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Gyrofluid Study on E×B Staircase structure and non-local transport

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Recent observations on the experiments in KSTAR suggest the evidence of the non-diffusive avalanche-like electron heat transport events from the L-mode and internal transport barrier (ITB) plasmas without magnetohydrodynamic (MHD) instabilities[1]. Corrugated electron temperature (T_e) structure is observed from the two-dimensional T_e measurement. Based on Self-Organized Criticality(SOC) dynamics, E×B staircase is known to strongly correlate with corrugated mean profile and regulate the avalanche events by the formation of micro-barriers[2,3]. Moreover, a model based on Hasegawa-Wakatani equation showed that those mesoscale structures can merge and become a global structure in the self-organized process, achieving an enhanced confinement state[4]. Inspired by previous works, we analyze the evolution of structures using gyrofluid code developed by Yagi[5], which adopts the 3-field equations with neoclassical poloidal flow damping. To understand the corrugated structure and E×B staircase observed in the simulation, we derive the mesoscopic mean field equations based on the 3-field equations. This model is similar to the reduced model from Hasegawa-Wakatani equation[4], but the effects from the compression of parallel flow fluctuations[6] are considered in our model equation. A coupling term between the fluctuating potential and parallel flow fluctuation acts as a source of zonal flow and facilitates the establishment of E×B staircase. To verify this effect from the simulations, we control the parallel flow fluctuations via changing the coefficient of neoclassical poloidal flow damping. Corrugated structures and E×B staircase emerge and evolve in the way similar to predicted in Ref. 4. Correlation between E×B staircase and parallel flow fluctuations is observed, but analysis of their detailed causal relation is required. The presentation will cover the results of the characteristics of self-organized global profile and E×B staircase structure.

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