Gyrokinetic study of ASDEX Upgrade discharges with QuaLiKiz

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In ASDEX Upgrade (AUG) discharges, strongly localized central wave heating has been applied regularly for the mitigation of central tungsten (W) accumulation. Yet, complete understanding of all W-transport mechanisms involved is still an outstanding issue as core \((m,n) = (1,1)\) MHD modes are in some cases suspected to facilitate outward transport [1, 2]. Outside this region, neoclassical transport has been found to dominate W-transport [3]. The strong dependence on the main ion density and temperature profiles necessitates accurate modelling of main ion transport as a vital prerequisite to ultimately simulate trace W-impurity transport.

Towards this goal, the fast quasilinear gyrokinetic code QuaLiKiz [4] is coupled to the transport code JETTO [5] and used for the first time for time-dependent integrated modelling of an AUG discharge. Anomalous particle and heat fluxes are calculated by QuaLiKiz for turbulence driven by ITG, TEM and ETG modes. Predictive heat and particle simulations neglecting impurities are performed in the plasma core to validate the main ion transport mechanisms calculated against experimentally obtained temperature and density profiles. Enhanced transport coefficients are applied in the central core to mimic MHD activity.

Heat transport is predicted satisfyingly. Particle transport depends strongly on collisionality, with reasonable agreement obtained only when reducing the collisionality below the default value, allowing the emergence of TEM modes. To assess the validity of the QuaLiKiz Krook collisionality operator [6] in this AUG-relevant regime, QuaLiKiz and linear-GENE [7] are compared on the collisionality dependence of the predicted transition from ITG to TEM modes.

The study serves as a precursor to eventually perform integrated core modelling of W-transport in the same AUG discharge using QuaLiKiz, as time-dependent integrated modelling with the latest generation of turbulent and neoclassical transport models has not been carried out.