URSI GASS 2023, Sapporo, Japan, 19 – 26 August 2023

Simulation study of the duct propagation of whistler-mode chorus emissions in the Earth's inner magnetosphere

Yuto Katoh[(1)]
(1) Tohoku University, Sendai, Japan; e-mail: yuto.katoh@tohoku.ac.jp

We study the duct propagation of whistler-mode chorus emissions in the magnetosphere by a spatially two-dimensional simulation code in the dipole coordinates. Whistler-mode chorus emissions are generated in the region close to the magnetic equator in the frequency range from 0.2 to 0.8 f_{ce0}, where f_{ce0} is the electron gyrofrequency at the magnetic equator, while the frequency range of chorus is classified into the lower-band (0.2 to 0.5 f_{ce0}) and upper-band chorus (0.5 to 0.8 f_{ce0}) by a distinct gap at 0.5 f_{ce0}. Observations have revealed that chorus emissions typically propagate along a magnetic field line in its source region and become oblique during their propagation away from the equator. The propagation property of chorus emissions is significantly influenced by the plasma density structure in the magnetosphere. Previous studies revealed that the density enhancement/depletion results in the ducting of chorus emissions along a field line. Since the minimum resonant energy inferred from the cyclotron resonance increases significantly in the high-latitude region, the duct propagation of chorus emissions is important in considering the precipitation of relativistic electrons through the pitch angle scattering.

In the present study, we compute the duct propagation of chorus emissions in the magnetosphere using the spatially two-dimensional code [Katoh, 2014]. We assume a model chorus element propagating northward from the magnetic equator of the field line at L=4 with a rising tone from 0.2 to 0.7 f f_{ce0} in the time scale of 5000 f f_{ce0}^{-1}. We assume the density enhancement of 10% at L=4. Simulation results show that chorus emissions propagate away from the equator along the assumed density duct. Next, we change the wave source region slightly inward, L=3.95, and conduct the simulation. The simulation result shows that chorus emissions become oblique in the region away from the equator but trapped by the density enhancement duct assumed at L=4. The simulation results imply that the duct structure plays an important role in bundling whistler-mode waves propagating in the magnetosphere along a specific field line and guiding the waves in the higher-latitude regions, not only waves generated inside the duct but also those generated outside the density duct.

References

[1] Y. Katoh, "A simulation study of the propagation of whistler-mode chorus in the Earth's inner magnetosphere", *Earth Planets Space*, **66**, 6, 2014, doi: 10.1186/1880-5981-66-6.