P 15: Theorie/Modellierung I

Zeit: Mittwoch 14:00–15:55 Raum: HS C

Hauptvortrag P 15.1 Mi 14:00 HS C

Multiscale effects in plasma microturbulence - from electron gyroradius to system size scales — •Tobias Görler — Max-Planck-Institut für Plasmaphysik, EURATOM-Association, D-85478 Garching

One of the remaining key physics problems on the way to efficient fusion power plants based on toroidal magnetic confinement is the thorough understanding and reliable prediction of the so-called anomalous transport across the magnetic surfaces. It is by now commonly attributed to plasma microturbulence being generated by various types of microinstabilities. The latter extract free energy from the inevitable background temperature and density inhomogeneities. Both numerical and experimental investigations have demonstrated that the range of involved space scales may extend from the electron gyroradius all the way to the machine size. Correspondingly, the time scales of interest are determined by the fast electron dynamics on the one hand and the comparatively slow energy confinement time on the other. In this contribution, various state-of-the-art theory approaches to a comprehensive treatment of such challenging multiscale problems are presented. In this context, examples of successful applications of massively parallelized numerical implementations of the gyrokinetic theory framework are shown and comparisons to experiments are given.

Fachvortrag P 15.2 Mi 14:30 HS C

Poincaré analysis of wave motion in ultra-relativistic electron-ion plasmas — •Götz Lehmann and Karl-Heinz Spatschek — Institut für Theoretische Physik I, Heinrich-Heine Universität, Düsseldorf

Based on a relativistic Maxwell-fluid description, the existence of ultra-relativistic laser-induced periodic waves in an electron-ion plasma is investigated. Within a one-dimensional (1D) propagation geometry nonlinear coupling of the electromagnetic and electrostatic components occurs which makes the fourth-order problem non-integrable. A Hamiltonian description is derived and the manifolds of periodic solutions are studied by Poincaré section plots. The influence of ion-motion is investigated in different intensity regimes. For ultra-relativistic laser intensities the phase-space structures change significantly compared to the weakly-relativistic case. Ion motion becomes very important such that finally electron-ion plasmas in the far-ultra-relativistic regime behave similar to electron-positron plasmas. The characteristic new types of periodic solutions of the system are identified and discussed.

P 15.3 Mi 14:55 HS C

Spectrum and Radial Decay of Runaway Electrons in a Disruption at TEXTOR — •Michael Forster[1], Karl Heinz Finken[1,2], Michael Lehnen[2], Jochen Linke[3], Bernd Schweer[2], Corinna Thomser[3], Oswald Willi[1], and Yuhong Xu[4] — [1]Institut für Laser- und Plasmaphysik, Heinrich-Heine-Universität Düsseldorf, Düsseldorf, Germany — [2]Institute of Energy and Climate Research - IEK-4, Forschungszentrum Jülich GmbH, Association EURATOM-FZJ, Jülich, Germany — [3]Institute of Energy and Climate Research, IEK-2, Forschungszentrum Jülich GmbH, Association EURATOM-FZJ, Jülich, Germany — [4]Laboratory for Plasma Physics, Ecole Royale Militaire - Koninklijke Militaire School, Brussels, Belgium

A heat load experiment was carried out with a new kind of probe for the detection of the damage caused by runaway electrons. The probe was inserted into the plasma edge of the tokamak TEXTOR during an induced disruption. The damages caused by the disruption generated runaway electrons in the probe material are evaluated by metallographical and thermogravimetrical methods. In comparison with 3D Geant4 code based Monte Carlo simulations of the runaways information about the energy spectrum and the radial decay of the runaway beam behind a limiter are deduced. The results are in good agreement with an exponential energy spectrum (e-folding energy 3-9 MeV) and corresponding exponential or linear radial decay. Reasonable parameter ranges for the distributions are given. Additional simulations show that the measurement gives the strongest results for the spectral part of the runaways with energies between 8 MeV and 16 MeV.

P 15.4 Mi 15:10 HS C

Modification of local plasma parameters by impurity injection — •Mikhail Koltunov and Mikhail Z. Tokar — Institute of Energy and Climate Research – Plasma Physics, Forschungszentrum Jülich GmbH, Association EURATOM-FZJ, Partner in the Trilateral Euregio Cluster, Jülich, Germany

Injection of impurities into the plasma of fusion devices may significantly change the global plasma behavior, e.g., through the radiation from the plasma core and modification of transport properties. However, even at puffing rates significantly lower than those being of importance for global plasma characteristics, noticeable changes can happen locally, close to the injection position. This in turn affects the impurity penetration process itself.

In this contribution we propose a model describing plasma behavior in the vicinity of strong sources of impurities. The model is based on a fluid description of electrons, main and impurity ions and takes into account the plasma quasi-neutrality, Coulomb collisions of background and impurity charged particles, radiation losses and sinks of particles to bounding material surfaces. Particle, momentum and energy balances are deduced by integrating transport equations within the clouds of neutral and singly charged impurities, both inside and beyond the scrape-off layer of the puffing limiter.

Computations are done for the conditions of impurity seeding experiments in the tokamak TEXTOR. The model allows to simulate two-dimensional images of radiation losses which can be directly compared with experimental observations.

P 15.5 Mi 15:25 HS C

Bestimmung der Elektronentemperatur an ASDEX Upgrade mittels Vorwärtsmodellierung der ECE Strahlung — •Sylvia K. Rathgeber, Rainer Fischer, Wolfgang Suttrop und das ASDEX Upgrade Team — Max-Planck-Institut für Plasmaphysik, EURATOM Association, Boltzmannstrasse 2, D-85748 Garching

In gegenwärtigen Auswertungen der ECE (electron cyclotron emission) Strahlung wird die Elektronentemperatur mit der Strahlungstemperatur an den Orten der kalten Resonanz entsprechender Messfrequenzen gleichgesetzt. Die zugrundeliegenden Annahmen von lokaler Emission und Strahlung auf Schwarzkörperniveau, die diese Methode rechtfertigen, sind für optisch dickes Plasma begründet. Im optisch dünnen Bereich des Plasmarands verlieren sie jedoch ihre Gültigkeit. Dies kann den sogenannten Shine-through Effekt verursachen, bei dem Frequenzmessungen mit kalter Resonanz ausserhalb der Separatrix Beiträge von Strahlung aus weiter innenliegenden Regionen erhalten.

Nachdem eine genaue Kenntnis der Elektronentemperatur in diesem Bereich von besonderem Interesse ist um Randphänomene untersuchen zu können, wird die Auswertung der ECE Daten auf alle optischen Tiefern erweitert.

Dafür müssen die durch Doppler- und relativistischen Effekte verbreiterten Emissions- und Absorptionsprofile betrachtet und die Strahlungtransportgleichung entlang der Sichtlinie gelöst werden. Die hierfür erforderliche Vorwärtsmodellierung wird im Rahmen der Bayesschen Wahrscheinlichkeitstheorie durchgeführt.

P 15.6 Mi 15:40 HS C

PIConGPU - A scalable GPGPU implementation of the particle-in-cell algorithm — •Heiko Burau[1], Florian Berninger[1], Alexander Debus[1], Thomas Kluge[1], Axel Jochmann[1], Arie Irman[1], Ulrich Schramm[1], Thomas E. Cowan[1], René Widera[2], Felix Schmitt[2], Wolfgang Hönig[2], Guido Juckeland[2], Wolfgang Nagel[2], Patrick Kilian[3], Urs Ganse[3], Stefan Siegel[3], Felix Spanier[3], Benjamin Ragan-Kelley[4], John Verboncoeur[4], and Michael Bussmann[1] — [1]HZDR, Dresden, Germany — [2]ZIH, Dresden, Germany — [3]University of Würzburg, Germany — [4]UC Berkeley, CA, USA

We present PIConGPU, an efficient and scalable implementation of the particle-in-cell algorithm for GPGPUs. We discuss the main building blocks of PIConGPU, the data access patterns used for both particle and field data and the communication model that allows to hide the large latency of network communication between GPGPU nodes on a cluster. PIConGPU provides a general framework which can be used to study both relativistic and nonrelativistic plasmas. We show first results on relativistic laser wakefield acceleration of electrons in underdense plasmas and on the progress of integrating new physics models. The fast response time of the code makes it possible to receive results in hours compared to weeks with particle-in-cell codes running on mid-size commodity clusters. With this increase in computational speed extensive parameter scans become possible even for large physical systems.