On the momentum re-distribution via turbulence in fusion plasmas

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The mechanisms underlying the generation of plasma flows play a crucial role to understand transport in magnetically confined plasmas. Simulations of plasma flows have been previously investigated in the scrape-off layer (SOL) including the effects of diamagnetic, ExB and B x grad B drifts. The amplitude of measured parallel flow is significantly larger than those resulting from simulations[1]. Recent experiments have pointed out the possible influence of turbulence to explain flows in the plasma boundary region [2]. In the plasma core region evidence of anomalous toroidal momentum transport has been reported in different devices[3,4,5]. Different mechanisms have been proposed to explain those results including neoclassical effects[6], turbulence driven models[7,8] and in the case of ICRF heating, fast particle effects. At present the cause of toroidal rotation generated in the absence of momentum source remains unexplained.

This paper reports the first experimental evidence of significant radial gradients in the cross-correlation between parallel and radial fluctuating velocities near the LCFS in JET tokamak. Plasmas studied in this paper were produced in X-point plasma configurations ohmic and L-mode plasmas. The present experimental results show that radial gradients of $< \tilde{v}_r \tilde{M}_{parallel} >, \tilde{v}_r$ and $\tilde{M}_{parallel}$ being the fluctuating (ExB) radial velocity and the fluctuating parallel Mach number respectively, are in the order 10^3 s^{-1}. These gradients are mainly due to the radial variations in the level of poloidal electric filed fluctuations and in the cross-phase coherence. Experimental results show that the contribution of $\frac{d}{dr} < \tilde{v}_r \tilde{M}_{parallel} >$ is larger than charge-exchange loss mechanisms in the parallel momentum balance equation in the plasma boundary region. These findings might provide the underlying physics of spontaneous toroidal rotation and large parallel flows in plasma boundary reported in fusion plasmas.

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