On the coupling between flows and turbulence

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Recent experiments in tokamaks and stellarators have shown that the paradigm of turbulence controlled by sheared flows should include both mean and oscillating sheared flows [1,2, 3]. In particular, experimental findings in the TJ-II stellarator point out the possible role of low frequency fluctuating sheared flows (zonal flows) as a trigger mechanism of edge transport barriers [1]. In addition pronounced oscillations in both radial electric fields and density fluctuation level are measured right inside the *E*x*B* shear layer [4] with characteristic predator-prey behaviour. These observations, together with the amplification of long-range spatial correlation in the potential fluctuations by steady state radial electric fields [5, 6, 7] and evidence non-local energy transfer [8], are consistent with L-H transition models based on turbulence induced zonal flows. Furthermore, comparative studies in tokamaks, stellarators and reversed field pinches have revealed significant differences in the level of the long-range toroidal correlations suggesting the damping role of magnetic perturbations on zonal flows, in agreement with observations during the Resonant Magnetic Perturbations experiments in the TEXTOR tokamak [7].

These observations provide a guideline for further developments in plasma diagnostics and multi-scale transport studies including: a) the investigation of 3-D effects in the damping of zonal flows [7]; b) the influence of magnetic shear/rationals on zonal flows and profile dynamics [9, 10, 11]; c) the role of magnetic viscosity in the dynamical interplay between electric fields and fluctuation levels [4]; d) the interplay between radial transport, turbulence spreading [12] and zonal flows [13]. e) the investigation of the radial propagation and time dynamics of zonal flows / GAMs [14, 15]; f) The development of advanced analysis tools to unravel the time dynamics of low frequency zonal flows [16].

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