Contribution ID: **3290** Type: **not specified**

P2.1083 Transport studies at ASDEX Upgrade: Cold pulses local or non-local? NBI particle source important or not? Pellet fuelling in or out?

Tuesday, 9 July 2019 14:00 (2 hours)

See full abstract here:
http://ocs.ciemat.es/EPS2019ABS/pdf/P2.1083.pdf

Magnetic confinement plasmas are usually primarily driven by heat sources, with limited particle sources, particularly in the core. This is also the case of a fusion reactor, where the limited penetration of the neutral particles leads to the requirement of using fuelling pellets. Depending on plasma conditions, the particle source can impact the turbulence and the transport of particles and heat. Here three situations are analyzed with new experimental results from ASDEX Upgrade (AUG), linear and nonlinear simulations with the gyrokinetic code GKW, and integrated modelling with the transport code ASTRA, coupled to the transport model TGLF and the impurity transport code STRAHL. First, we identify the conditions under which the impact of the particle source produced by neutral beam injection on the density profile is significant. New AUG experimental results which match the conditions of a fusion reactor demonstrate the dominant role of convection with respect to source, and are consistent with both the gyrokinetic and the TGLF results. This clarifies possible differences between devices, such as AUG and JET [1], and increases the reliability of the density profile predictions for a reactor, a key element for the fusion performance. The second problem is related to the impact of a localized particle source as produced by fuelling pellets on the local shape of the density profile and the consequent turbulence and transport that can be destabilized by locally very steep profiles with both positive and negative gradients. A new microinstability with hollow density profiles is identified, and the associated turbulent particle transport is computed by means of non-linear gyrokinetic simulations and shown to be experimentally relevant and consistent with observations. However, the predicted inward diffusion decreases when collisionality is decreased to that of a reactor. Finally, the impact of a peripheral source of impurities, like those produced by laser ablation, on the plasma density profiles is analyzed from new experiments in AUG, which demonstrate the dominant role of the electron to ion heating fraction in determining the plasma response to cold pulses. At low density, the impurity penetration, modelled with STRAHL, is shown to modify the local turbulence causing a fast penetration of the particles, which explains the observation of a very fast flattening of the density profile. In trapped electron mode turbulence, this flattening causes a local reduction of the electron heat transport, leading to a fast increase of the central electron temperature, consistent with recent experimental and related modelling results in C-Mod [2]. Thereby, the complex and very fast density and temperature responses to a cold pulse can be fully explained by multi-channel interactions within a local model like TGLF.

[1] T. Tala et al, 27th IAEA Fusion Energy Conf., Gandhinagar, India, 2018.
[2] P. Rodriguez-Fernandez et al, Phys. Rev. Lett. 120, 075001 (2018).

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Session Classification: Poster P2

Track Classification: MCF