Evaluation of the toroidal torque driven by external non-resonant non-axisymmetric magnetic field perturbations in a tokamak

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The toroidal torque driven by external non-resonant magnetic perturbations (neoclassical toroidal viscosity) is an important momentum source affecting the toroidal plasma rotation in tokamaks. The well-known force-flux relation directly links this torque to the non-ambipolar neoclassical particle fluxes arising due to the violation of the toroidal symmetry of the magnetic field. Here, a quasilinear approach for the numerical computation of these fluxes is described. It reduces the dimension of a standard neoclassical transport problem by one without model simplifications of the linearized drift kinetic equation. The only limiting condition is that the non-axisymmetric perturbation field is small enough such that the effect of the perturbation field on particle motion within the flux surface is negligible. Therefore, in addition to most of the transport regimes described by the banana (bounce averaged) kinetic equation also such regimes as, e.g., ripple-plateau and resonant diffusion regimes are naturally included in this approach. Based on this approach, a quasilinear version of the code NEO-2 has been developed and benchmarked against a few analytical and numerical models. Results from NEO-2 stay in good agreement with results from these models in their pertinent range of validity. In addition to results for a simplified tokamak geometry used for benchmarking, also results for tokamak geometry (ASDEX Upgrade) will be shown.

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