On the role of turbulence on momentum redistribution in fusion devices

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The mechanisms underlying the generation of plasma flows play a crucial role in understanding key issues on transport in magnetically confined plasmas. It is well known the importance of driving shear in plasma rotation in the development of transport barriers. Rotation can be driven by external forces such as momentum from Neutral Beam Injection (NBI). However, in large scale devices like ITER (where the available NBI power is limited and the energy of injected neutrals must be high to reach the core plasma region) the NBI driven rotation will be limited. Then, it is important to study the possible role of other mechanisms which can drive plasma rotation.

The amplitude of parallel flow measured in the scrape-off layer (SOL) is significantly larger than those resulting from simulations [*1*]. Recent experiments have pointed out the possible influence of turbulence in explaining a component of the anomalous flows observed in the plasma boundary region [*2*, *3*].

In the plasma core region, evidence of anomalous toroidal momentum transport has been reported [4, 5, 6]. Different mechanisms have been proposed to explain these results, including neoclassical effects [7], turbulence driven models [8, 9] and fast particle effects. The response of toroidal rotation to near-perpendicular NB injection on JT-60U has been interpreted on the basis of the influence of loss of high-energy particles [10]. The flow reversal observed in the CHS stellarator can be explained by the spontaneous flow driven by large radial electric fields [11]. Neoclassical effects can also play an import role [12].

Recent experiments in the TJ-II stellarator have shown that the generation of spontaneous perpendicular sheared flows requires a minimum plasma density. Near this critical density, the level of edge turbulent transport and the turbulent kinetic energy significantly increases in the plasma edge [13,14]. Experimental results also show significant turbulent parallel forces at plasma densities above the threshold value to trigger perpendicular ExB sheared flows [15]. These findings provide the first experimental evidence of the important role of parallel turbulence forces on edge momentum dynamic in fusion devices.

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[1] K. Erents et al., Plasma Phys. Control. Fusion 42 (2000) 905.
[2] C. Hidalgo et al., Phys. Rev. Letters 91 (2003) 065001.
[3] B. Labombard et al., Nuclear Fusion 44 (2004) 1047.
[4] S. D. Scott et al., Phys. Rev. Lett. 64 (1990) 531.
[5] W. D. Lee et al., Phys. Rev. Lett. 91 (2003) 205003.
[6] J.E. Rice et al., Nucl. Fusion, 44 (2004) 339
[7] A. L. Rogister et al., Nucl. Fusion 42 (2002) 1144.
[8] B. Coppi, Nucl. Fusion 42 (2002) 1.
[9] X. Garbet et al., Phys. Plasmas 9 (2002) 3893
[10] Y. Koide et al., in Plasma Physics and Controlled Nuclear Fusion Research 1992 (Proc. 14th Int. Conf. Wurzburg, 1992), Vol. 1, IAEA, Vienna (1993) 777.
[11] K. Ida et al., Phys. Rev. Lett. 86 (2001) 3040.
[12] K. Ida et al., Nucl. Fusion 45 (2005) 391.
[13] M.A. Pedrosa et al., Plasma Phys. Control Fusion **47** (2005) 777.
[14] C. Hidalgo et al., Phys. Rev. E **70** (2004) 067402.
[15] B. Gonçalves et al., Phys. Rev. Lett. (2005) (submitted)