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TH/P2-06: The Role of Convective Structures in the Poloidal and Toroidal Rotation in Tokamak

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Mixed regimes consisting of coexistence large scale flows (H-mode, Internal Transport Barriers) and turbulence are expected to be the current state in ITER. The rotation, either spontaneous or induced, will play a major role in the quality of the confinment. We investigate the influence of the poloidal rotation on the toroidal flow. The efficiency of the sheared poloidal rotation to control the instabilities is considerably higher than that of the toroidal rotation but it is usually assumed that the poloidal rotation should be at the neoclassical level due to the damping induced by magnetic pumping. This is true if the drive of the poloidal rotation relies on the Reynold stress of a poloidally cuasi-symmetric turbulence. Much higher drive of the poloidal rotation is however provided by flows associated with the convective structures that can be generated in the plasma cross-section beyond a threshold in the plasma pressure gradient. This drive overcomes the damping due to the magnetic pumping and the poloidal rotation is sustained. Cells of convection consisting of closed, large scale flows can be spontaneously generated, triggered by streamers sustained by the baroclinic term able to generate vorticity. Similar to the Reyleigh-Benard first bifurcation (from purely conductive to convective regime), the onset is very fast and the drive exerted on the poloidal rotation leads to a fast time variation of the polarization radial electric field. This is sufficient to create a distinction between the phases (first half, second half) of bounce on a banana of trapped ions and, implicitely, leads to acceleration in the toroidal direction (F. Spineanu and M. Vlad, arXiv.org/pdf/1202.4426)
The structure consisting of cells of convection, breaking the azimuthal symmetry, is not a stationary state, mainly because they will induce magnetic perturbations. The reconfiguration of the flow due to the magnetic reconnections will reinstall the conductive state even if the gradients are still favorable to a convective response. The intermittent generation of convective structures must then be treated as a stochastic process consisting of a random sequence of events. The effect on the (toroidal) angular momentum transport will be discussed on the basis of the fluctuating drive of the Reynolds stress (a doubly random process).

Country or International Organization of Primary Author

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Collaboration (if applicable, e.g., International Tokamak Physics Activities)

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