Properties of avalanches and momentum transport in driven ITG turbulence

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Simulations of driven Ion Temperature Gradient (ITG) turbulence under an experimentally relevant fixed heat flux condition were enabled using a global Gyrokinetic Toroidal full-*f* five dimensional (5D) Vlasov code GT5D [1,2], which solves a conservative gyrokinetic equation with the linear Fokker-Planck operator. In the simulation, the neoclassical ion heat transport is included, and the radial electric field is determined consistently through the neoclassical force balance relation, which relates the radial electric field, the pressure profile, and the parallel flow profile. In recent driven ITG turbulence simulations, basic properties of ion turbulent transport such as the stiffness of ion temperature profile, intermittent heat transport due to self-organized critical (SOC) phenomena [3], and non-diffusive momentum transport producing intrinsic toroidal rotation were successfully recovered [1]. In the simulation, it was found that avalanches or non-local propagation of heat flux have an order of magnitude larger spatio-temporal scales compared with those of turbulent fluctuations, and their amplitudes increased with the heating power. These observations suggest that avalanche phenomena produce key features of turbulent transport in the driven ITG turbulence, namely intermittent ion heat transport and the stiffness of ion temperature profile. Therefore, it is important to study the underlying mechanism of avalanche phenomena in understanding the stiffness of ion temperature profile, which is considered to limit an overall performance of H-mode plasmas once the pedestal temperature is given. In the present study, we perform simulations with different conditions with respect to the neoclassical radial electric field and the aspect ratio, and clarify roles of the radial electric field shear and toroidal mode coupling in the avalanche phenomena. We also discuss a relation between the avalanche phenomena and the strength of stiffness of ion temperature profiles. Another important feature found in the latter simulation is non-diffusive momentum transport leading to intrinsic toroidal rotation. In the simulation, it was found that non-diffusive momentum transport is related to the shear of neoclassical radial electric field. In the present work, we address elementally processes which support this observation. From the viewpoint of radial electric field shear stress [4], we show the shift of $k_{//}$ spectrum observed in the latter simulation, and discuss the mechanism of non-diffusive momentum transport.

References

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