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# Gyrokinetic Simulation Study of Zonal Flow Staircases in a KSTAR L-mode Plasma

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In predicting anomalous transports in tokamak, it is critical to understand the complex natures of plasma turbulence, especially their interactions with flows. In tokamak, plasma flows can be driven by both external and internal means. Among the flows, which contribute to the regulation of turbulences, zonal flow is considered as a key contributor to the regulation. Therefore, it is very important to study the physics of zonal flow generation and dynamics. However, due to technical difficulties of global measurement of fluctuation and flow in tokamak experiment, detailed natures of zonal flow and their impacts on transport are still poorly understood.

Recently, there was an important progress in measuring global structures of $T_e$ fluctuations in a KSTAR L-mode experiment[1]. Employing 2D ECEI diagnostics, 2D $T_e$ fluctuations were measured, which revealed regulated avalanches in electron heat transport and quasi-stationary corrugations on the electron temperature profile. To investigate the physical origin of the regulations in avalanches and measured corrugation structures, we perform global gyrokinetic simulations using the KSTAR experimental parameters. Global PIC-code gKPSP[2,3] is employed for the simulations. Simulation results show that the KSTAR L-mode plasma is dominated by $\nabla T_e$-driven TEM turbulence, which is caused by strong ECH. Large scale avalanching in TEM driven electron heat transport observed in experiments is successfully reproduced from our nonlinear gyrokinetic simulations. Zonal flow generated by the TEM turbulence is found to have quasi-stationary staircase structures[4], which are demonstrated responsible for the regulations of electron heat avalanches and causing corrugations in $T_e$ fluctuation radial profile. The staircase scale from our simulations i.e., $\Delta \sim 40\rho_i$, is consistent and can well explain the experimental observation of corrugation scale in $T_e$ fluctuation.

References

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