Impact of the ion heat flux channel on the edge radial electric field and on transport barrier dynamics.

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The ExB velocity shear, determined by the radial profile of the radial electric field, has been identified as a key component of the suppression of turbulent-driven transport observed during the formation of transport barriers in edge plasma and thus during the transition from low to improved confinement regimes [1, 2]. More recently, experimental observations on the ASDEX Upgrade tokamak point out the role of the ion heat channel during the L-H transition, especially on the region of the pedestal [3].

In this work, we investigate the impact of the ion heat flux channel on the formation and the dynamics of transport barriers at the transition between open and closed field lines. More precisely, we focus our investigations on the contribution of the ion diamagnetic velocity in the polarization drift, i.e. in ion perpendicular inertia. While the ExB velocity contribution leads to a vorticity \( W = \nabla^2_{\perp} \phi \), adding the ion diamagnetic term leads one to define a generalized vorticity \( W = \nabla^2_{\perp} \phi + \nabla \cdot \left( \frac{\nabla \cdot P_i}{N} \right) \). A link is thus established between the radial electric field and the ion pressure gradient which seems to be a key feature of the pedestal formation.

A reduced bi-dimensional fluid code based on the interchange instability, TOKAM-2D [4], is used to study spontaneous transport barriers which appear at the transition between open and closed field lines. These transport barriers are characterized by their turbulence stopping capability, using the ratio between turbulent and total radial fluxes as defined in [5]. The barrier efficiency and intermittency can be estimated using statistical moments of the criterion. The TOKAM-2D model has been improved in order to include closed field lines and to solve consistently the electron and ion energy balances. A parametric scan on ions injected power reveals the existence of a threshold which controls the radial electric field profile and the dynamic of the transport barrier which seems qualitatively coherent with previously reported results [6]. However, these simulations appear to strongly underestimate this injected power threshold compared to experimental observations suggesting that additional mechanisms are probably at play to limit the build-up of the barrier. A similar scan is then realized on the 3D turbulence edge code TOKAM-3X [7] and leads, at equivalent input power, to the formation of much weaker, although non zero, transport barriers. A detailed comparison between the two simulations and models is realized in order to emphasize the impact of the parallel dynamic and of geometrical effects on the input power threshold and on the transport barriers formation.

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