Simulation study of whistler-mode chorus in planetary magnetospheres

*Yuto Katoh[1], Keiichiro Fukazawa[2]

1.Graduate School of Science, Tohoku University, 2.Academic Center for Computing and Media Studies, Kyoto University

We study the generation process of whistler-mode chorus emissions in planetary magnetospheres based on results of electron hybrid and MHD simulations. Chorus emissions are electromagnetic plasma waves commonly observed in planetary magnetospheres and are a group of coherent wave elements showing a variety of frequency shifts in time; typically rising tones, occasionally falling tones, and sometimes observed as hiss-like broadband emissions. While the generation process of chorus has been reproduced by numerical experiments [e.g., Katoh and Omura, GRL 2007a] and has been explained by the nonlinear wave growth theory [Omura et al., JGR 2008, 2009], numerical experiments have revealed that nonlinear wave-particle interactions between chorus and energetic electrons play essential roles not only in generating chorus but in energizing relativistic electrons. Since the nonlinear trapping of resonant electrons by chorus results in very efficient acceleration of trapped particles, chorus should play significant roles in the energization process of radiation belt electrons in planetary magnetospheres. On the other hand, previous studies revealed similarities and differences of the spectral characteristics of chorus in planetary magnetospheres, which has not been understood yet.
In the present study, by carrying out cross-reference simulations by electron hybrid and MHD codes, we investigate physical processes which differentiate the spectral characteristics of chorus emissions in planetary magnetospheres. Our previous simulations have revealed that the spectral characteristics of chorus vary depending on both the inhomogeneity of the background magnetic field and the velocity distribution function of energetic electrons in the equatorial region of the magnetosphere. We use the MHD code for the investigation of the range of variation of the spatial scale of the Jovian magnetosphere in the region from 5 to 20 Rj, where Rj is the radius of Jupiter, corresponding to the region where intense chorus emissions are identified by the Galileo spacecraft observations [Katoh et al., JGR 2011]. By referring the results of the MHD simulations, we conduct a series of electron hybrid simulations for the condition required for the chorus generation and resultant spectral characteristics of chorus in the Jovian magnetosphere. Our simulation results should provide important clues in understanding similarities and differences of chorus emissions in planetary magnetosphere and also the energization process of relativistic electrons.

Keywords: whistler-mode chorus, planetary magnetosphere, numerical experiments

