Gyrokinetic simulation of zonal flows in helical plasmas with equilibrium-scale radial electric field

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Zonal flows spontaneously generated by plasma turbulence in toroidal fusion plasmas play leading roles in the anomalous transport reduction. Thus, it is important to seek a magnetic configuration with strong zonal-flow generation. The zonal-flow response in helical system is enhanced by optimizing the configuration with slower radial drift of trapped particles. It is also pointed that an equilibrium-scale radial electric field (E_r) leads to further increase of zonal flows in helical systems [1]. Our gyrokinetic simulations are recently extended for studying the zonal flow response in helical systems with E_r [2]. The simulation results manifest increase of the residual zonal flows in case with the poloidal Mach number of 0.1-0.3, and support the theoretical prediction. The dependence of the residual zonal-flow amplitudes on the radial wavenumbers is weak in the inward-shifted LHD plasma in contrast to the case without E_r. In the standard LHD configuration, furthermore, the zonal-flow response shows an oscillatory behavior. The obtained results also suggest that using ions with a heavier mass gives rise to a higher zonal-flow response under the identical conditions on the magnitude of E_r and the magnetic geometry. It is, thus, expected that the turbulent transport show a more favorable ion-mass dependence than the conventional gyro-Bohm scaling.

[1] H. Sugama and T.-H. Watanabe, Phys. Plasmas **16,** 056101 (2009).

[2] T.-H. Watanabe, 22nd IAEA Fusion Energy Conference 2008, Geneva, Switzerland (IAEA, Vienna, 2008) TH/P8-20.