コヒーレントなホイッスラーモード波動による電子ピッチ角散乱にみられる非線形効果について
Nonlinear effect in the pitch angle scattering of energetic electrons by coherent whistler-mode waves

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Coherent whistler-mode waves, such as chorus emissions, are frequently observed by various satellites in the Earth's inner magnetosphere. Coherent whistler-mode waves are generated by energetic electrons in the kinetic energy range from a few to tens of keV through nonlinear wave-particle interactions, and energetic electrons are scattered their pitch angle by the generated whistler-mode waves. The pitch angle scattering is closely related to energetic electron precipitation into the ionosphere, contributing to diffuse and/or pulsating aurora. Hikishima et al. (2009, 2010) showed a nonlinear effect in the pitch angle scattering and reproduced the microburst precipitation using a self-consistent full particle simulation, and Saito et al. (2012) and Miyoshi et al. (2015) reproduced the energy spectrum of energetic electrons simultaneously observed with pulsating aurora by a test particle simulation. These results suggest that the significance of investigating the detailed mechanism of pitch angle scattering. We carry out a spatially one dimensional test particle simulation with a coherent whistler-mode wave propagating along the dipole magnetic field, and reproduce the interaction between electrons and coherent whistler-mode waves in the region close to the magnetic equator. In this study, we assume two cases; the case A is pitch angle scattering of electrons with pitch angle around 80 degrees cased by coherent waves of frequency of 0.5 f_{ce0}, where f_{ce0} is the electron cyclotron frequency at the magnetic equator, and the case B is pitch angle scattering of electrons near the loss cone angle (~ 5 degrees) cased by coherent waves of frequency of 0.3 f_{ce0}. In the simulation result of the case A, we reproduce trajectories of trapped/un-trapped electrons as discussed in previous studies (e.g., Omura et al., 2008, 2009) and pitch angle of un-trapped particles is scattered toward the loss cone. In the case B, results indicate that the pitch angle variation due to the nonlinear effect strongly depends on the wave amplitude and the length of the wave packet. In particular, for the case of the large amplitude wave and relatively long wave packet, most of resonant electrons are trapped by the coherent wave and are efficiently scattered away from the loss cone, resulting in less precipitating electrons. In this presentation, we discuss the parameter dependence of the trapping (or un-trapping) in the Poincare diagram and that nonlinear effect for pitch angle scattering of energetic electrons.

キーワード：ピッチ角散乱、非線形波動粒子相互作用、ホイッスラーモード波動
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