IMPACT OF COLLISIONALITY ON TURBULENCE IN THE EDGE PLASMA AND SCRAPE-OFF LAYER (SOL)

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A better understanding of how turbulent transport influences the scrape-off layer width and more in general the confinement of the plasma itself is required in sight of the design of future fusion reactors, as ITER. State of the art modeling tools can provide a deeper understanding of these phenomena.

The TOKAM3X code [1, 2] has been developed between M2P2 and IRFM. This is a 3D fluid turbulence code which can simulate self –consistently the plasma turbulence in full torus geometry (both open and closed field lines) in limited and diverted configurations. Including energy balance equations in TOKAM3X opens the way to consistently take into account variations of collisionality and its direct impact in heat and charge conductivity, in the edge and SOL [3, 4].

To study those effects a set of TOKAM3X simulations have been run using COMPASS characteristic parameters with different value of resistivity. All simulations are performed with high field side limiter in circular plasma geometry. This analysis shows that the size and the amplitude of turbulent structures are sensitive at the changes of collisionality, especially the lower is the resistivity and the smaller the structures become. This opens numerical issues on the code resolution and therefore it gives a constraint on the value of collisionality that we can use in our simulation. Moreover heat conductivity is found to have the same qualitative impact.

To assess these results, the impact of resistivity has been analyzed in a simplified model that allows us to determine analytical growth rates and investigated some of non-linear properties. Here we have found analytically that reducing the resistivity leads to a larger typical wave length and therefore generate smaller turbulent structures. The scaling is weakly sensitive on the resistivity (power 1/4). Based on this model the amplitude of the fluctuations exhibits a maximum with two branches. Thus, at larger resistivity the amplitude tends to increase and vice versa. The dependence of wave vector with thermal energy is typically T^(3/8). A balance argument between the damping and drive terms indicates that for the large resistivity branch the amplitude tends to decrease when decreasing the resistivity. This analytical work is consistent with simulations from TOKAM2D [5], a 2D version of TOKAM3X. The discrepancy of 2D simulation and 3D is further discussed.

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