P 15: Helmholtz Graduate School 3 and Magnetic confinement 3

Time: Wednesday 14:00–16:05 Location: b305

Invited Talk P 15.1 Wed 14:00 b305

How turbulence sets boundaries for fusion plasma operation — •Peter Manz, Thomas Eich, and the ASDEX Upgrade Team — Max-Planck-Institut für Plasmaphysik, 85748 Garching, Germany

The operational space for safe and efficient operation of a tokamak is limited by several constraints. Well known examples are the Greenwald density limit and the accessibility of high confinement. Their extrapolation to reactor machine size is based on empirical scalings. Both phenomena are related to turbulent transport. Large turbulent transport can lead to a transition to low confinement (the H-mode density limit) and also trigger a sequence of events finally leading to a disruption (the L-mode density limit). The strength of turbulent transport in the plasma edge depends on the competition between rather gentle drift-wave and the rather violent resistive ballooning turbulence. In the electrostatic limit relevant for L-mode their relative strength depends on the collisionality only. In H-mode also electromagnetic effects are important. In order to develop a more physics based understanding of the operation boundaries turbulence control parameters have been measured at the separatrix in ASDEX Upgrade. Taking into account over a hundred discharges, different confinement regimes are mapped into a phase space of normalized collisionality and plasma beta. Thereby confinement regimes can be assigned to different regimes of plasma edge turbulence. The density limit occurs around the transition from drift-dominated to interchange dominated turbulence, the transition to improved confinement regimes is around the transition to finite-beta turbulence.

P 15.2 Wed 14:30 b305

Geometry and Kinetics of Astrophysical Plasmas: A gyrokinetic approach — •Felipe Nathan de Oliveira Lopes[1,2], Karen Pommois[1,2], Aleksander Mustonen[1,2], Rainer Grauer[2], and Daniel Told[1,2] — [1]Max Planck Institute for Plasma Physics — [2]Ruhr-University Bochum

In the context of astrophysical plasmas, various methods are used in order to study problems such as dissipation of turbulent energy and magnetic reconnection[1][2][3]. The use of fluid models allow us to understand macroscopic phenomena[4], but lacks the dynamics of kinetic physics[5]. On another hand, kinetic models[6] usually consume an enormous amount of computing time. The use of reduced models such as gyrokinetics are foreseen to bridge the gap between the fluid and kinetic approaches[7].

In the present work, we aim to investigate the use of gyrokinetics in two different scenarios. Firstly we are going to consistently derive a hybrid hamiltonian field theoretical system[8, 9, 10], based on the lagragian formulation of a symplectic two-form[11]. In this system, ions are treated fully kinetically, and electrons gyrokinetically. With this model, we wish to develop a cost effective kinetic computational framework. The second aspect of the present work addresses a well known problem in space physics, namely magnetic reconnection with guide field[12]. We start with a gyrokinetic analysis using the code GENE[13]. Firstly we analyze the dynamics of the parallel electric field and reconnection rate on the X point, and proceed with benchmarking GENE with a fully kinetic PIC code.

P 15.3 Wed 14:55 b305

Carbon distribution and transport in ECRH and NBI heated plasmas with Charge Exchange Spectroscopy on W7-X — •Lilla Vanó, Oliver P. Ford, and Robert C. Wolf — Max-Planck-Institute for Plasma Physics, Greifswald, Germany

Impurity transport plays a crucial role in the optimization of fusion plasmas, as impurities affect the plasma radiation and can cause power losses. If neoclassical effects dominate the transport, strong impurity accumulation is predicted in the plasma core. According to simulations, neoclassically dominated impurity transport is a possibility in the optimized stellarator Wendelstein 7-X (W7-X) plasma.

To quantify impurity confinement in W7-X, carbon concentration profiles are investigated and used with the impurity transport modeling code STRAHL to determine the transport coefficients (diffusivity and radial convective velocity). The results are compared with neoclassical predictions in order to assess the anomalous contribution.

The profiles are derived from the Charge Exchange Recombination Spectroscopy (CXRS) diagnostic that observes the Neutral Beam Injection (NBI) which is well-suited for determining spatially resolved profiles of fully-stripped low-Z impurities. This work concentrates on carbon, the main intrinsic impurity in W7-X.

Different configurations, densities and heating scenarios with different NBI and ECRH power ratios are explored. Of particular interest are discharges with pure NBI heating phases or with very low ECRH power, where indications of unusually high impurity confinement times have been observed.

P 15.4 Wed 15:20 b305

Impurity transport studies on Wendelstein 7-X by Tracer-Encapsulated Solid Pellets (TESPEL) — •René Bussiahn[1], Naoki Tamura[2], Kieran McCarthy[3], and The W7-X team[1] — [1]Max-Planck-Institute for Plasma Physics, Greifswald, Germany — [2]National Institute for Fusion Science(NIFS), Toki, Japan — [3]Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas

During OP1.2b operation phase of the stellarator Wendelstein 7-X, the TESPEL injections have proven successfully as a complementary tool to Laser-Blow-Off (LBO) for impurity transport studies. Contrary to LBO - depositing tracers close to the plasma edge which are subsequently transported and spread out into the plasma, TESPEL can release the embedded impurity tracers instantly after the ablation of the protecting polystyrene shell in the core of the plasma within a well defined spatial region of a few cm^3. Comparing the temporal dynamics of the shell ablation with a neutral gas shielding model gives good agreement. As seen from fast frame camera images of the shell ablation cloud, the TESPEL trajectory through the plasma does not suffer any deflections. This permits localizing the deposited tracer in the plasma by a simple time-of-flight attempt. The temporal evolution of the line emissions by tracer impurity ions of various charge states, observed by vacuum ultraviolet spectroscopy (HEXOS) and high resolution X-ray imaging spectrometry (HR-XIS) shows distinct differences between LBO and TESPEL, especially in their initial phase. Later, the curves are similar and the related impurity decay times are inversely proportional to the heating power.

P 15.5 Wed 15:35 b305

Spectroscopic characterization of the boronization impact on the impurity sources in Wendelstein 7-X — •Stepan Sereda[1], Sebastijan Brezinsek[1], Erhui Wang[1], Tullio Barbui[2], Rudolf Brakel[3], Birger Buttenschön[3], Peter Drewelow[3], Andrei Goriaev[4], Ralf König[3], Maciej Krychowiak[3], Yunfeng Liang[1], Dirk Naujoks[3], Andrea Pavone[3], Marcin Rasinski[1], Lukas Rudischhauser[3], Holger Viebke[3], Tom Wauters[4], Victoria Winters[3], and the W7-X team[3] — [1]Forschungszentrum Jülich GmbH, Institut für Energie- und Klimaforschung - Plasmaphysik, Partner of the Trilateral Euregio Cluster (TEC), Jülich, Germany — [2]Princeton Plasma Physics Laboratory, Princeton, NJ 08540, United States of America — [3]Max-Planck-Institut für Plasmaphysik, Greifswald, Germany — [4]Laboratory for Plasma Physics, LPP-ERM/KMS, B-1000 Brussels, Belgium, Trilateral Euregio Cluster (TEC) Partner

In the last experimental campaign of Wendelstein 7-X the passively cooled test divertor unit made of carbon and the stainless steel wall were the main sources of low-Z impurities oxygen and carbon. To tackle this problem three boronizations were performed which significantly decreased the impurity levels (more than factor of 10 for oxygen and 4 for carbon). These changes are characterized by the emission spectroscopy focused at the impurity sources. The ion flux change for the second and the third boronizations is deduced from the divertor Langmuir probes data. The change of hydrogen recycling after the boronization is studied employing filter cameras for hydrogen line radiation observing the complete divertor module.

P 15.6 Wed 15:50 b305

Reynolds stress formation of ZF drive under imposed shear flows at the stellarator TJ-K — •Til Ullmann[1], Bernhard Schmid[1], Peter Manz[2], and Mirko Ramisch[1] — [1]IGVP Universität Stuttgart, Germany — [2]IPP, Max-Planck Institut, Garching

Shear flows in magnetized fusion plasmas are considered to have a major impact on the non-linear dynamics. In drift-wave (DW) turbulence, shear flows tilt and stretch turbulent eddies, resulting in the generation of large structures such as zonal flows (ZF). ZFs tap energy from the DW turbulence and, hence, are supposed to be involved in the formation of transport barriers at the transition into the high confinement regime. ZFs are themselves shear flows and react upon the turbulence. The stellarator TJ-K confines low-temperature plasmas, which allow for measurements of potential fluctuations with Langmuir probes inside the confinement region. In order to identify ZFs and to calculate the Reynolds stress (RS), which indicates the tilt of stretched eddies, 128 probes are poloidally positioned on four neighbouring flux surfaces. The background $E \times B$ flow as imposed by external plasma biasing is calculated from radial profiles of the plasma potential, measured by an emissive probe. The influence of stationary $E \times B$ flow shears on the tilt of turbulent eddies, the RS drive of ZFs and the energy transfer process into the ZFs are investigated experimentally.