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Effect of energy-non-transporting nonlinear flux on the turbulent plasma transport

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Turbulent plasma transport is an important issue in the confinement of the fusion plasmas. E×B nonlinear flux plays a deciding role in redistributing the energy and the momentum. In the case of the isothermal plasma the particle flux Γ is the fundamental measure of the turbulent transport. In the fusion plasma where the particle collisions are relatively rare the plasma is near the adiabatic state. The present work sets out to study Γ near adiabatic state of the electrostatic resistive fluid plasma fluctuations [1]. Simulations are performed in the BOUT++ frame [2] in two-dimensional slab Lx=Ly=80π perpendicular to the equilibrium magnetic field with grids 256×256. The fixed equilibrium density gradient is in the negative x direction and the electron diamagnetic drift is along the y axis. Fluctuations at small scales kρ_s≫1 are cut off by the hyper dissipation.

At a quasi-steady state of the energy Γ, in contrast to the energy, is not quite steady exhibiting intermittent peaks as it changes between less than 10 to larger than 40. It is found that secondary broad peak 0.6≤kρ_s≤1.0 is present when Γ is large. The spectra of the E×B energy flux illustrate a similar distribution in the range kρ_s≥0.5 that generally agrees with the difference of Γ's. The E×B energy flux is divided into two parts: one directly involved in the energy redistribution and the other [3]. Preliminary results indicate the strong impact of the latter part on Γ by controlling the phases of the fluctuations. Similar process is believed to be working inside the fusion plasma. Detailed analyses of the correlation between the energy flux and the phases as well as extension to the thermal flux of more realistic plasma models will be discussed at the conference.

[1] A. Hasegawa and M. Wakatani, Phys. Rev. Lett. 50, 682 (1985).

[2] B. D. Dudson et al, Comput. Phys. Commun. 180, 1467 (2009).

[3] B. Min et al, Plasma Phys. Control. Fusion 57, 095009 (2015); B. Min et al, J. Kor. Phys. Soc. 66, 1226 (2015).

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