Effect of the isotope mass on tokamak turbulent transport: experimental observations and gyro-kinetic simulations

Nicola Bonanomi, IPP-Garching

The edge turbulence plays a key role in the understanding of the L-H transition as well as of the edge transport properties of some ELM-free high-confinement regimes such as the I-mode and the EDA H-mode. This work combines observations in ASDEX Upgrade and JET-ILW and related gyro-kinetic turbulence simulations. We explore both the role of the isotope mass as well as that of the temperature and density profiles in driving or stabilizing the edge turbulence in the edge of L-modes towards the L-H transition. Recent experiments in ASDEX Upgrade and JET-ILW have given some new indications on these two aspects. For both devices pairs of D and H L-modes with matched profiles and with heating power scans have been performed. Different behaviors of the different normalized gradients are observed. A local gyro-kinetic approach with the GENE code quantitatively reproduces the experimental fluxes and shows that the edge high collisionality favors instabilities strongly affected by the parallel electron dynamics. The corresponding linear term in the gyro-kinetic equation, ($\propto (me/mi)^{0.5}$), leads to increased transport at lower mass, an effect which is magnified when electromagnetic effects are included. Moreover, a competition has been found between R/L_{Te}, R/L_{Ti} and R/L$_n$, in driving the turbulence. In contrast, the concomitant increases of the equilibrium ExB shear, consistent with measurements, and of the self-generated zonal flow shear stabilize the turbulence. These results suggest a path towards edge turbulence stabilization in which the evolution of T_i, connected with an increased ion heat flux, leads to increased shearing without enhancing the edge turbulent fluxes. Experimental observations on the edge turbulence from H and D I-modes and EDA H-modes from the ASDEX Upgrade tokamak are also presented. Some new indications on the role of the edge turbulence and on its dependence on the isotope mass in determining the properties of these two regimes are derived.