P 5: Magnetic Confinment Fusion/HEPP III

Time: Tuesday 11:00–12:35 Location: ZHG102

Invited Talk P 5.1 Tue 11:00 ZHG102

Mode activity at the Wendelstein 7-X stellarator - Turbulence driven Alfvén modes — •S. Vaz Mendes[1], K. Rahbarnia[1], H. Thomsen[1], C. Büschel[1], J. Riemann[1], C. Slaby[1], R. Kleiber[1], A. Könies[1], M. Borchardt[1], J.P. Bähner[2], A. von Stechow[1], and Wendelstein 7-X Team[1] — [1]Max-Planck-Institute for Plasma Physics, Wendelsteinstr. 1, 17491 Greifswald, Germany — [2]MIT Plasma Science and Fusion Center, MA 02139, USA

In the optimized stellarator Wendelstein 7-X, magnetic fluctuation measurements reveal the excitation of Alfvén eigenmodes (AEs) in electron cyclotron resonance heated plasmas, despite the absence of a normal fast-particle driving source. This work presents an explanation for AE excitation via ion-temperature-gradient (ITG) turbulence. The detected AEs (Mirnov-measurements) in the range $50 < f < 450$ kHz are consistent with ellipticity, toroidicity, and non-circularity induced AEs. Density fluctuations (Phase Contrast Imaging measurements) indicated dominant ITG turbulence in these plasmas. The amplitudes of AEs and density fluctuations show a correlation for different magnetic field configurations. Moreover, in turbulence-reduced regimes, caused by peaking of the density profile via pellet injection, a reduction in the AE amplitude is found. Non-linear gyrokinetic simulations using the EUTERPE code revealed simultaneous excitation of zonal flow activity and generation of AEs driven by ITG turbulence. They also show that ITG modes are necessary to excite AEs above their initial low level.

P 5.2 Tue 11:30 ZHG102

Characterization of low frequency electromagnetic modes in the W7-X core and scrape-off layer plasma — •Dario Cipciar[1], Carsten Killer[1], Jiri Adamek[2], Kian Rahbarnia[1], Christian Brandt[1], Olaf Grulke[1,3], Neha Chaudhary[1], Henning Thomsen[1], and W7-X Team[1] — [1]Max-Planck-Institut fur Plasmaphysik, Wendelsteinstr. 1, 17491 Greifswald, Deutschland — [2]Institute of Plasma Physics of the CAS, U Slovanky 2525/1a, 18200 Prague 8, Czech Republic — [3]Department of Physics, Technical University of Denmark, Lyngby, Denmark

Global low-frequency electromagnetic oscillations of m=1 type are often observed in the Wendelstein 7-X stellarator. These modes significantly modulate the plasma stored energy and can appear as harmonic oscillations or as intermittent bursts, depending on the magnetic configuration. The bursty mode activity occurs in scenarios with large stationary magnetic islands just inside the last closed flux surface. In this case, a particularly strong effect on the plasma confinement is observed, via the effect of bursts on the density gradient and a gradient-associated temporary suppression of cross-field losses. Further, both continuous and bursty mode activity is observed in the Scrape-Off Layer using electric probes. The fluctuations of the poloidal electric field, electron temperature and density is captured using an array of Langmuir and ball-pen probes and used to calculate the perpendicular transport parameters. A Ball-pen probe in a swept regime (20 kHz) is used to measure the fluctuations of ion temperature, crucial for the material sputtering of the first wall due to transiently high Ti.

P 5.3 Tue 11:55 ZHG102

Turbulent magnetic fluctuations in plasma edge — •Kaiyu Zhang, Wladimir Zholobenko, Andreas Stegmeir, and Frank Jenko — Max Planck Institute for Plasma Physics, Garching, Germany

Small magnetic fluctuations are inherently present in a magnetic confinement plasma due to turbulent currents. These fluctuations flutter the background field lines, thereby reshaping the turbulence, which is investigated with GRILLIX, a global full-f fluid turbulence code using a locally field-aligned scheme. This study introduces a real-time high-pass filter to screen the magnetic fluctuations in turbulence, based on which the magnetic flutter effect is implemented. The implementation is verified by the method of manufactured solution and validated in the full-size simulations for the edge and scrap-off layer of Asdex Upgrade tokamak. The magnetic flutter in the drift-Alfvén-wave is found to reduce ExB transports by decreasing the phase shift between potential and density fluctuations, imparting stabilizing factors of 2 in the low confinement conditions and up to 100 in high confinement conditions. These findings establish the flutter stabilization as a fundamental aspect of edge turbulence. In reactor-relevant small edge-localized-modes (ELMs) regimes, the magnetic fluctuations form substantial Maxwell stresses, which flatten the radial electric field and weaken the associated flow shear near the separatrix. This facilitates the growth of the quasi-coherent mode driven by the kinetic-ballooning-mode, ultimately contributing to increased flutter transport of particles, conducive to avoiding Type-I ELMs and alleviating the heat exhaust challenge.

P 5.4 Tue 12:20 ZHG102

Investigation of Density-Potential Coupling as Agent for the Interplay of Particle and Momentum Transport in Drift Wave Turbulence — •Ralph Sarkis, Bernhard Schmid, Günter Tovar, and Mirko Ramisch — IGVP, University of Stuttgart, Germany

The experimental investigation of turbulent transport dynamics in the edge of magnetically confined plasmas highlights the coupling of density and potential fluctuations in the interplay of particle and momentum transport. At the TJ-K stellarator, a poloidal Langmuir-probe array is set up to simultaneously measure density and potential fluctuations, providing spatiotemporal observations of particle transports and Reynolds stress. While both transport phenomena rely on conflicting density-potential coupling conditions, experimental measurements exhibit a shared local region of maximum levels. Dynamics investigations reveal an inverse temporal relation of particle and momentum transport, substantiated by their strong correlation and anti-correlation with the density-potential decoupling, respectively. The spectral decomposition of the coupling parameter emphasizes the role of small-scale contributions in the drift-wave dominated transports' formation. Furthermore, the occurrence of zonal flows appears to alter the transports' dependence on the coupling. Both particle and momentum transport appear to be decorrelated from the density-potential coupling during zonal flows. This phenomenon is elucidated by analyses of spectral energy transfer between small-scale fluctuations in density and potential and meso-scale shear flows.