P 22: Helmholtz Graduate School for Plasma Physics II

Zeit: Mittwoch 16:30–18:25 Raum: HZO 50

Fachvortrag P 22.1 Mi 16:30 HZO 50

Confinement and stability of plasmas with externally driven steady-state elevated q-profiles — •Alexander Bock, Jörg Stober, Rainer Fischer, Emiliano Fable, Matthias Reich, and ASDEX Upgrade Team — Max-Planck-Institut für Plasmaphysik, Garching bei München, Deutschland

The helicity profile of the magnetic field lines is an important quantity for the operation of Tokamak fusion devices and can be expressed as the so-called safety factor q. It has profound influence on both the stability of the fusion plasma, as well as its confinement properties.

Operation scenarios with centrally elevated and flat, or even reversed q-profiles promise fewer central instabilities and better core confinement and are thus considered potentially attractive for future fusion power plants. To verify these predictions, centrally elevated q-profiles are created using external counter current drive, with additional heating power added afterwards to explore the stability limits and transport properties of the resulting plasmas. The tailored q-profiles are calculated using magnetic equilibrium reconstruction constrained by internal motional Stark effect data to confirm to the presence of the desired helicities. They are then used as a basis for simulations of the transport properties with the gyro-Landau-fluid code TGLF. The simulation results are then compared to the experimentally measured kinetic profiles.

Fachvortrag P 22.2 Mi 16:55 HZO 50

Study of the edge radial electric field during the L-H transition — •Marco Cavedon[1,2], Thomas Puetterich[1], Eleonora Viezzer[1], Gregor Birkenmeier[1,2], Tim Happel[1], Francois Ryter[1], Ulrich Stroth[1,2], and the ASDEX Upgrade Team[1] — [1]Max-Planck-Institut für Plasmaphysik, Boltzmannstr. 2, D-85748 Garching — [2]Physik-Department E28, TUM, D-85748 Garching

The access to the high confinement mode in fusion plasmas occurs through a transport barrier whereby plasma turbulence is reduced by the shear of the edge radial electric field (E_r). The neoclassical theory predicts E_r to be driven by the main plasma ions, as also suggested by experimental observations. A recent upgrade of the charge exchange recombination spectroscopy diagnostic (CXRS) in the ASDEX Upgrade tokamak (AUG) provides a full reconstruction of the impurity density, temperature and E_r profiles and allows us to address the fast dynamics of these quantities during the L-H transition. The characteristic time scale of the L-H transition can be associated to the typical frequency (1-10 kHz) of the fluctuating phases (often called limit cycle oscillations) observed before the L-H transitions. The new CXRS system has a time resolution of $50\mu s$ which allows to investigate these phenomena and analyze the causality of the transition mechanism. Correlations between turbulent fluctuations and changes in the edge profile gradients will be presented.

Fachvortrag P 22.3 Mi 17:20 HZO 50

Fluid-electron, gyrokinetic-ion simulations of global modes in magnetic fusion devices — •Michael Cole, Alexey Mishchenko, and Axel Könies — Max-Planck-Institut für Plasmaphysik, 17491 Greifswald, Germany

A practical fusion reactor will require a plasma beta of around 5%. In this regime, the MHD stability of the plasma is an important limiting factor. The influence of gyrokinetic effects on the stability of MHD modes is incompletely understood. Some phenomena, such as the Toroidal Alfvén Eigenmode, are inherently unstable as a result of kinetic interactions with MHD modes. Others, such as ballooning modes, may be significantly stabilised or destabilised by gyrokinetic effects. In this work, a fluid-electron, gyrokinetic-ion model is implemented for an existing gyrokinetic code. This model offers certain practical benefits over full gyrokinetic codes, such as faster running times and reduced utilisation of computational resources, at the expense of reduced completeness. When combined with existing MHD and gyrokinetic models, however, a hierarchy of numerical tools can be applied to isolate and characterise the relative influence of different physical effects. It is intended to apply these models to investigate the behaviour of large tokamaks such as ITER and optimised stellarators such as Wendelstein 7-X at realistic reactor betas.

Fachvortrag P 22.4 Mi 17:45 HZO 50

Modelling the Vlasov equation on complex geometries using the Semi-Lagrangian scheme — •Laura Mendoza[1], Virginie Grandgirard[2], Ahmed Ratnani[1], and Eric Sonnendrücker[1] — [1]Max-Planck-Institut für Plasmaphysik, 85748, Garching, Germany — [2]CEA-Cadarache, IRFM, 13108, Saint-Paul-lez-Durance, France

The GYSELA code is a non-linear 5D global gyrokinetic code which performs flux-driven simulations to solve the gyrokinetic Vlasov equation coupled with the Poisson equation. Its 3D spatial representation is limited to circular toroidal geometry (r, θ, φ). Currently the poloidal plane, a circular cross-section, is discretized with a polar mesh. Due to the singularity of this mapping on its origin, the geometry is discontinuous (with a hole in the center).

Thus our aim is to generalise GYSELA's geometry definition using IGA so that any geometry, however complex, can be simulated by mapping one or multiple patches. We decided to study two different approaches to solve this problem: on the one hand, Non-Uniform Rational B-Splines (NURBS), which provide an exact representation of complex shapes; on the other hand, using a regular equilateral triangle mesh of hexagonal form on which we will work with Box-Splines.

The GYSELA code is one of many examples of why we need Semi-Lagrangian codes adapted to complex geometries. Other examples from plasma physics (and further goals) are the X-point, the scrape-off layer or edge plasma, 3D representation of a Tokamak and Stellarator, etc.

P 22.5 Mi 18:10 HZO 50

Influence of Alfvén eigenmodes and ion cyclotron heating on the fast-ion distribution in the ASDEX Upgrade tokamak — •Markus Weiland, Benedikt Geiger, Roberto Bilato, Philip Schneider, Giovanni Tardini, Philipp Lauber, Francois Ryter, Mirjam Schneller, and ASDEX Upgrade Team — Max-Planck-Institut für Plasmaphysik, Garching

Fast, supra-thermal ions are created in the tokamak ASDEX Upgrade by neutral beam injection and ion cyclotron resonance heating (ICRH) and they are needed for plasma heating and current drive. A possibility to study them is the spectroscopic observation of line radiation (fast-ion D-alpha, FIDA), which emerges from charge exchange reactions. Here, the fast ions can be distinguished from the thermal particles through there strong Doppler-shift, and their radial density profile can be measured and compared to theoretical models.

An analysis of the whole Doppler spectrum yields information about the 2D velocity distribution $f(v_\parallel, v_\perp)$. Observation from different viewing angles allows consequently a tomographic reconstruction of $f(v_\parallel, v_\perp)$. For this purpose, the FIDA diagnostic at ASDEX Upgrade has been extended from two to five views, and the spectrometer setup was improved to allow a simultaneous measurement of blue and red Doppler shifts. These recently developed diagnostic capabilities are used to study changes in the fast-ion distribution, which are caused by Alfvén eigenmodes. Moreover, the further acceleration of fast ions through 2^{nd} harmonic ICRH is investigated and compared to theoretical predictions.