P 6: Codes and Modelling

Time: Monday 16:15–17:45 Location: KI 1.174

Invited Talk P 6.1 Mon 16:15 KI 1.174

Collisionless damping in the spectra of active plasma resonance spectroscopic probes — •Jens Oberrath — Institute of Product and Process Innovation, Leuphana University Lüneburg, Germany

Different designs of probes, which are based on the concept of active plasma resonance spectroscopy, were invented since the early sixties of last century. Within the last decade improved designs gained new interest as possible devices for industrial plasma diagnostics. Therefore, a mathematical model to determine simple relations between plasma and resonance parameters is needed. A suitable choice to derive a simple model is based on a fluid description of the plasma. However, in low pressure plasmas a fluid model can only predict the resonance frequency, which is related to the electron density. To measure also the electron temperature simultaneously in one measurement, a relation to a second resonance parameter is needed. Such a parameter is given by the half width of the peak, which is related to the damping of the system. In low pressure plasmas not only collisional damping takes place, but also collisionless, which has to be determined kinetically. Within this work, spectra of different probe designs are compared, some are determined by a fluid and others by a kinetic model. It will be shown, that a broadening of the resonance is caused by kinetic effects. Furthermore, good agreement of the spectra can be reached, if the collisionless damping is added to the collisional damping in the fluid calculations. The author acknowledges the financial support by internal funding of Leuphana University and the German Research Foundation (DFG) via the project OB 469/1-1.

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Impedance modeling for DF-plasmas where one of the frequencies is well below the ion plasma frequency — •Jan Kuhfeld[1], Yukinori Sakiyama[2], and Uwe Czarnetzki[1] — [1]Institute for Plasma and Atomic Physics, Ruhr-University Bochum, Germany — [2]Lam Research Corporation, 11361 SW Leveton Dr, Bldg. C, Tualatin OR 97062, USA

For industrial applications, e.g. plasma enhanced chemical vapor deposition (PECVD), dual frequency (DF) plasmas are used to gain a better control over important plasma parameters. In contrast to traditional DF discharges where both frequencies are in the MHz range, here the lower frequency is 400 kHz and well below the ion plasma frequency. This means that the ion sheath dynamics play an important role and cannot be neglected. Additionally PECVD reactors are operated at pressures of a few hundred Pa, so that secondary electrons have to be considered as well. Measurements for this case show a typical capacitively dominated impedance for the high frequency voltage (13.56 MHz) while the behavior of the low frequency current is of a resistive nature. Here, this phenomenon is investigated with a fluid simulation and a simple analytical model is developed for a better understanding of the underlying physics.

P 6.3 Mon 17:00 KI 1.174

Towards a tight coupling of fluid model calculations with a multiterm electron Boltzmann solver — •C. M. Hinz[1,2], M. M. Becker[2], D. Loffhagen[2], and M. Bonitz[1] — [1]ITAP, Christian-Albrechts-Universität zu Kiel, Leibnizstr. 15, 24098 Kiel — [2]INP Greifswald, Felix-Hausdorff-Str. 2, 17489 Greifswald

Nonthermal plasmas are frequently described by fluid models using tabulated electron transport and rate coefficients as input. These tables are generated prior to the fluid calculations by solving the steady-state electron Boltzmann equation for given electric field strength, species densities, and atomic data. The present contribution reports on the attempt to enable a tight coupling of a time-dependent, spatially one-dimensional fluid model with an electron Boltzmann solver, which is based on a multiterm expansion of the velocity distribution function in Legendre polynomials. This coupling is realized by concurrently solving the electron kinetic equation for each occurring set of electrical field strength and particle densities determined by the fluid model. To enable this hybrid modelling approach and overcome the significant increase in computational costs, the parallelization framework Qubus (https://qubusproject.org) is used to solve the electron kinetic equation on highly parallel hardware without sacrificing the opportunity to easily adapt the hybrid code to new requirements. The presented results demonstrate the abilities of the hybrid method by the example of an abnormal glow discharge in argon at 1 Torr. Using these first results as a baseline, the advantages and shortcomings of the new approach are discussed.

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Yacora on the Web: providing collisional radiative models for plasma spectroscopists — •Dirk Wünderlich[1], Maurizio Giacomin[1], Raphael Ritz[2], and Ursel Fantz[1] — [1]Max- Planck-Institut für Plasmaphysik, 85748 Garching, Germany — [2]Max Planck Computing and Data Facility, 85748 Garching, Germany

Collisional radiative (CR) models are essential tools for interpreting population densities measured in low temperature plasmas, for example by optical emission spectroscopy.

The flexible solver Yacora was used in the last years for developing and extensively benchmarking a multitude of CR models for different atomic and molecular species. These models then have been applied for plasma diagnostics at plasma experiments worldwide. The steadily increasing interest triggered the development of Yacora on the Web (`www.yacora.de`), a web application making available some of the Yacora CR models to the broad public, namely the models for atomic and molecular hydrogen and for helium. The model for H includes excitation channels involving other particle species like electron-ion recombination of H^+ and H_2^+ and mutual recombination of positive with negative hydrogen ions. The model for H_2 includes all electronically excited states up to the principal quantum number p=3.

The presentation introduces Yacora on the Web and the features and properties of the available models. Examples for the application for plasma diagnostics are given and future extensions of Yacora on the Web are discussed.

P 6.5 Mon 17:30 KI 1.174

Protection of the First Wall of Wendelstein 7-X with Artificial Neural Networks — •Daniel Böckenhoff[1], Marko Blatzheim[1,2], Hauke Hölbe[1], Roger Labahn[2], and Thomas Sunn Pedersen[1] — [1]Max-Planck-Institut für Plasmaphysik, Wendelsteinstraße 1, 17491 Greifswald — [2]Institut fur Mathematik, Universitat Rostock, Ulmenstraße 69, 18057 Rostock

One of the main objectives of the nuclear fusion experiment Wendelstein 7-X is to demonstrate steady state capability of the stellarator confinement concept. To ensure the safety of the first wall and protect the plasma from impurities, heat load pattern control is essential for long term operation.

It is demonstrated that artificial neural networks can be used to accurately and efficiently predict details of the magnetic topology at the plasma edge of Wendelstein 7-X, based on simulated as well as measured heat load patterns onto plasma-facing components observed with infrared cameras. The use of a neural network makes it feasible to analyze and control the plasma exhaust in real-time, an important goal for Wendelstein 7-X, and for magnetic confinement fusion research in general.