Toroidal momentum maintenance and transport in simulations of nonlinear turbulent convection in tokamak core plasmas

V.P. Pastukhov, D.V. Smirnov

NRC "Kurchatov Institute", Moscow, Russian Federation

The paper continues our previous theoretical study and simulations of low-frequency turbulence and the associated cross-field anomalous transport processes in tokamak core plasmas [1-3]. The main goal of the paper is simulation of toroidal momentum transport in the presence of self-consistent nonlinear turbulent plasma convection. Contrary to many other studies our simulations are based on adiabatically-reduced MHD-like plasma dynamic model in which the toroidal plasma flows are the natural parts of the nonlinear turbulent plasma convection [1, 2]. We assume that magnetic field in tokamaks is axi-symmetric with nested magnetic flux surfaces. As a result, there are inherent conservation laws for the toroidal momentum and the dynamic vorticity in this model. Code CONTRA-C developed in a frame of simplified cylindrical model for tokamaks was used for this series of simulations. Temporal evolution and radial profiles of plasma potential, toroidal momentum density, and dynamic vorticity in presence of different torque sources are simulated and analyzed. We consider torque sources those correspond to neutral beam injection, various symmetry breaking mechanisms, as well as to momentum and vorticity exchange between plasma core and SOL region at the external boundary of simulation domain. Special attention is paid to regimes in which conditions for ITB formation near the major rational surfaces could be satisfied [3].

References

[1] V.P. Pastukhov, N.V. Chudin and D.V. Smirnov, Plasma Phys. and Controlled Fusion 53, 054015 (2011)

[2] V.P. Pastukhov and D.V. Smirnov, Plasma Phys. Reports 42, 307 (2016)

[**3**] V.P. Pastukhov and D.V. Smirnov, Proceedings of 44th EPS Conference on Plasma Physics, report P2.173 (http://ocs.ciemat.es/EPS2017PAP/pdf/P2.173.pdf)