

Effects of the magnetic field inhomogeneity on the excitation process of whistler mode waves

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Results of in-situ observation in the Earth's inner magnetosphere revealed that the local acceleration process is needed to explain the variation of the flux of relativistic electrons in the storm-time outer radiation belt. The resonant scattering process via whistler mode chorus waves has been recognized as the strong candidate mechanism for the local acceleration process of relativistic electrons during the recovery phase of a geomagnetic storm. The frequency modulation which is the definite characteristics of whistler mode chorus waves should play an important role in the resonant scattering process of high energy electrons, because the frequency shift causes a change of resonance condition between chorus waves and high energy electrons. Moreover, while the generation mechanism of whistler mode chorus waves has been discussed in several decades, several models have been proposed concerning the relation between the frequency modulation and an inhomogeneity of background magnetic field. Since the effect of the inhomogeneity should be essential in both acceleration process of relativistic electrons and generation process of whistler mode chorus waves, it is highly important to study fundamental physics of wave-particle interaction in the inhomogeneous system.

In this paper we study wave excitation process of whistler mode waves in an inhomogeneous system by using an original simulation model. The simulation model used in the present study is based on the model which treats background cold electrons as a fluid and hot electrons as relativistic particles by PIC method. By using this simulation model, we investigate the effect of inhomogeneity on wave growth process of whistler mode waves generated by a temperature anisotropy at the equatorial region of the Earth's inner magnetosphere. We assume one dimensional simulation system aligned with a field line of a magnetic dipole. Although we assume the simulation system as one dimension, particle motion in an inhomogeneous system is accurately solved with satisfying the adiabatic invariant; the effect of mirror force on particle motion is explicitly included in our simulation model by treating a radial gradient of magnetic field intensity related to a Larmor radius of each particle.

Results of theoretical analyses given by former studies have revealed that the inhomogeneity of magnetic field affects wave excitation process of whistler mode waves during linear stage as well as nonlinear stage; their results showed that the inhomogeneity modify a linear growth rate and induce a rapid generation of whistler mode waves. Based on the simulation results, we discuss wave growth of whistler mode waves in the inhomogeneous system and effect on the acceleration process of high energy electrons in the inner magnetosphere.