Wave-Kinetic Simulations of Lower-Hybrid Turbulence driven by Velocity Ring Instabilities

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We develop numerical solutions to the wave-kinetic equation in a periodic box, including the effects of nonlinear (NL) scattering of Lower-hybrid waves, which gives the evolution of the wave-spectra in wavenumber space. Simultaneously we solve the particle diffusion equation of both the background plasma particles and the ring ions, due to both linear and nonlinear Landau resonances. At early times when the ring ions are cold, an electrostatic beam mode is excited, while a kinetic mode is stable. As the instability progresses the ring ions heat, the beam mode is stabilized, and the kinetic mode destabilizes. When the amplitude of the waves becomes sufficient the lower-hybrid waves are scattered (by either nearly unmagnetized ions or magnetized electrons) into electromagnetic magnetosonic waves [Ganguli et al 2010]. The effect of NL scattering is to limit the amplitude of the waves, slowing down the quasilinear relaxation time and ultimately allowing more energy from the ring to be liberated into waves [Mithaiwala et al., 2011]. The effects of convection out of the instability region are modeled, additionally limiting the amplitude of the waves, allowing further energy to be liberated from the ring [Scales et al., 2012]. Results are compared to recent 3D PIC simulations [Winske and Duaghton 2012], and the potential implications for the radiation belts are discussed [Crabtree et al., 2012].