Geophysical Research Abstracts
Vol. 20, EGU2018-4959, 2018
EGU General Assembly 2018

In-situ Measurement of Scale-dependent Net Energy Conversion Spectrum in Turbulent Plasmas

Jiansen He (1), Die Duan (1), Tieyan Wang (2), Xingyu Zhu (1), Daniel Verscharen (3), Xin Wang (2), and Chuanyi Tu (1)

(1) School of Earth and Space Sciences, Peking University, Beijing, 100871, China (jshept@gmail.com), (2) School of Space and Environment, Beihang University, Beijing, 100191, China, (3) Mullard Space Science Laboratory, University College London, Holmbury Hill Rd, Dorking RH5 6NT, UK

In turbulent plasmas, it is a fundamental issue to address the energy conversion from turbulent waves to particles. The quantity $J\cdot E$ is a good measure to study the ongoing energy conversion between electromagnetic energy and particle energy. In previous studies, the time average $<J\cdot E>$ is often calculated to give the total amount of magnetic energy dissipation within coherent structures, e.g., reconnection current sheet.

In this study, we expand it to calculate the energy conversion spectra in scale dimension, $<\mathrm{Re}(\delta J(t,\omega)\cdot\delta E^*(t,\omega))>/2$, where δJ is the wavelet coefficient vector of current fluctuations, and δE is the conjugate wavelet coefficient vector of electric field fluctuations. We apply this technique to the magnetosheath turbulence. The thermal anisotropy of protons (T_perp/T_para>1) is found to be linearly unstable and responsible for the power spectral bump of circularly-polarized magnetic fluctuations.

However, the scale-dependent energy conversion spectrum is calculated to be positive at the concerned scales, indicating a net energy conversion from the turbulent electromagnetic waves to the plasmas (or called “dissipation of the turbulent waves” in some sense).
To compromise the "counter-intuitive contradiction" between the unstable growth of waves according to linear theory and the damping of waves from real measurements, one needs to consider two possibilities: (1) one speculation is nonlinear state of the excited waves when extra free energy is transferred back to the particles by scattering them in phase space (2) the other possibility is spatial decay of the turbulence as moving further downstream of the shock.

Furthermore, we demonstrate that, to investigate the damping rate spectra in the turbulence, one needs to calculate $<\mathrm{Re}(\delta J(\omega,k)\cdot\delta E^*(\omega,k))>/2$ with δE being the electric field fluctuation in the inertial frame rather than $\delta E'$ in the reference frame of electron fluid motion. Otherwise, the value as calculated from $<\mathrm{Re}(\delta J(\omega,k)\cdot\delta E'^*(\omega,k))>/2$ would be greatly smaller than the real dissipation rate.