ホイスラーモード・コーラス生成機構についての計算機実験

加藤 雄人 [1]; 大村 善治 [2]
[1] 東北大・理・惑星プラズマ大気; [2] 京大・生存圏

Simulation study on the generation mechanism of whistler-mode chorus emissions

Yuto Katoh[1]; Yoshiharu Omura[2]
[1] Planet. Plasma Atmos. Res. Cent., Tohoku Univ.; [2] RISH, Kyoto Univ

We study the generation mechanism of whistler-mode chorus emissions by a self-consistent particle code with a dipole magnetic field. Whistler-mode chorus emissions are narrow band electromagnetic emissions observed in the dawn side of the Earth's magnetosphere. Results of *in situ* observations have revealed that the emissions which often consist of rising tones are generated from the equatorial region of the magnetosphere and that its activity is enhanced during geomagnetically disturbed peorids. Theoretical analyses have also suggested that the generation process of chorus emissions is deeply related to the nonlinear cyclotron resonance with energetic electrons in a non-uniform magnetic field, and several models have been proposed to explain the generation mechanism. However, the detailed mechanism of chorus generation has been left as a fascinating mystery because the complexity of the nonlinear wave-particle interactions prevents studies without several simplifying assumptions.

In the present study, we simulate the generation process of whislter-mode chorus emissions starting from the thermal noise. Although the simulation system used in the present study is spatially one-dimensional, we use a simulation model by assuming a cylindrical field model, which enables us to solve the adiabatic motion of the energetic electrons due to the mirror force in the non-uniform magnetic field. As for the initial conditions of the simulation, we assume the energetic electrons having an anisotropic loss-cone velocity distribution which drives an instability generating narrow band whislter-mode waves.

Simulation result shows that coherent whistler-mode waves propagating away from the equaotr are generated through the instability due to the anisotropic electrons. We find that the coherent whislter-mode waves interact with counter-streaming energetic electrons and that the emissions with rising tones are intermittently generated in the equatorical region of both hemisphere. The frequency range of the emissions reproduced in the present study corresponds to the 'lower-band chorus' in the Earth's magnetosphere; frequency rising from 0.2 f_{ce} to 0.5 f_{ce}, where f_{ce} is the electron cyclotron frequency at the magnetic equator. As growing of the wave amplitude, the effect of the nonlinear wave-particle interaction becomes significant. Recent studies have revealed that the nonlinear resonant interaction in the dipole magnetic field creates an electromagnetic electron hole in the wave phase space. Besides, recent simulation study clarified that the appearance of the electromagnetic electron hole induces the formation of reonant currents which contribute to both wave growth and frequency rising of whislter-mode waves. We find that the roles of the resonant currents formed by phase bunched untrapped electrons are essentail in the generation mechanism of chorus emissions. Moreover, it is also clarified that the present simulation model has an enough potential to investigate the detailed physics of the whistler-mode chorus emissions.