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Edge turbulent transport towards the L-H transition in ASDEX Upgrade and JET-ILW

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Edge turbulence in L-mode plasmas plays a key role in the understanding of the L-H transition as well as of some ELM-free high-confinement regimes such as the I-mode. This work combines observations in ASDEX Upgrade and JET-ILW and related gyrokinetic 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. 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 [1,2]. It is observed that the normalized logarithmic gradients R/L_{Te} and R/L_{Ti} are free to evolve towards the L-H transition while, despite the changes in n_e and in its gradient, R/L_n shows more limited variation. A local gyrokinetic approach is demonstrated to be applicable to the study of L-mode edge turbulence, and provides critical new insights in the understanding of these observations [3]. Results with the GENE code [4] reproduce quantitatively the experimental fluxes and show that the edge high collisionality favors instabilities strongly affected by the parallel electron dynamics [3]. The corresponding linear term in the gyrokinetic equations, ($\propto (m_e/m_i)^{0.5}$), 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 driving the turbulence.

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