P 20: Plasma-Wand-Wechselwirkung

Zeit: Donnerstag 14:35–16:00 Raum: 6C

Fachvortrag P 20.1 Do 14:35 6C

Neutral particle transport effects in large 2D divertor plasmas — •Vladislav Kotov[1], Detlev Reiter[1], Andrey Kukushkin[2], Petra Börner[1], and Sven Wiesen[1] — [1]Institut für Plasmaphysik, Forschungszentrum Jülich GmbH, EURATOM-Association, Trilateral Euregio Cluster, D-52425, Julich, Germany — [2]ITER International Team, Cadarache, France

Predicting the heat load on the plasma-facing components and the impurity content in the edge plasma is of crucial importance for the design of a tokamak fusion reactor. The conditions at the plasma edge and, especially, in the most severely loaded divertor region are largely determined by the interaction between the plasma and the neutral particles produced by recombination and sputtering. An integrated code which combines the multi-species 2D fluid plasma transport code B2 and the 3D Monte-Carlo neutral gas and radiation transport code EIRENE is currently used to guide the design of the ITER divertor. This code package is now updated with an improved model for low temperature hydrogen molecular kinetics. It is also extended to take into account intrinsically non-linear effects: neutral-neutral collisions and line radiation opacity in a self consistent way. The influence of these new features on the self consistent gas-radiation-plasma solution is studied for the large tokamaks ITER and JET. It is found in both cases that the refined description of molecular kinetics has a strong effect on the predicted plasma parameters in front of the divertor targets and on the divertor heat loads. The impact of the non-linear effects can be also significant for the ITER conditions (and larger machines, e.g. DEMO).

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A 3D TRACE ION MODULE FOR FUSION EDGE PLASMA MONTE CARLO CODES — •Josef Seebacher[1], Detlev Reiter[2], and Petra Börner[2] — [1]Association EURATOM-ÖAW,Institute for Theoretical Physics, University of Innsbruck, A-6020 Innsbruck, Austria — [2]Institute for Plasmaphysics, Forschungszentrum Jülich, Association EURATOM, D-52425 Jülich, Germany

3D modelling of kinetic transport effects of impurity ions is important for quantifying various elementary physical processes in the scrape off layer (SOL) of magnetic fusion devices. For this purpose a trace ion module (TIM) has been developed and incorporated into the Monte Carlo transport code EIRENE. The TIM consists of a trajectory integrator tracing the motion of a guiding centre particle in general 3D electric and magnetic fields, and a stochastic form of the Fokker-Planck operator treating Coulomb collisions with the plasma background species. The TIM enables the integrated SOL simulation packages B2-EIRENE and EMC3-EIRENE to treat the physical and chemical processes near the divertor targets and in the bulk of the SOL in greater detail than before. Of special interest is the formation and transport of hydrocarbon molecules and ions in the divertor in tokamaks, where the tritium codeposition via hydrocarbons remains a serious issue for next generation fusion devices like ITER. Code verification studies as well as real tokamak modelling scenarios will be discussed with the code packages B2-EIRENE (2D) and EMC3-EIRENE (3D). Applications to hydrocarbon transport studies in TEXTOR and ITER will be presented.

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Model extensions of the 3D edge plasma fluid Monte Carlo code EMC3 — •Derek Harting[1], Detlev Reiter[1], Heinke Frerichs[1], and Yühe Feng[2] — [1]Institut für Plasmaphysik, Forschungszentrum Jülich GmbH, EURATUM Association, Trilateral Euregio Cluster, D-52425 Jülich, Germany — [2]Max-Plank-Institut für Plasmaphysik, EURATOM Association, 17491 Greifswald, Germany

The 3D edge plasma code EMC3/EIRENE has already been used to simulate the edge plasma of various different magnetic fusion devices (W7AS, W7X, LHD, ITER) and it is currently validated in particular with TEXTOR-DED experimental data. In order to make connection to the physical model of well established 2D edge plasma codes (such as B2-EIRENE) some extensions to the EMC3 code are developed. The energy balance equation is further completed and kinetic corrections ("flux limiter") to the fluid model which are also standard in 2D fluid plasma edge codes are implemented. Especially the term $\vec{\nabla}\cdot(\frac{1}{2}mnV^2\vec{V})$ in the energy balances, which was originally neglected, showed a strong influence on Ti in front of the target. For TEXTOR this term leads to a localized adiabatic cooling of the ions by about 25% (10eV), as the flow is accelerated towards the target. Te is effected only weakly by this term. Due to the more than ten times faster conductive parallel heat transport of the electrons, the cooling of the electrons by acceleration of flow towards the target extends nearly over the entire edge plasma and Te is reduced by about 3-4 eV. The various extensions to the EMC3 code will be described, and their effects on the predicted edge plasma conditions of the tokamak TEXTOR will be discussed.

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Numerical investigation of impurity transport in the ergodized edge plasma at TEXTOR-DED — •Heinke Frerichs[1], Derek Harting[1], Detlev Reiter[1], and Yühe Feng[2] — [1]Institut für Plasmaphysik, Forschungszentrum Jülich GmbH, EURATOM Association, Trilateral Euregio Cluster, D-52425 Jülich — [2]Max-Planck-Institut für Plasmaphysik, D-17491 Greifswald

Recent numerical studies of impurity transport in the ergodized edge plasma for the tokamak TEXTOR-DED are discussed. The dynamic ergodic divertor (DED) at TEXTOR induces a complex 3D magnetic field structure at the plasma boundary, which brakes symmetry between neutral and charged particle transport and, hence, leads to an intrinsically 3D transport problem. Calculations for TEXTOR-DED are performed with the 3D Monte Carlo code package EMC3/EIRENE. The effect of the DED on impurity production and transport is investigated and sensitive model parameters are identified. In particular the frequently neglected finite population of electronically excited states of impurity ions ("corona approximation") within the transport code instead of a more sophisticated collisional-radiative model leads to a significant overestimation of the radiated power for TEXTOR conditions. A pronounced reduction of the carbon density at the inner simulation boundary (inside the last closed flux surface) after turning on the DED magnetic perturbation field is robustly predicted, despite an enhanced sputtered flux. However, experimentally this strong screening effect has not yet been identified.

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Rovibrationally excited H_2 production in expanding thermal plasmas — •Onno Gabriel[1], Peter Vankan[2], Daan Schram[1], and Richard Engeln[1] — [1]Department of Applied Physics, Plasma & Materials Processing, Technische Universiteit Eindhoven, Postbus 513, 5600 MB Eindhoven, The Netherlands — [2]present address: Philips Lighting, Central Development Lighting, P.O.Box 80020, 5600 JM Eindhoven, The Netherlands

Plasma surface interactions are recognized to play a dominant role in the chemical kinetics of plasmas. Ions and radicals from the plasma gas phase recombine at surfaces producing new molecules. For example rovibrationally excited H_2 molecules (H_2^{rv}) can be formed at surfaces under circumstances, where a volume production mechanism is much less efficient. The extra energy content of these excited molecules enhances several plasma chemical processes, like the H^- formation in dissociative attachment reactions, and is hence important for the understanding of processes in this kind of plasmas. We investigate an expanding thermal hydrogen plasma by means of VUV LIF spectroscopy and measure the rovibrational energy levels in the electronic ground state of H_2. The exact mechanism of the production of rovibrational excited molecules is still not clarified yet. Therefore, we measure the distribution of H_2^{rv} after the collision of the plasma jet with different surface materials. We want to show that H_2^{rv} is a product of surface association processes, and that its energy distribution reveals information on the surface process itself.