P 14: Magnetic Confinement V

Time: Thursday 11:00–12:30 Location: KH 02.016

P 14.1 Thu 11:00 KH 02.016

Understanding the impact of the divertor configuration on the L-H transition in the ASDEX Upgrade tokamak — •Roxána Takács[1], Michael Dunne[1], Gregor Birkenmeier[1], Matthias Willensdorfer[1], and the ASDEX Upgrade Team[2] — [1]Max Planck Institute for Plasma Physics, Garching, Germany — [2]See author list of H. Zohm et al, 2024 Nuclear Fusion

Future fusion devices, such as ITER, will operate in high-confinement mode (H-mode) to achieve the plasma confinement required for sustained energy production. H-mode is characterized by increased stored energy and the formation of a steep pressure gradient at the plasma edge. In the leading interpretation, the transition into H-mode occurs when the E×B shear becomes strong enough to suppress edge turbulence. Previous studies from many major tokamaks have shown that the power threshold for the L−H transition (P_{LH}) depends on various parameters, including the main isotope, plasma shape, and plasma density. This study investigates how the P_{LH} varies with different divertor configurations in the ASDEX Upgrade tokamak. The experimental dataset consists of lower- and upper single null plasma discharges, in low and high density regimes, with different divertor configurations. Significant variations in P_{LH} are observed across the different divertor configurations. This work presents an analysis of the divertor conditions as well as kinetic profiles at the midplane which aids in understanding the underlying physics of the L−H transition and improving our ability to optimize H-mode access in future fusion reactors.

P 14.2 Thu 11:25 KH 02.016

Multi-Color Gas Puff Imaging in the ASDEX Upgrade Divertor — •Manuel Herschel[1,2], Michael Griener[1], Felix Albrecht[1,2], Alessandro Mancini[1], Ou Pan[1], Christoph Pitzal[1], Tim Happel[1], Ulrich Stroth[1,2], and The ASDEX Upgrade Team[3] — [1]Max Planck Institute for Plasma Physics, Garching, Germany — [2]Technical University of Munich, Physics Department, Chair for Plasma Edge and DIvertor Physics, Garching, Germany — [3]H. Zohm et al. 2024 *Nucl. Fusion* **64** 112001

The divertor will play a critical role in a future magnetic confinement fusion power plant. It distributes heat and particle loads onto the plasma-facing materials and controls impurity influx into the main plasma volume.

To study the newly constructed upper divertor at the ASDEX Upgrade fusion experiment, it has been equipped with a variety of novel plasma diagnostics. One of these diagnostics is a Multi-Color Gas Puff Imaging (GPI) system to study fast (tens of μs) events in the divertor volume. The GPI system uses a small injection of helium gas to emit line radiation depending on local plasma parameters, which is detected by a fast camera.

The design of the diagnostic, operational challenges and results from the first experiments are presented. Various comparisons with other diagnostics and numerical turbulence simulations are shown.

P 14.3 Thu 11:50 KH 02.016

Characterization of Neutral Helium Beam Injection at ASDEX Upgrade — •Manuel Matsumoto[1,2], Athina Kappatou[2], Lucía Sanchis[3], Michael Dunne[2], Christian Hopf[2], Thomas Pütterich[2], Gregor Birkenmeier[1,2], Rachael M McDermott[2], and ASDEX Upgrade Team[2] — [1]Technical University of Munich, Germany — [2]Max Planck Institute for Plasma Physics, Garching, Germany — [3]University of Sevilla, Spain

The confinement and slowing-down behaviour of energetic alpha particles are critical for the performance of future reactors, as they are expected to heat the background plasma. Pulses with helium neutral beam injection (NBI) have been carried out at ASDEX Upgrade to produce an energetic helium population. Charge Exchange Recombination Spectroscopy (CXRS) measurements reveal a slowing down feature characteristic of the fast helium ion population.

To interpret the measurements, an ASCOT5 based particle tracking model is used to describe the helium beam ionization and slowing-down process in a fusion plasma. A forward model allows direct comparison between experimental CXRS spectra and synthetic spectra generated from ASCOT5 distribution functions. This approach allows the interpretation of the CXRS measurements, and the validation of the ASCOT5 model itself against the measurements.

Additionally, an analysis of the beam emission components of the measured spectra allows for a detailed characterisation of the helium neutral beam and its attenuation. The results quantify the impact of metastable populations in reproducing the CXRS spectra.

P 14.4 Thu 12:05 KH 02.016

Toward a nonlinear Schrödinger equation for the description of geodesic-acoustic-modes in tokamaks — •David Korger[1], Emanuele Poli[1], Fulvio Zonca[2], Matteo Valerio Falessi[2], Riccardo Stucchi[1], Alberto Bottino[1], and Thomas Hayward-Schneider[1] — [1]Max-Planck-Institut für Plasmaphysik, Garching, 85748, Germany — [2]Center for Nonlinear Plasma Science and C.R. ENEA Frascati, C.P. 65, 00044 Frascati, Italy

The geodesic-acoustic-mode (GAM) is a plasma oscillation observed in fusion reactors with toroidal geometry and is recognized to be the nonstationary branch of the zonal flows (ZFs). Prior studies have established that as a direct consequence of nonlinear gyrokinetic theory, the GAM dynamics is well described by an equation of Schrödinger type - i. e., an equation whose linear contribution is exactly of the same form as the linear Schrödinger equation, while the nonlinear dynamics necessitates an integro-differential expression.

The presented work takes a closer look into the nonlinear contributions by deriving approximate, but well-defined analytic expressions from the (exact) integro-differential operators. At the lowest order of accuracy, prior numerical studies anticipate the retrieval of a cubic nonlinear Schrödinger equation. This may come unexpected since nonlinear interactions usually have a quadratic structure, such as e. g. the $E\times B$-nonlinearity. The third power is found to stem from an interaction of quadratic structures generated by the GAMs (with oscillation frequencies that are either zero or twice the GAM frequency) with the GAM itself. Analytic results are compared to gyrokinetic simulations.