuity and electron energy balance

coupled to analytical sheath model

The microparticles will be input as stationary charge distribution in the plasma simulation

get the distribution of microparticles $n_d$ from the MD simulation

use as stationary sinks in the fluid code

influence the plasma particles via ambipolar electric field

after the plasma simulation: use particle densities $n_i$ and $n_e$, electron temperature $T_e$ and ion flux $j_i$ to calculate the microparticle charge $Q_d$ and the forces on the microparticles

Acknowledgements

M. S. is funded by the European Research Council under the European Union’s Seventh Framework Programme (FP7/2007-2013) via a Marie Curie IOF fellowship. The PK-3 Plus project is funded by the space agency of the Deutsches Zentrum für Luft- und Raumfahrt e.V. with funds from the federal ministry for economy and technology according to a resolution of the Deutscher Bundestag under grant number 50 WP 0203.

contact: mierk@berkeley.edu

Mierk Schwabe$^b$ and David Graves$^a$

$^a$Department of Chemical Engineering, University of California, Berkeley, USA $^b$Max Planck Institute for Extraterrestrial Physics, Garching, Germany