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Simulation study of the whistler-mode chorus generation in the Earth's inner magnetosphere

Yuto Katoh*(1), Yoshiharu Omura(2)
(1) Tohoku University, Sendai, Miyagi 980-8578, Japan, e-mail: yuto.katoh@tohoku.ac.jp
(2) Kyoto University, Uji, Kyoto 611-0011, Japan; e-mail: omura@rish.kyoto-u.ac.jp

Abstract

Whistler-mode chorus emissions play crucial roles in the evolution of radiation belt electrons. Chorus emissions are coherent electromagnetic plasma waves with varying frequencies in the typical frequency range of 0.2 to 0.8 f_{ce0}, where f_{ce0} is the electron gyrofrequency at the magnetic equator. They often have a gap at half the local cyclotron frequency. The generation process of chorus has been explained by the nonlinear wave growth theory [see review by Omura et al., 2012] and has been reproduced by self-consistent numerical experiments [e.g., Katoh and Omura, 2007, 2011, 2013, 2016; Katoh et al., 2018].
In the present study, we investigate dependencies of the chorus generation process on properties of energetic electrons, the background magnetic field, and the thermal plasma condition. First, we conduct a series of electron hybrid simulations for different temperature anisotropy (A_T) of the initial velocity distribution function of energetic electrons. We vary A_T in the range from 3 to 9 with changing the number density of energetic electrons (N_h) so as to study whether distinct rising-tone chorus emissions are reproduced or not in the assumed initial condition. Simulation results reveal that N_h required for the chorus generation decreases as the temperature anisotropy of energetic electrons increases. We also find that reproduced spectra become hiss-like for large N_h cases. Next, we carry out simulations by changing the spatial gradient of the background magnetic field intensity along a field line. Simulation results clarify that the small magnetic field gradient lowers the threshold amplitude for the chorus generation. These simulation results demonstrate the validity of the nonlinear wave growth theory and suggest that the coherent nonlinear wave-particle interaction is essential for generation of whistler-mode chorus emissions in the magnetosphere.

References

1. Y. Katoh and Y. Omura, “Computer Simulation of Chorus Wave Generation in the Earth's Inner Magnetosphere”, *Geophys. Res. Lett.*, **34**, 2007, L03102.

2. Y. Katoh and Y. Omura, “Amplitude dependence of frequency sweep rates of whistler mode chorus emissions”, *J. Geophys. Res.*, **116**, 2011, A07201.

3. Y. Katoh and Y. Omura, “Effect of the background magnetic field inhomogeneity on generation processes of whistler-mode chorus and hiss-like broadband emissions”, *J. Geophys. Res. Space Physics*, **118**, 2013, pp. 4189-4198.

4. Y. Katoh and Y. Omura, “Electron hybrid code simulation of whistler-mode chorus generation with real parameters in the Earth's inner magnetosphere”, *Earth Planets Space*, **68**, 2016, pp. 4189-4198.

5. Y. Katoh, Y. Omura, Y. Miyake, H. Usui, and H. Nakashima, “Dependence of generation of whistler mode chorus emissions on the temperature anisotropy and density of energetic electrons in the Earth's inner magnetosphere”, *J. Geophys. Res. Space Physics*, **123**, 2018, pp. 1165-1177.

6. Y. Omura, D. Nunn, and D. Summers, “Generation process of whistler mode chorus emissions: current status of nonlinear wave growth theory”, in *Dynamics of the Earth’s radiation belts and inner magnetosphere*, edited by Summers D et al., Geophys. Monogr. Ser., **199**, 2012, AGU, Washington, DC, pp. 243-254.