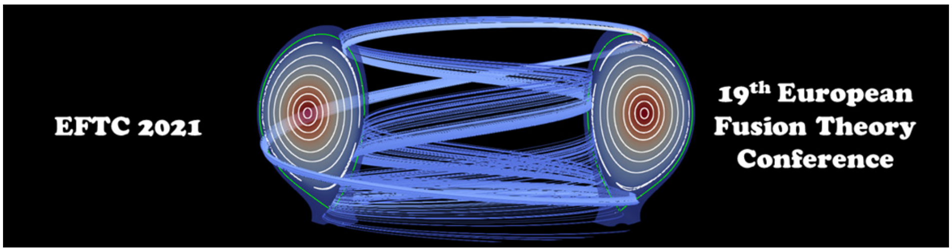

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Impact of non-axisymmetric magnetic field perturbations on flows

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While the achievement of high confinement regime is ensured through the formation and sustainment of edge transport barriers associated with sheared flows, the effect of non-axisymmetric perturbations of the magnetic field, like non-resonant magnetic perturbations or ripple, on the transition remains an open issue. The underlying loss of axisymmetry is responsible for a toroidal torque, sometimes called Neoclassical Toroidal Viscosity (NTV), which, as predicted by neoclassical theory, leads to magnetic braking. This constraint lifts the degeneracy between the mean toroidal velocity and the radial electric field which results from toroidal symmetry in the standard neoclassical theory. As a result, predictions on meaningful quantities regarding transport barriers, i.e. mean flows and radial electric field, are available in the low collisionality limit. The implementation of non-axisymmetric perturbations in the gyrokinetic code GYSELA shows quantitative agreement between neoclassical theory and simulations for experimentally relevant magnetic perturbation magnitude and collisionalities. In realistic plasmas, mean flows result from a competition/synergy between neoclassical effects and turbulence. In ion temperature gradient driven turbulence, this competition reveals that even a small perturbation amplitude, typically a few percents of the unperturbed magnetic field magnitude, tends to change the plasma mean toroidal rotation toward the counter-current direction. This effect has already been observed experimentally in JET, JT-60U and Tore Supra. The radial electric field increases by up to +80%, thus showing that a non-axisymmetric perturbation may impact the transition toward transport barriers. To understand and quantify this competition, the turbulent Reynold's stress is compared with the theoretical magnetic drag. Simulations with realistic plasma parameters show that turbulent transport prevails for a ripple amplitude below a critical value. Above this threshold, sheared flows are controlled by the NTV.

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