Whistler Turbulence at Ion and Electron Scales: Particle-In-Cell Simulations

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At magnetohydrodynamic (MHD) scale, power-law spectrum of magnetic fluctuations in the solar wind is similar to the Kolmogorov spectrum for a hydrodynamic spectrum with an index -5/3. The MHD turbulence cascades the fluctuation energy into shorter scales, and supplies fluctuation energy into kinetic turbulence where the MHD approximation is no longer valid. The kinetic turbulence is expected to consist of some kinds of fluctuations, which are kinetic Alfven waves, whistler waves, and nonlinear structures. Important issues of the kinetic turbulence are, how the MHD turbulence is converted into the kinetic turbulence, what fluctuations have a key role in the kinetic turbulence, and how they are dissipated and scatter plasma particles.

In this study we focus on cascade of whistler turbulence from ion scales to electron scales. We demonstrate nonlinear development and the dissipation of the whistler turbulence by using two-dimensional fully kinetic particle-in-cell simulations. We found a power-law spectrum of magnetic fluctuation with a power-law index -2.5 at ion scales, which is predicted by a scaling law discussed in Narita and Gary (Ann.Geo 2010). At electron scales, the spectrum clearly shows a steeper spectrum than ion scales, which is evidence that whistler turbulence at electron scales is dissipated through wave-particle interactions. We will discuss nature of whistler turbulence at ion scales and dissipation process at electron scales.

[1] Y. Narita and S. P. Gary (2010), Inertial-range spectrum of whistler turbulence, Ann. Geophys., 28, 597-601.