

惑星磁気圏におけるホイッスラーモード・コーラス放射の発生と相対論的電子加速についての計算機実験

Simulation study of whistler-mode chorus and relativistic electron acceleration in planetary magnetospheres

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Whistler-mode 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 2007] 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.

We carry out a series of electron hybrid and MHD "cross-reference" simulations for the study of the generation process of whistler-mode chorus emissions in planetary magnetospheres. 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. We use the MHD code for the investigation of the range of variation of the spatial scale of the Jovian magnetosphere at the region of 15 R_J, where R_J 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]. We use the

results of MHD simulations as the initial condition of electron hybrid simulations and reproduce the generation process of whistler-mode waves in the Jovian magnetosphere. By a series of electron hybrid simulations for different properties of energetic electrons at the equator, we clarify the condition for the chorus generation in the Jovian magnetosphere. Our results can be applied to the condition of chorus generation in other planetary magnetospheres.

References:

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