# P 17: Helmholtz Graduate School VI

Zeit: Donnerstag 14:00–16:15 Raum: HS 21

**Hauptvortrag** P 17.1 Do 14:00 HS 21

**Impurity Transport Investigations at the Wendelstein 7-X Stellarator** — •Rainer Burhenn and W7-X Team — Max Planck Institute for Plasma Physics, Wendelsteinstr. 1, 17491 Greifswald, Germany

A critical issue for fusion devices is the plasma contamination by impurities released by interaction of the plasma with plasma-facing components. Depending on impurity concentration they can cause unacceptable dilution of the fusion fuel and substantial radiation cooling in case of highly charged species. The latter might lead to degraded plasma performance or even plasma termination either by an abrupt disruption as in tokamaks or a soft radiative collapse as in devices with small plasma currents such as stellarators. The magnetic field of the superconducting modular stellarator Wendelstein 7-X is optimized to reduce the enhanced particle transport at low collisionality, typically inferred by non-axisymmetric configurations. This allows for long-pulse operation with good energy confinement. For impurities, nevertheless, theory predicts inwards directed fluxes at high densities, potentially causing accumulation and endangering long-pulse operation. However, the latter had not been observed for microwave heated W7-X plasmas so far, indicating the existence of additional transport channels. First modelling of experiments with active impurity tracer injection reveals predominantly anomalous diffusive transport. For clearification of the relevance of turbulence for the observed impurity transport properties a comparison of impurity and bulk plasma confinement with turbulence measurements and gyrokinetic calculations is under investigation.

**Hauptvortrag** P 17.2 Do 14:30 HS 21

**The role of the radial electric field in the edge of fusion plasmas** — •Marco Cavedon[1], Gregor Birkenmeier[1], Ralph Dux[1], Tim Happel[1], Ulrike Plank[1], Thomas Pütterich[1], Francois Ryter[1], Ulrich Stroth[1], Eleonora Viezzer[2], Matthias Willensdorfer[1], Elisabeth Wolfrum[1], and The Asdex Upgrade Team[1] — [1]Max Planck Institute for Plasma Physics, Garching (Germany) — [2]Dept. of Atomic, Molecular and Nuclear Physics, Uni. Seville, Seville (Spain)

It is widely accepted that the edge radial electric field ($E_r$) gradient and the accompanying $E \times B$ velocity shear is responsible for the suppression of the edge turbulence, thus leading to the transition from the low (L-) to the high (H-) confinement mode in diverted tokamaks. The latter shows a factor of two higher energy confinement time making this regime the baseline for any future fusion device based on the tokamak concept. However, the origin of $E_r$ is still debated. The $E \times B$ flow may be generated by turbulence stresses, collisional (neoclassical) processes via the main ion pressure gradient or by any non-ambipolar transport process. Several experiments were performed at the ASDEX Upgrade tokamak to clarify the dominant drive of $E_r$. A comparison of neoclassical $E_{\mathrm{r,neo}}$ and of measured $E_r$ profiles close to the L-H transition and during a complete edge localized mode cycle shows the main role of the neoclassical contribution to the $E \times B$ velocity. In line with the above, across a large database of L-H transitions the same $E \times B$ shear is observed at the H-mode onset, which indicates that the key role of $E_{\mathrm{r,neo}}$ is a general property.

P 17.3 Do 15:00 HS 21

**2D impurity ion flow characteristics in different Wendelstein 7-X island divertor configurations** — •Valeria Perseo[1], Ralf König[1], Dorothea Gradic[1], Oliver Patrick Ford[1], Florian Effenberg[2], David Ennis[3], and Thomas Sunn Pedersen[1] for the The Wendelstein 7-X Team-Collaboration — [1]Max Planck Insitut für Plasmaphysik, Greifswald, Germany — [2]University of Wisonsin, Madison, USA — [3]Auburn University, Auburn, USA

The last campaign of Wendelstein 7-X (W7-X) was characterized by the island divertor. This concept exploits the stellarator intrinsic magnetic island topology, that is inherently 3D. In this context, a system able to measure 2D Doppler velocity patterns, such as Coherence Imaging Spectroscopy (CIS), is helpful to understand and confirm the basics of the impurity flow physics. The CIS diagnostic is a camera-based interferometer able to detect wavelength variation of the order of tens of pm (∼tens km/s) of an impurity selected by a narrow bandpass filter. A modulation pattern encoding the spectral line properties is generated by the usage of birefringent crystals. Two systems, set up in order to monitor the conditions of the same divertor module from nearly perpendicular lines of sight, have been designed for W7-X. Flows and line emissions have been recorded under different magnetic and plasma configurations, characterizing the behavior of the intrinsic carbon impurities. The measurements are compared with EMC3-EIRENE simulations, highlighting the presence of counter-streaming flows around the magnetic islands.

P 17.4 Do 15:25 HS 21

**Langmuir probe measurements of plasma fluctuations in the Wendelstein 7-X divertor** — •Lukas Rudischhauser[1], Michael Endler[1], Kenneth Charles Hammond[1], and Boyd Douglas Blackwell[2] for the The Wendelstein 7-X Team-Collaboration — [1]Max-Planck-Insitute for Plasma Physics, Greifswald, Germany — [2]Australian National University, Canberra, Australia

Simultaneous, non-invasive and continous measurement of plasma density, temperature and potential is a unique capability of langmuir probes. During the operation phase 1.2b of the stellerator Wendelstein 7-X two newly installed fast swept Langmuir systems were operated, sampling these quantities with typically 50 kHz.

The first system is a Mirror Langmuir Probe, a time domain triple probe with automatic bias adjustement based on the work of LaBombard (RSI 78, 2007). The second is a new development we call Bridge Probe, removing transmission line influences with a compensation cable.

The two systems are described and evaluation methods explained. Fluctuation results are related to local and global plasma parameter averages, and their spectra discussed in detail. This analysis will guide futher development of diagnostics for the steady state high heatflux divertor operation phase of Wendelstein 7-X.

P 17.5 Do 15:50 HS 21

**Parametric Decay Instabilities in the Electron Cyclotron Resonance Heating Beams at ASDEX Upgrade** — •Søren Kjer Hansen[1,2], Stefan Kragh Nielsen[2], Jörg Stober[1], Jesper Rasmussen[2], Mirko Salewski[2], Morten Stejner[2], and the ASDEX Upgrade Team[3] — [1]Max-Planck-Institut für Plasmaphysik, D-85748 Garching b. München, Germany — [2]Department of Physics, Technical University of Denmark, DK-2800 Kgs. Lyngby, Denmark — [3]See Appendix in *Nucl. Fusion* **57**, 102015 (2017)

In a parametric decay instability (PDI), a large-amplitude pump wave decays to two daughter waves once its amplitude exceeds a nonlinear threshold. PDIs determine the limit of validity of linear theories in quadratically nonlinear media, such as fluids and plasmas. Here, we consider PDIs occurring in connection with injection of high-power mm-waves for electron cyclotron resonance heating (ECRH) of the fusion-relevant plasmas at the ASDEX Upgrade tokamak. We particularly investigate PDIs near the fundamental and second-harmonic upper hybrid resonance (UHR). Near the UHR strong field enhancement leads to the PDI threshold being exceeded at typical ECRH power levels. We have experimentally confirmed theoretical predictions of the PDI threshold and characterised the nonlinear response beyond the threshold for these PDIs. Near the second-harmonic UHR trapping of the daughter waves is required to reduce the PDI threshold to a level accessible with ECRH; this may occur near a local maximum of the electron density. We have investigated such PDIs near the plasma centre, in connection with edge localised modes, and in magnetic islands.