3D turbulence in tokamak scrape off layers and consequences for core rotation

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Recently, experimental studies of SOL flows phenomena have revealed the influence of such flows in the dynamics of intrinsic rotation in L-mode and the threshold of L-H transition[1][2]. Since the phenomena in question occurs in L-mode, the explanation must take into account the turbulence in the vicinity of the LCFS to figure out the interaction of SOL transport on core rotation and electric field shear prior to the transition. The explanation must also include the asymmetry breaking by physical boundaries and LFS localised particle outflux. Here we propose to review the experimental studies of SOL particle transport in the tokamak Tore Supra, in the framework of transport nature, asymmetries and large scale flow generation. The ultimate advantage of this device is to propose a set of reciprocating Langmuir probes located at the plasma top and a set of movable limiters located at the LFS.

We first demonstrate that in usual ohmic conditions the parallel flows correspond to return flows along isopressure field lines that tend to balance the radial particle flux asymmetry. The poloidal mapping of the steady-state radial particle flux is estimated from the amplitude and variation of local parallel flows according to the limiters topology [3]. The radial flux is centered at the ouboard midplane with a poloidal Gaussian opening width of about $\Delta\theta \pm 50^o$ at the LCFS, in agreement 3D simulations [4][5].

The local electrostatic radial flux (also at the top) corresponds to the outdrift of density bursts. Close to the LCFS, its amplitude matchs the poloidal mapping obtained from density and parallel flow profiles. The picture is completed with fast visible imaging: plasma filaments are anambiguously observed in the LCFS to propagate radially across the LCFS to the far SOL, but are hardly found in the HFS. Filaments are thus $\Delta\theta \pm 50^o$ structures, largely influenced by the magnetic shear as suggested by the transversal orientation of electrostatic fluctuations. In turns they drive large scale parallel flows and parallel front explusion along field lines. Since at the LCFS a large fraction of the time fluctuating radial flux is directed inward, these flows can be convected to the plasma core. The optimal SOL geometry for SOL/core coupling can be investigated from the resolution of poloidal asymmetries of radial flux, parallel flows and transversal flows. Comparison between modeling and Tore Supra experiment is discussed.

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