P 18: Theory and Modeling II

Zeit: Mittwoch 14:30–15:45 Raum: HS 2010

Hauptvortrag P 18.1 Mi 14:30 HS 2010

The structure and its role in uncovering the physics of warm dense matter — •Jan Vorberger — Institute of Radiation Physics, Helmholtz-Zentrum Dresden-Rossendorf, Dresden, Germany

Warm dense matter states in the transition region from high pressure solids to high temperature plasmas are found in terrestrial planets, giant planets, and exoplanets. Such states are created in the laboratory during interaction of lasers or shock waves with matter. The intention is usually to obtain direct experimental access to equilibrium or non-equilibrium warm dense matter states or it might be an intermediate state on the way to fusion plasmas states or laser-plasma acceleration experiments.

Studying warm dense matter, one faces several challenges. The first is the determination of a full set of basic parameter like density, charge state, temperature, or the momentum distribution function that fixes the state of matter in the phase space. Only then is it meaningful to investigate important quantities like the equation of state, phase transitions, structure, collective excitations, relaxation processes, or the stopping power.

Here, we present recent developments and results in warm dense matter physics. The close interplay between theory and experiment via x-ray scattering and first principle simulations is highlighted. The dynamic structure factor containing a wealth of information serves as the connection between measurements and calculations. Results are given for a number of elements like aluminium, carbon, or iron, and materials like plastic.

P 18.2 Mi 15:00 HS 2010

An iterative model to study the coupling between the plasma and a floating surface — •Jan Kaiser, Sebastian Wilczek, and Ralf Peter Brinkmann — Ruhr-Univesität Bochum, Lehrstuhl für Theoretische Elektrotechnik, 44780 Bochum

Measuring plasma parameters (e.g. plasma density, electron temperature) has practical importance to control the plasma process. Common tools to determine these parameters are probes, such as the multipole resonance probe (MRP) or different types of Langmuir probes (LP). All kinds of active probes represent a floating surface which leads to the generation of a plasma sheath and, therefore, to a disturbance of the plasma dynamics in the region around the probe. In this work an iterative model to determine the coupling between the MRP and the plasma is presented. The MRP is modeled as a curved boundary with a fixed potential. The electron and ion physics are treated in two coupled models which are iterated until convergence is achieved. Results for the potential, the electron and ion densities in the region of the MRP are presented.

P 18.3 Mi 15:15 HS 2010

Scaling laws for a High Efficiency Multistage Plasma Thruster — •Tim Brandt[1,3,4], Ralf Schneider[2], Julia Duras[2,6], Daniel Kahnfeld[2], Franz Georg Hey[5], Frank Jansen[1], Thomas Trottenberg[4], Holger Kersten[4], Johann Ulrich[5], and Claus Braxmaier[1,3] — [1]DLR, Institute of Space Systems, Bremen, Germany — [2]Institute of Physics, Ernst-Moritz-Arndt University Greifswald, Germany — [3]Center of Applied Space Technology and Microgravity, University of Bremen, Germany — [4]Institute of Experimental and Applied Physics, University of Kiel, Germany — [5]Airbus Defence and Space, Claude-Dornierstraße 1, Immenstaad, Germany — [6]Department of Applied Mathematics, Physics and Humanities, Nuremberg Institute of Technology, Germany

Upcoming formation flying space missions have unprecedented requirements in both low thrust and low noise-to-thrust ratio for attitude control. With the recent discovery of gravitational waves, LISA (Laser Interferometer Space Antenna) is an outstanding example for such a mission. Its requirements are thrust no more than 100 μN and root of the noise spectral density $\leq 0.1\ \mu\mathrm{N}/\sqrt{\mathrm{Hz}}$. One attempt to reach this regime is to develop a downscaled version of the High Efficiency Multistage Plasma Thruster (HEMPT). One part of this activity is to support the development by computer modeling. In order to simulate the thruster plasma, the Particle-in-Cell (PiC) method is used. We will present analytical considerations and models using the PiC method for a downscaled and an unscaled HEMPT which has been performed in order to investigate the scaling laws of this kind of plasma thruster.

P 18.4 Mi 15:30 HS 2010

3d Energy-Conserving Implicit Particle-in-Cell (PIC) Code for Simulations of Magnetized Plasmas — •Denis Eremin — Institute for Theoretical Engineering, Ruhr University Bochum, Univeristätsstrasse 150, 44801, Bochum, Germany

One of the most heavily used tools for the thin film deposition applications in plasma processing industry is magnetron discharge, operated in a broad range of different regimes, from the dc to the HiPIMS. Despite low pressure of the neutral gas characteristic of the sputtering regime in such devices, they have enhanced electron confinement and power deposition due to the magnetic field. Owing to the non-uniformities of the latter, the plasma density profile is also strongly non-uniform, exhibting very large gradient close to the cathode and relatively small gradient in the bulk plasma. Whereas the low pressure regime demands a kinetic modeling approach, standard PIC schemes often fail to adequately simulate such magnetized plasmas within reasonable computational time due to the numerical limitations on applicability of such schemes. This work proposes a novel energy-conserving implicit PIC approach with a non-uniform computational grid resolving the cathode sheath region. The new approach has fewer limitations and its ability to simulate early stages of HiPIMS discharges is demonstrated. The corresponding code is in part massively parallelized on GPU.

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