P 19: Codes and Modelling - Poster

Time: Wednesday 16:15–18:15 Location: Zelt Ost

P 19.1 Wed 16:15 Zelt Ost

Progress of the research data management platform InPT-Dat — •Markus M. Becker, Ionut L. Paulet, Steffen Franke, and Detlef Loffhagen — INP Greifswald, Felix-Hausdorff-Str. 2, 17489 Greifswald

The interdisciplinary nature of current research in the field of plasma technology gives rise to the question of how research results in the different fields of science (physics, chemistry, biology, medicine and very recently agriculture) can be effectively linked together and made accessible and reusable for scientists and industry in the different fields. The project InPT-Dat (Interdisziplinäre Plasmatechnologie-Datenplattform) aims to tackle this question. The goal of this project is to establish a web-based research data management platform for the collection and provision of research data from all fields of low-temperature plasma science and to sensitize researchers for a handling of research data according to the FAIR (Findable, Accessible, Interoperable, Reusable) principles. In the present contribution the progress of the project will be reported and the current concept will be discussed to collect impressions and suggestions from the plasma physics community.

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P 19.2 Wed 16:15 Zelt Ost

Towards a nested neutral–ion kinetic transport model in the plasma boundary — •Friedrich Schluck, Michael Rack, and Detlev Reiter — Forschungszentrum Jülich GmbH, Institut für Energie- und Klimaforschung – Plasmaphysik, Partner of the Trilateral Euregio Cluster (TEC), 52425 Jülich, Germany

The kinetic Monte Carlo plasma edge code EIRENE is well established for mainly three reasons: (1) broad databases of atomic, molecular, and reactive processes, (2) applicability to real geometries, and (3) integration in frequently used code packages, e.g. SOLPS and EMC3-EIRENE. Ions are typically modelled in fluid description and, thus, handled by different codes, as they are assumed to be in local equilibrium. However, simple collisionality arguments, as well as previous code results have indicated that this approach might be insufficient. They emphasized the importance of kinetic treatment in particular of short-living minority ions.

Until recently, only a strongly reduced handling of ions was implemented in EIRENE, i.e. energy relaxation along magnetic field lines, before other reactive loss mechanisms take place. The goal of our extended kinetic ion transport description within EIRENE is to fully implement all guiding center drifts, pitch-angle scattering, radial diffusion, and equilibration checks for ion ensembles. We present the current status of aforementioned upgrades for EIRENE. Moreover, we embed first simulation results in topical context as we discuss implications in transport for today's fusion devices like Wendelstein 7-X.

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Simulation of inductive rf coupling in low pressure low temperature hydrogen plasmas — •Dominikus Zielke[1], Stefan Briefi[1,2], David Rauner[1,2], and Ursel Fantz[1,2] — [1]AG Experimentelle Plasmaphysik, Universität Augsburg, 86135 Augsburg — [2]Max-Planck-Institut für Plasmaphysik, Boltzmannstr. 2, 85748 Garching

Inductively coupled hydrogen plasmas are applied in many diverse fields, among them are materials processing and ion sources for accelerators or neutral beam heating systems for fusion. In general, it is desirable to maximize the power transfer efficiency η, i.e. the ratio of power absorbed by the plasma to the power delivered by an rf generator. Many quantities such as plasma and antenna geometry, delivered rf power, rf frequency and gas pressure influence η. In order to understand these influences quantitatively, a numerical model has been set up which simulates the inductive coupling between the antenna and the plasma self-consistently. The low pressure low temperature plasma is described using a stationary multi-fluid approach, i.e. continuity equations are used for the neutral and charged species. The electromagnetic part, which is described by Maxwell's equations in the frequency domain, is coupled to the fluid part by means of the electron energy balance. The highly nonlinear model is implemented using the finite element method and the solver of the COMSOL Multiphysics Software package. The contribution covers the model verification as well as the validation against experimentally obtained results from a cylindrical ICP.

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Estimation, Validation and Uncertainty of the Position of the Separatrix Contour at ASDEX Upgrade — •Johannes Illerhaus[1,2], Rainer Fischer[1], Gregor Birkenmeier[1,2], Mike Dunne[1], Louis Giannone[1], Bernd Kurzan[1], Patrick McCarthy[1], Matthias Willensdorfer[1], Ulrich Stroth[1,2], and the ASDEX Upgrade Team[1] — [1]Max Planck Institute for Plasma Physics, Garching, Germany — [2]Physics Department E28, TUM, Garching, Germany

To properly describe magnetic equilibria of tokamak plasmas in fusion research it is important to be able to accurately reconstruct the posi- tion of the last closed flux surface, the separatrix. Measurements of the currents of the scrape-off-layer onto the divertor plates, in the poloidal field coils and those induced in vessel components are used to apply constraints to this reconstruction. The influence of the uncertainties in these quantities on the separatrix reconstruction will be studied. In this contribution the goal is to illustrate the uncertainty and sensitivity of the reconstructed separatrix position and their respective dependence on the allowed flexibilities in the prescribed coil currents. Different ki- netic diagnostics (Thomson scattering,electron cyclotron emission and lithium beam) are used to validate the reconstructed separatrix po- sition. Additionally, different poloidal field coil arrays can be used to better understand their influence on the equilibrium reconstruction. The result will be an uncertainty quantification of the separatrix con- tour and a study of the systematic deviations of the diagnostics among themselves and with respect to the equilibrium, respectively.

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Modelling,simulation of a 4-mirror imaging antenna for plasma diagnostics — •Peshawa Husain — Institut fur grenzflachenversahrenstechnik und plasmatechnologie

for the spatially resolved measurement of radiation from a collective thomson scattering experiment, an imaging antenna based on a 4-mirror arrangement is used, this antenna is to be modeled with a physical optics code (fortran), which needs to be revived. The results shall be cross-checked with the finite difference code ipf-fd3d.

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PIC-Molekulardynamik-Hybrid-Code für Mikroplasmen — •Viktoria Pauw, Hartmut Ruhl und Christian Herzing — LMU München, Deutschland

Die Simulation von Plasmen ist aufgrund der komplexen elektromagnetischen Wechselwirkung und der hohen Anzahl der Teilchen eine anspruchsvolle Aufgabe. Der von uns entwickelte Plasma-Simulation-Code (PSC) kann sowohl auf Particle-In-Cell-Basis (PIC) betrieben werden, als auch molekulardynamisch, wobei die direkte Teilchen-Teilchen-Interaktion relativistisch durch Berechnung retardierter Lienard-Wiechart-Felder modelliert wird. Die Particle-In-Cell-Methode versagt für stark korellierte Systeme, da nur kollektive Plasmabewegungen dargestellt werden können. Die volle Molekulardynamik ist jedoch für Systeme mit mehr als einigen Tausend Teilchen aufgrund des quadratischen Scalings zu kostenintensiv. Wir arbeiten daher zur Zeit an einem Verfahren für eine hybride Modellierug von Plasmen. Die Unterschiede der Ansätze, die korrekte Darstellung physikalischer Prozesse und der Rechenaufwand, sowie die Möglichkeiten und das Scaling des hybriden Ansatzes werden von uns untersucht und sollen in einem Poster vorgestellt werden. Als Test-Case verwenden wir u.A. expandierende Mikroplasmen im Vakuum, mit und ohne Interaktion mit externen Laserpulsen. Anschluss an das Experiment bietet eine Kooperation zum Thema laser-getriebenen Mikroplasmen mit der Gruppe um Jörg Schreiber (LMU, Lehrstuhl für Medizin-Physik), deren Experimente bereits erfolgreich mit unserem Code modelliert wurden.

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Kinetic Model of the Planar Multipole Resonance Probe — •Michael Friedrichs and Jens Oberrath — PPI, Leuphana University Lüneburg, Germany

Measuring plasma parameters, e.g. electron density and electron temperature, is an important procedure to verify the stability and behavior of a plasma process. The planar Multipole Resonance Probe (pMRP) offers this ability and is a suitable diagnostic tool to monitor plasma processes in industrial applications. The analysis of the fluid-model of the pMRP led to a formula for the resonance frequency, which can be used to determine the electron density. To widen its field of application in terms of measuring the electron temperature additionally to the electron density another relation between the electron temperature and second resonance parameter is needed. Such a parameter is given by the half width of the resonance peak, which represents the damping of the system. In low pressure plasmas the half width depends not only on collisional damping, but also on collisionless damping. To investigate the influence of collisionless damping on the half width and to determine a relation between the half width and the electron temperature a kinetic model is required. Such a model of the pMRP, based on functional analytic methods, will be presented in this work and the result of the explicit expansion of the admittance will be shown.

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Higher order MHD numerics — Prabal Singh Verma[1], •Jean-Mathieu Teissier[2,3], Oliver Henze[2], and Wolf-Christian Müller[2,4] — [1]Aix-Marseille Université, Laboratoire de Physique des Interactions Ioniques et Moléculaires — [2]Technische Universität Berlin, Zentrum für Astronomie und Astrophysik — [3]Berlin International Graduate School in Model and Simulation based Research — [4]Max-Planck/Princeton Center for Plasma Physics, Princeton, NJ, USA

We present a simple fourth-order accurate finite volume scheme for solving compressible astrophysical ideal magnetohydrodynamics (MHD) problems using Cartesian meshes. Evolution of the magnetic field is realized by the constrained transport approach. Reconstruction and flux computation are performed in a dimension-by-dimension fashion to achieve better computational efficiency. Validation was performed through a variety of standard test cases.

Several reconstruction methods are employed, including Central Weighted Essentially Non Oscillatory reconstruction. In order to enhance robustness at higher Mach numbers, the reconstruction method is selected depending on the local gradient of the solution. Higher order is achieved in the dimension-by-dimension approach using a face-to-point value transformation based on a Taylor expansion. The system can be driven by external stochastical forcing such as an Ornstein-Uhlenbeck process. Lagrangian aspects can be studied by a parallelized tracking of passively advected tracer particles.

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Ion Energy Distribution Functions in Capacitively Coupled Argon-Xenon Plasmas — •Maximlian Klich[1], Sebastian Wilczek[1], Jan Trieschmann[1], Thomas Mussenbrock[2], and Ralf Peter Brinkmann[1] — [1]Ruhr University Bochum, Bochum, Germany — [2]BTU Cottbus - Senftenberg, Cottbus, Germany

While accurate control of the ion energy is a crucial requirement of industrial plasma processes, its intrinsics are still not fully understood. Specifically, plasmas used for etching or thin film deposition consist of various gas and ion species. Thus, the control of the ion dynamics of multiple gas and ion species is a topic of current research. In order to contribute to this topic, we investigate low-pressure argon-xenon discharges via Particle-In-Cell/Monte Carlo Collision (PIC/MCC) simulations. The main advantage of this noble gas mixture is the simple chemistry, which leads to a feasible number of ion species and collision processes to be considered. The ion energy distribution functions (IEDFs) at the electrodes of a geometrically symmetric capacitively coupled radio-frequency discharge provide information about the ion dynamics within the discharge volume. Several variations of the discharge parameters (e.g., pressure, driving voltage and gas composition) are presented in order to influence the ion dynamics. Furthermore, a power balance model is used, which allows for a better understanding of the obtained results. The final goal of this study is to achieve deeper insights about complex (e.g., bimodal) IEDFs of different ion species.