P 10: Theory and Modeling I

Zeit: Dienstag 14:00–15:45 Raum: HS 2010

Hauptvortrag P 10.1 Di 14:00 HS 2010

Filamentary plasma eruptions: results from the nonlinear ballooning model — •Sophia A. Henneberg[1], Steven C. Cowley[2,3], and Howard R. Wilson[4] — [1]Max-Planck-Institut für Plasmaphysik, Wendelsteinstr. 1, 17489 Greifswald — [2]Rudolf Peierls Centre for Theoretical Physics, University of Oxford, Oxford OX1 3NP, UK — [3]Corpus Christi College, Oxford OX1 4JF, UK — [4]York Plasma Institute, University of York, Heslington, YO10 5DD, UK

Two distinct studies are investigated exploiting the nonlinear model for ideal ballooning modes with potential applications to Edge Localized Modes (ELMs). The nonlinear model for tokamak geometries was developed by Wilson & Cowley 2004 and consists of two differential equations which characterize the temporal and spatial evolution of the plasma displacement.

In the first study, the interaction of multiple filamentary eruptions is addressed in magnetized plasma in a slab geometry. Equally sized filaments evolve independently in both the linear and nonlinear regime. However, if filaments are initiated with slightly different heights from the reference flux surface, they interact with each other in the nonlinear regime: Lower filaments are slowed down and then completely suppressed while the higher filaments grow faster due to the nonlinear interaction.

In the second study, this model of nonlinear ballooning modes is examined quantitatively against experimental observations of ELMs in MAST and JET-like geometries. The results suggest experimentally relevant results can only be obtained using modified equilibria.

P 10.2 Di 14:30 HS 2010

Influence of plasma backgrounds including neutrals on SOL filaments using 3D simulations — •David Schwörer[1,2], Nick Walkden[2], Huw Legatte[1], Fulvio Militello[2], and Miles M. Turner[1] — [1]Dublin City University, Dublin, Ireland — [2]Culham Centre for Fusion Energy, Culham, UK

Filaments are field aligned density and temperature perturbations, which can carry a significant amount of particles and heat from the last closed flux surface to the far scrape-off layer (SOL). In order to design next generation machines, understanding this non diffusive transport mechanism is beneficial to predict wall fluxes.

We have carried out non-linear, three-dimensional simulations, including neutral-plasma interactions, using the STORM module for BOUT++. The heat and particle influx is varied, generating self-consistent 1D profiles that reproduce both low and high recycling regimes. Filaments where seeded on the backgrounds, and the resulting filament motion was studied. Additional to density and temperature scans, a scan in filament size was performed. This increases the understanding of filaments and their scaling with plasma background, in the experimentally relevant regime. These filaments radial velocity showed a linear increase in mid-plane background temperature T, lying between the $T^{\frac{1}{2}}$ scaling for inertial limited and the $T^{\frac{3}{2}}$ scaling for sheath limited filaments. The suitability of the target temperature as well as the average temperature instead of the upstream temperature as scaling quantity have been studied. With the exception of low temperatures, an increased density results in a decreased radial velocity.

P 10.3 Di 14:45 HS 2010

The Uniform Electron Gas at Warm Dense Matter Conditions — •Simon Groth[1], Tobias Dornheim[1], Travis Sjostrom[2], and Michael Bonitz[1] — [1]Christian-Albrechts-Universität zu Kiel, D-24098 Kiel, Germany — [2]Los Alamos National Laboratory, Los Alamos, New Mexico 87545, USA

The availability of an accurate parametrization of the exchange correlation energy of the uniform electron gas (UEG) on the basis of ground state quantum Monte Carlo simulations has been crucial for the success of density functional theory (DFT) calculations within the local density approximation. However, it is widely agreed [1] that the description of recent experiments with inertial confinement fusion and laser-excited solids within the DFT framework requires to go beyond the ground state. While an explicitely thermodynamic DFT approach is long known, it relies on an accurate parametrization of the exchange correlation free energy of the UEG at warm dense matter conditions. Here we present our novel parametrization that is based on our ab initio simulations [2,3] and perform benchmarks against various other parametrizations.

[1] V. Karasiev et al. Phys. Rev. E 93, 063207 (2016)
[2] T. Schoof et al., Phys. Rev. Lett. 115, 130402 (2015)
[3] T. Dornheim et al. Phys. Rev. Lett. 117, 156403 (2016)

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P 10.4 Di 15:00 HS 2010

Study on the effect of impact ionization by the proton bunch on plasma density — •Gabriel Fior, Patric Muggli, and Allen Caldwell — Max-Planck-Institut für Physik, Munich, Germany

The Advanced Wakefield Experiment (AWAKE) at CERN is a proof-of-principle of plasma wakefield acceleration. The proton bunch travels through a 10m cell containing rubidium vapor, which is ionized by a laser pulse thus creating plasma. While the proton bunch travels inside the plasma self-modulation instability (SMI) occurs, and micro bunches of the order of the plasma wavelength scale (1mm) are formed. The focus of AWAKEs first phase is to investigate SMI.

Since the SMI heavily depends on the plasma density, it must be very well defined. Impact collisions between the incoming protons and rubidium atoms lead to additional electronic density via ionization. The focus of this work is to investigate and assess how large is this contribution.

Theoretical calculations, combined with Monte Carlo simulations, were carried out to characterize the collisions taking place during the experiment.

In the collisions between the protons and the rubidium, we account both for direct ionization, caused by the protons, as well as the secondary ionization, arising from secondary electrons. Therefore we can determine the electron density generated from the impact collisions and assess the impact on the SMI.

A brief explanation on the AWAKE experiment will be given, along with more details about the simulations and the results.

P 10.5 Di 15:15 HS 2010

Electrical conductivity of partially ionized noble gases — •Sebastian Rosmej, Heidi Reinholz, and Gerd Röpke — Universität Rostock, Institut für Physik, 18051 Rostock, Deutschland

The conductivity of partially ionized noble gases is considered within the Linear Response Theory in a chemical picture. The different scattering mechanisms (electron-ion, electron-electron and electron-atom) contribute to the electrical resistivity. Correlation functions are evaluated including strong collisions via the T matrix approximation for different densities and temperatures. Especially the influence of electron-electron and electron-atom collisions is presented. The interaction between free electrons and atoms for isolated systems is modeled by an optical potential, screening effects caused by the plasma environment are included. The low-density Spitzer limit as well as the Ziman limit for high degeneracy are reproduced. Further analytical limits are given. Our theoretical results are compared with MD simulations and experiments.

P 10.6 Di 15:30 HS 2010

Theoretical investigation of power balance of a miniature microwave ICP-plasmajet — •Michael Klute[1], Horia-Eugen Porteanu[2], Wolfgang Heinrich[2], Peter Awakowicz[3], and Ralf Peter Brinkmann[1] — [1]Institute of Theoretical Electrical Engineering, Ruhr University Bochum, Germany — [2]Microwave Department, Ferdinand-Braun-Institut Berlin, Germany — [3]Electrical Engineering and Plasma Technology, Ruhr University Bochum, Germany

Microwave-driven plasmas-jets offer attractive properties for various technical applications. They are usually operated in a capacitive mode. However experimental experience show a number of disadvantages for capacitive energy-coupling. Therefore in large scale plasmas inductive energy-coupling is preferable. Recently Porteanu et al.[1] proposed a small scale plasma-jet operated as an inductive discharge. The key characteristic of the suggested plasma-jet is the implementation of an LC-resonance-circuit into a cavity resonator. In this work the proposed plasma-jet is examined theoretically. A global model for the electromagnetic fields and energy balance is presented. Consequent mathematical analysis of the electromagnetic fields leads to a description based on a sum of different modes. It is found that the modes of zero

and first order can be identified with inductive and capacitive coupling. In a second step the matching network and its frequency depended characteristic are taken into account. Finally an investigation of stable working points and possible hysteresis effects is done. [1]H. E. Porteanu et al. Plasma Sources Sci.Technol.22, 035016(2013)