P 7: Helmholtz Graduate School II - Magnetic Confinement I

Zeit: Montag 16:30–18:30 Raum: HS 21

Hauptvortrag P 7.1 Mo 16:30 HS 21

3-D physics of the tokamak edge — •Matthias Willensdorfer[1], Tyler Cote[2], Michael Griener[1], David Ryan[3], Erika Strumberger[1], Wolfgang Suttrop[1], Nengchao Wang[4], Dominik Brida[1], Marco Cavedon[1], Severin Denk[1], Mike Dunne[1], Rainer Fischer[1], Christopher Ham[3], Chris Hegna[2], Matthias Hoelzl[1], Andrew Kirk[3], Nils Leuthold[1], Marc Maraschek[1], Hartmut Zohm[1], and The ASDEX Upgrade Team[1] — [1]Max Planck Institute for Plasma Physics, 85748 Garching, Germany — [2]University of Wisconsin-Madison, Madison, Wisconsin 53706, USA — [3]CCFE, Culham Science Centre, Abingdon, Oxon, OX14 3DB, UK — [4]AEET, SEEE, HUST, Wuhan 430074, P R China

Non-axisymmetric perturbation coils in tokamaks are commonly used to modify the properties of the plasma edge. This can be beneficial for future fusion, since it allows to influence possible harmful edge instabilities.

Recent research has shown that the perturbation field from these coils excite static ideal magnetohydrodynamic (MHD) modes at the edge, which significantly distort the axisymmetry of tokamaks. This three-dimensional (3D) tokamak geometry is well described by MHD equilibrium codes originally developed for stellarators. Moreover, measurements of small (helically) localised instabilities combined with stability analysis demonstrate that the induced 3D geometry produces regions of lower stability on the plasma surface.

P 7.2 Mo 17:00 HS 21

A ballooning mode description of small ELMs — •G.F. Harrer[1], E. Wolfrum[2], M.G. Dunne[2], T. Eich[2], M. Griener[2], P. Hennequin[3], B. Labit[4], P. Manz[2], L. Radovanovic[1], F. Aumayr[1], the ASDEX Upgrade Team[2], and the EUROfusion MST1 Team[5] — [1]Institute of Applied Physics, TU Wien, Fusion@ÖAW, Vienna, Austria — [2]Max Planck Institute for Plasma Physics, Garching, Germany — [3]Laboratoire de Physique des Plasmas, CNRS, Ecole Polytechnique, Palaiseau, France — [4]Swiss Plasma Center, EPFL, Lausanne, Switzerland — [5]see author list in H. Meyer et al. Nuclear Fusion 57 102014 (2017)

The foreseen operational scenario for future fusion devices is the high confinement mode, which is characterized by a strong increase in confinement due to the formation of a transport barrier at the plasma edge. The periodic crash of this so-called pedestal is caused by large edge localized modes (type-I ELMs) which can lead to possibly intolerable heat and particle loads if not controlled. In ASDEX Upgrade, discharges with high separatrix collisionality $\nu_e^* \propto n_e/T_e^2$, comparable to ITER, exhibit small ELMs at good confinement, if the plasmas are strongly shaped. In the experiment, type-I ELMs and small ELMs can coexist. In this contribution a model is proposed that explains how the small ELMs modify the shape of the pedestal close to the separatrix in such a way that it is stable against large type-I ELMs. The manifestation of small ELMs at reactor-like separatrix conditions as filamentary transport rather than large bursts offers a possible route to tolerable heat loads at high pedestal top pressure in future devices.

P 7.3 Mo 17:25 HS 21

Linear and nonlinear dynamics of GAMs and EGAMs — •Ivan Novikau[1], Alessandro Biancalani[1], Alberto Bottino[1], Peter Manz[1], Garrard D. Conway[1], Alessandro Di Siena[1], Philipp Lauber[1], Emanuele Poli[1], Emmanuel Lanti[2], Laurent Villard[2], Noé Ohana[2], and Asdex Upgrade Team[1] — [1]IPP, Garching, Germany — [2]SPC-EPFL, Lausanne, Switzerland

Turbulence in tokamaks generates radially sheared zonal flows (ZFs), that can reduce the radial transport in the system. Their oscillatory counterparts, geodesic acoustic modes (GAMs), appear due to the action of the magnetic field curvature. The GAMs can be driven by energetic particles leading to the formation of EGAMs. In addition to ion Landau damping (LD), both the GAMs and EGAMs have been found to be subject to the electron LD. Due to that, the EGAMs can spread energy from the fast particles to the thermal plasma. To investigate the influence of the electron LD on the EGAMs, a Mode-Particle-Resonance diagnostic has been implemented in the global gyrokinetic (GK) PIC code ORB5. Based on the projection of the energy transfer terms on the velocity domain, the diagnostic gives an opportunity to estimate the contributions of different resonances to the mode's dynamics. It has been applied in electromagnetic GK simulations of the NLED AUG shot #31213 to show the influence of the drift-kinetic electrons on the EGAM dynamics. The second part of the talk is dedicated to the nonlinear interaction of zonal structures and turbulence in AUG shot #20787. GAM excitation by ITG instabilities will be shown with a good numerical prediction of the GAM frequency scaling.

P 7.4 Mo 17:50 HS 21

Investigation of enhanced transport due to magnetic perturbations — •Nils Leuthold[1,2], Wolfgang Suttrop[1], Matthias Willensdorfer[1], Marco Cavedon[1], Mike Dunne[1], Luis Gil[3], Tim Happel[1], Andrew Kirk[4], Jose Vicente[3], the ASDEX Upgrade Team[5], and the EUROfusion MST1 Team[6] — [1]Max Planck Institute for Plasma Physics, 85748 Garching, Germany — [2]Ludwig-Maximilian-Universität, München, Germany — [3]Instituto de Plasmas e Fusao Nuclear, Instituto Superior Tecnico, Universidade de Lisboa, Portugal — [4]CCFE, Culham Science Centre, Abingdon, Oxon, OX14 3DB, UK — [5]See the author list "H. Meyer et al 2019 Nucl. Fusion (in preparation)" — [6]See the author list "H. Meyer et al 2017 Nucl. Fusion 57 102014"

Since Edge Localized Modes have the potential to damage the first wall in a tokamak, magnetic perturbations are currently investigated as a tool to mitigate or suppress them. At low collisionalities relevant for future fusion devices, magnetic perturbations also cause an enhancement of outward particle and heat transport.

The influence of this so called 'pump-out' effect on the temperature and density of the plasma is shown. Also, first insights into its driving mechanism are discussed. No significant increase of neoclassical transport due to field penetration to resonant magnetic surfaces at the pedestal top has been observed. However, broadband density fluctuations can be measured in the plasma edge. Their toroidal asymmetry is seen in scans of the surface corrugation of the perturbed 3D equilibrium.

P 7.5 Mo 18:15 HS 21

Influence of magnetic islands on plasma profiles and dynamics in the Scrape-Off-Layer of Wendelstein 7-X — •Carsten Killer[1], Olaf Grulke[1,2], Philipp Drews[3], Alexander Knieps[3], Dirk Nicolai[3], Guruparan Satheeswaran[3], and W7-X Team[1] — [1]Max-Planck-Institute for Plasma Physics, Greifswald, Germany — [2]Department of Physics, Technical University of Denmark, Lyngby, Denmark — [3]IEK4-Plasmaphysik, Forschungszentrum Jülich, Germany

The W7-X divertor concept employs large resonant magnetic islands at the plasma edge to control the heat and particle fluxes to the divertor. Using reciprocating probe measurements, we show that the presence and particular topology of magnetic islands significantly affects the Scrape-Off Layer (SOL) profiles of electron temperature, density and electric field, as well as the fluctuation characteristics, turbulence-induced radial transport, and plasma flows. These quantities are explored in different magnetic configurations and the role of central plasma heating and fuelling is discussed.

As a key result, we report on particularly broad SOL temperature and density profiles in the presence of magnetic islands, resulting in very large effective SOL widths up to 5 cm (with a strongly non-exponential profile shape) which is favourable as it results in a broader heat flux distribution on the divertor. In these situations, the islands can feature a local minimum of the plasma potential accompanied by a direction reversal of $E \times B$ driven dynamics, indicating that the islands with connection lengths of a few 100 m can act as plasma confining regions.