Gyrokinetic Particle Simulation of Spectral Cascade and Energy Dissipation in Magnetohydrodynamic Turbulences

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Random magnetic fluctuations are ubiquitous in space and astrophysical plasmas. Low frequency magnetohydrodynamic (MHD) turbulence is typically driven at large spatial scales, cascades through inertial ranges, and dissipates the energy to the plasmas at smaller scales. The kinetic processes leading to the dissipation of the turbulence energy at small scales, and associated spectral cascade from large to small scales, are not well understood due to the difficulties of kinetic simulations resolving disparate spatial-temporal scales in MHD turbulences. We have developed a 3D, massively parallel, particle-in-cell electromagnetic code to study the energy cascade and dissipation in anisotropic Alfven turbulences. The ion is modeled using the gyrokinetic method and the electron dynamics is treated using a fluid-kinetic hybrid model based on an expansion of the electron response using the electron-ion mass ratio as a small parameter [1]. The rectangular geometry with uniform magnetic field is used to focus on the fundamental physics process. Linear dispersion relation for decaying kinetic shear Alfven waves has been recovered in linear simulations. Nonlinear simulations with energy injection at large scales will be discussed. This work is supported by U.S. DOE Grant No. DE-FG02-03ER54694.

[1] *A Fluid-Kinetic Hybrid Electron Model for Electromagnetic Simulations*, Zhihong Lin and Liu Chen, *Phys. Plasmas* **8**, 1447 (2001).