Vortex structures and transport levels in slab electron temperature gradient driven turbulence

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A strong anomaly of electron heat transport has commonly been observed in a core region of magnetically confined plasmas even when the ion anomalous heat transport is reduced by the internal transport barrier(ITB) [1]. Turbulent transport driven by the electron temperature gradient (ETG) modes is considered as one of the possible candidates causing the anomalous electron heat transport. Recently, a number of gyrokinetic simulations of the ETG turbulence have been performed with various simulation codes [2,3]. However, the saturation mechanism of the toroidal ETG instability and the estimation of the resultant transport level are still open problems. The slab ETG turbulence has also been investigated with the aim of understanding its saturation process [4–6].
In our recent gyrokinetic Vlasov simulations of the slab ETG turbulence, two different flow structures, i.e., steady isotropic turbulence and coherent aligned vortices, are observed. Nonlinearly excited zonal flows, which suppress elongated streamers, lead to the isotropic turbulence with steady heat transport. When the coherent vortex structures are formed, however, the electron heat transport is significantly reduced by the reduction of phase difference between the potential and temperature fluctuations. A traveling wave solution of the Hasegawa-Mima type fluid equation including electron temperature gradient successfully describes the coherent vortex structures. In the present study, we investigate how the parameters of $\eta_{\mathrm{e}} \equiv L_n/L_T = d\ln T_{\mathrm{e}}/d\ln n_0$ and $\Theta = k_{\parallel} L_T/k_{\perp}\rho_{\mathrm{te}}$ affect the formation of the coherent vortex structures and the resultant transport levels. Parameter-scans clarify that the ratio of the zonal flow energy to the turbulence one depends on Θ. More detailed analyses of the results are currently in progress and will be reported at the conference.

[1] B. W. Stallard, C. M. Greenfield *et al.*, Phys. Plasmas. **6**, (1999) 1978
[2] Y. Idomura, S. Tokuda and Y. Kishimoto, Nucl. Fusion **45**, (2005) 1571
[3] W. M. Nevins, J. Candy *et al.*, Phys. Plasmas **13**, (2006) 122306
[4] Y. Idomura, Phys. Plasmas **13**, (2006) 080701
[5] T. Matsumoto, J. Li and Y. Kishimoto, Nucl. Fusion **47**, (2007) 880
[6] J. Li and Y. Kishimoto, Phys. Plasmas **15**, (2008) 112504