Shear Alfven wave turbulence: Particle-In-Cell simulation

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The solar wind is known to be in highly turbulent state. Turbulent cascade process supplies fluctuation energy at magneto-hydrodynamics (MHD) scales into kinetic scales where ion and electron kinetics have a crucial role for physics of turbulence such as nonlinear cascade to shorter scales and dissipation. In-situ observations in the solar wind at 1 AU have demonstrated that magnetic energy spectrum at the kinetic scales becomes steeper than that at MHD scales, and reaches at electron kinetic scales. It suggests that undamped or weakly dissipated fluctuations cascade into electron kinetic scales. Various kinetic wave modes, such as Alfven-cyclotron mode, kinetic Alfven mode, and whistler mode, are proposed as key constituent modes in kinetic turbulence. These fluctuations are expected to be converted from fluctuations in MHD regime. However, there is an open question for the conversion process from MHD to kinetic fluctuations.

The purpose of this study is to investigate nonlinear cascade process of shear Alfven mode turbulence into electron kinetic scales. In order to demonstrate the conversion process in wave turbulence in fully kinetic regime, two-dimensional fully kinetic particle-in-cell simulation is used, which covers scales well-larger than ion kinetic scales by resolving electron kinetics. The simulation is initialized by a superposition of shear Alfven mode waves with wave length well-longer than ion inertial length. It is expected that the self-consistent development of shear Alfven mode turbulence leads to some undamped/weakly dissipated fluctuations at kinetic scales and finally dissipate at electron kinetic scales. We will show the cascade of shear Alfven wave turbulence into electron kinetic scales and discuss how the fluctuations at electron kinetic scales are dissipated.