Impact of flow poloidal asymmetries on transport in tokamaks

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Physics of turbulent transport in tokamaks has long relied on the paradigm of helical fluctuations on top of a fully symmetrical equilibrium. Symmetry is still preserved whenever zonal fields or zonal flows are generated by turbulence, since these structures are left invariant by rotations in both poloidal and toroidal directions. However it turns out that turbulence generates flows that are not poloidally symmetric, while still zonal in the toroidal direction. These structures are dubbed “poloidal convective cells”.

These cells affect transport, via several processes - some similar to those at play for neoclassical transport. It appears in particular that poloidal convective cells contribute to a significant fraction of heavy impurity fluxes [1] and stress tensors [2]. Mechanisms for the formation and sustainment of these cells have been clarified and will be presented. Their impact on transport will be illustrated with results from GYSELA gyrokinetic simulations where neoclassical and turbulent fluxes are computed simultaneously.

Evidence of flow poloidal asymmetries has been found in measurements by Doppler backscattering in the Tore Supra tokamak [3]. Possible explanations for these flow asymmetries, including convective cells, will be discussed. Finally turbulence self-regulation via asymmetrical flow generation and feed-back due to flow shear will be discussed.

[1] D. Estève et al., https://hal-insu.archives-ouvertes.fr/cea-01380649/, to appear in Nucl. Fusion.

[2] X. Garbet et al., New J. Phys. **19**, 015011 (2017).

[3] L. Vermare et al., 44th EPS conference on plasma physics (2017), submitted to Physics of Plasmas.