Computation of neoclassical toroidal viscosity with the account of non-standard orbits in a tokamak

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Neoclassical toroidal viscous (NTV) torque from internal and external non-axisymmetric magnetic field perturbations is usually computed using a local approach where toroidal torque density is directly related to local, gradient-driven neoclassical particle fluxes via an algebraic flux-force relation. Validity of this approach requires that the radial orbit width is small compared to both, radial perturbation scale and distance to the magnetic axis. For the typical medium-range tokamak parameters, both conditions may be violated for the ion plasma component. In particular, this concerns the radial scale of resonant magnetic perturbations (RMPs) used to mitigate edge localized modes at the plasma edge. The code NEO-RT [1] computes ion NTV in the most typical "collisionless" resonant plateau regime using a Hamiltonian approach. Taking finite orbit width into account showed that the local model correctly predicts the order of magnitude of the torque from RMPs but the profile of torque density is modified [2]. For the externally driven and internal kink-like perturbations localized near the axis, conditions for both radial perturbation scale and distance to the magnetic axis are usually violated. This may lead to a significant overestimation of the ion torque. In the present report, a modified, fully non-local version of NEO-RT code is presented. Besides the standard, passing and banana particle orbits, the underlying model takes into account all other possible types of non-standard orbits. The later orbits (e.g. "potato" orbits) form additional classes separated in the phase space by homoclinic orbits with infinite bounce time. More orbit classes are created near the magnetic axis when a weak radial electric field is present. When the field can not be treated as weak, there can be arbitrary many classes. In this report, results of this fully non-local NTV model are compared to local models for the resonant plateau regime [1] and general collisionality regimes [3].

References

[1] C.G. Albert *et al*, Physics of Plasmas 23, 082515 (2016)

[2] C.G. Albert *et al*, 44th EPS Conference on Plasma Physics ECA 41F P1.182 (2017)

[3] S.V. Kasilov *et al*, Physics of Plasmas 21, 092506 (2014)