P 10: Magnetic Confinement III/HEPP V

Time: Wednesday 11:00–13:10 Location: CHE/0091

Invited Talk P 10.1 Wed 11:00 CHE/0091

Diagnosing the plasma edge with helium beam spectroscopy
— •Michael Griener and the ASDEX Upgrade Team — Max-Planck-Institut für Plasmaphysik, Boltzmannstr. 2, 85748 Garching

The outer 5% of the plasma radius of magnetically confined fusion plasmas – the plasma edge region – plays a key role for reactor performance. It sets the boundary for the plasma core by establishing transport barriers and it distributes the power to the plasma facing components.

The power and particle transport at the plasma edge is influenced by coherent plasma modes and turbulent structures like convective filaments. To study these important physical phenomena, diagnostics with high spatiotemporal resolution are required as typical structures with a size of around 1 cm move with velocities of several km/s.

One diagnostic dedicated to this is active spectroscopy on a locally injected neutral helium beam, which gets excited mainly by plasma electrons. Dependent on temperature T_e and density n_e of the plasma electrons, the population densities of the neutral helium energy levels vary. Subsequently, n_e and T_e can be reconstructed out of measured line intensity ratios together with a collisional radiative model.

In this talk the diagnostic principle is explained and inventive measurements of plasma modes and filaments in fusion reactor relevant plasma scenarios are discussed.

P 10.2 Wed 11:30 CHE/0091

Determination of SOL filament cooldown at ASDEX Upgrade
— •Daniel Wendler[1,2], Michael Griener[1], Gregor Birkenmeier[1,2], Elisabeth Wolfrum[1], Ulrich Stroth[1,2], and the ASDEX Upgrade team[3] — [1]Max-Planck-Institut für Plasmaphysik, Garching — [2]Physik-Department E28, Technische Universität München, 85747 Garching, Germany — [3]See author list of U. Stroth et al. 2022 Nucl. Fusion 62 042006

Filaments, alternatively called blobs, are coherent structures, appearing in the scrape-off layer (SOL) of magnetic fusion devices in all plasma scenarios. They have a higher pressure than the background plasma and a radial motion outwards, which also differs from the background. As a consequence, blobs cause convective transport, being correlated with phenomena like the density shoulder formation and in general the power deposition in the plasma vessel. To better estimate the power transported by the filaments, their temperatures, densities and velocities are measured. This is done by means of a two-dimensional grid of lines of sight at the ASDEX Upgrade thermal helium beam. Measured radiances of helium transitions are then converted into the plasma electron temperature and density by applying a collisional radiative model. Via the calculation of the temporal evolution of these quantities and the blob position, the convective power of the filament is determined. This shows a cooldown of the filament's temperature which is combined with a loss of density. These processes are compared to analytical models, allowing to determine the temporal evolution of the convective power.

P 10.3 Wed 11:55 CHE/0091

Experimental Exploration of a Two Point Model for the Island Divertor of Wendelstein 7-X via Helium Line Ratio Spectroscopy
— •Erik Flom[1,3], Tullio Barbui[2], Oliver Schmitz[1], Maciej Krychowiak[3], Ralf König[3], Marcin Jakubowski[3], Sergei Bozhenkov[3], Valeria Perso[3], Felix Reimold[3], and The Wendelstein 7-X Team[3] — [1]UW-Madison, Madison, WI, USA — [2]PPPL, Princeton, New Jersey, US — [3]Max Planck Inst. for Plasma Physics, Greifswald, Germany

Understanding the basic plasma parameters of temperature and density, as well as their gradients in the scrape-off layer (SOL), is a topic critical for providing information about the performance of a divertor concept. The stellarator Wendelstein 7-X features a novel resonant island divertor with an adjustable rotational transform of $\iota = 2\pi$ (5/6, *, 5/4). In order to study the performance of this divertor concept, an active spectroscopy system on an atomic helium beam [1] was developed and installed on the stellarator [2]. The diagnostic was successfully operated in the first two divertor campaigns of the device in two magnetically connected modules. In this work, a database analysis of experiments from the operational phase OP1.2b is performed and systematic trends in divertor performance are discussed within the framework of a two-point, single-fluid model [3]. Particular focus is applied to separatrix vs. target density scaling and evidence for a *high-recycling* conduction limited regime, as well as an exploration of the validity of the helium beam as a downstream proxy given its displacement from the strike line poloidally.

P 10.4 Wed 12:20 CHE/0091

Low-collisionality extension of the edge turbulence fluid code GRILLIX
— •Christoph Pitzal, Andreas Stegmeir, Kaiyu Zhang, Wladimir Zholobenko, and Frank Jenko — Max-Planck-Institut für Plasmaphysik, Boltzmannstr. 2, 85748 Garching, Germany

Fluid models are yet the workhorse for plasma edge turbulence simulations, but the fluid assumptions have certain limitations. As one leaves the realm of validity, by decreasing collisionality, the most fragile quantity is the heat flux, as it represents usually the highest order fluid moment. These conditions can already be present in the near SOL of present day experiments and the commonly used Spitzer-Härm formula vastly overestimates the parallel heat conductivity. An approach to introduce Landau damping into fluid models and therefore predict the kinetic heat flux, is given in [1]. A method to translate this approach from k-space into configuration space, where most fluid codes act is presented in [2]. In this work the Landau-fluid closure is implemented into the edge turbulence fluid code GRILLIX [3]. This requires solving a set of elliptic equations along magnetic field lines. Turbulence simulations are performed to compare the Landau-fluid closure with the Spitzer-Härm formula. The aim is to find out whether this model is capable of predicting the parallel heat conductivity self-consistently and to investigate if non-local effects of the Landau-fluid closure can be seen. Finally, the performance of the model is assessed.

[1] G. Hammett et al., Phys. Rev. Lett., vol. 64, pp. 3019, 1990.
[2] A. Dimits et al. Physics of Plasmas, vol. 21, no. 5, 2014
[3] A. Stegmeir et al., Physics of Plasmas, vol. 26, no. 5, 2019.

P 10.5 Wed 12:45 CHE/0091

Gyrokinetic investigation of linear and non-linear excitation of energetic particle driven instabilities in ASDEX Upgrade
— •Brando Rettino[1], Thomas Hayward-Schneider[1], Alessandro Biancalani[2,1], Alberto Bottino[1], Philipp Lauber[1], Ilija Chavdarovski[3], Markus Weiland[1], Francesco Vannini[1], and Frank Jenko[1] — [1]Max-Planck-Institut für Plasmaphysik, 85748 Garching, Germany — [2]Léonard de Vinci Pole Universitaire, Research Center, 92916 Paris la Défense, France — [3]Korea Institute of Fusion Energy, 34133 Daejeon, South Korea

Excitation of Alfvén Waves (AW) and Geodesic Acoustic Modes (GAM) by energetic particles (EPs) is an important topic of study for the physics of fusion reactors. In tokamaks, ions are injected with high energies to heat the plasma. These energetic particles are very weakly collisional and exist far from thermal equilibrium. We examine the effects of experimental-like anisotropic in velocity distribution functions of EPs on the excitation of such instabilities with the gyrokinetic particle-in-cell code ORB5. The growth rate of GAMs is found to be sensitively dependent on the phase-space shape of the distribution function as well as on the non-linear wave-wave coupling with AWs.