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TH/8-1: Turbulence Spectra, Transport, and ExB Flows in Helical Plasmas

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Turbulence spectra and transport in helical plasmas are investigated by the gyrokinetic simulations of ion temperature gradient (ITG) turbulence interacting with microscopic ExB zonal flows (ZFs) and by the neoclassical transport analysis of macroscopic ExB flows. Our recent kinetic simulations enable us quantitative evaluation of the turbulent transport level and the macroscopic radial electric field (Er) relevant to the Large Helical Device (LHD) experiments. The gyrokinetic simulations with the GKV-X code clarify the spectral transfer of potential fluctuations toward stable modes with higher radial wavenumbers through ZF-turbulence interactions, and elucidate the regulation of turbulent transport due to ZFs in the neoclassically-optimized magnetic configuration. The radial electric field Er with an equilibrium-scale length, which is evaluated by the neoclassical transport code, FORTEC-3D, including the finite-orbit-width effects, leads to further enhancement of the ZF response. Thus, turbulent transport processes are significantly influenced by neoclassical processes in helical systems through the effects of the magnetic configuration and macroscopic Er on microscopic ZFs. The "flux-tube bundle"model is constructed for the multi-scale simulation studies on turbulence, ZFs, and Er, and is confirmed to reproduce the same Er effect on the ZF response as that obtained by the poloidally-global simulation.

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