Gyrokinetic turbulence cascade via predator-prey interactions between different scales

Sumire Kobayashi & Ozgur Gurcan

Affiliation : Laboratoire de Physique des Plasmas, Ecole Polytechnique, CNRS, Paris-Sud, UPMC, UMR7648, F-91128 Palaiseau, France
sumire.kobayashi@gmail.com

Nonlinear gyrokinetic simulations in a closed fieldline geometry is presented to explore the physics of collisionless plasma turbulence cascade. While spontaneously formed zonal flows and small-scale turbulence demonstrate predator-prey dynamics, a particular cascade spectrum emerges even in the presence of energy injection. The electrostatic potential and the density spectra appear in good agreement with simple theoretical prediction $\left|\widetilde{\phi}_k\right|^2 \sim \left|\widetilde{n}_k\right|^2 \propto k^{-3}/\left(1+k^2\right)^2$[?], with the spectra becoming anisotropic at small scales. The results indicate that the disparate scale interactions, and in particular the refraction and shearing of larger scale eddies by the self-consistent zonal flows, play the dominant role over the local interactions in creating the characteristic turbulence spectrum, and that the nonlinear physics in gyrokinetic system in a simple geometry compares reasonably well with reduced model such as Charney-Hasegawa-Mima equation.