木星電離圏アルフベン共鳴モデル検証のための木星デカメータ電波Sバースト地上観測データの統計解析

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Statistical analyses of S-bursts of Jovian decametric radiation for verification of Jovian ionospheric Alfven resonator model

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Jovian ionospheric Alfven resonator (IAR) model has been investigated based on the statistical analyses of ground-based observation datasets obtained since 1985. In the Jovian magnetosphere, the radio waves are generated in decametric wavelength range due to the interactions between the rotating magnetic field and the plasma around the satellite Io. Among them, the S-busts are most intense emissions, which show quasi-periodic frequency drift on a time scale of msec. The typical repetition frequencies are within 2-400 Hz [Carr and Reyes, 1999]. Based on the studies of the Earth's IAR, Ergun et al. [2006] proposed that the periodicity of the S-bursts was caused by the Jovian IAR. According to the hypothesis, it is expected that the repetition frequency of S-bursts increase as the solar zenith angle at the Io footprint increases and plasma density in the Jovian ionosphere decreases. For the purpose of the verification of the Jovian IAR hypothesis, we performed statistical analyses of the repetition frequency of S-burst observed at Jovian radio observatories of Tohoku University since 1985. The analysis results clarified that the repetition frequency of S-bursts decreases as the solar zenith angle (SZA) at the Io footprint increases. It was different from our initial expectations that the repetition frequency increased in the nightside due to decrease of the scale height of the ionosphere. We therefore explained it by assuming that the scale height in the nightside increases due to precipitations of auroral electrons, which was also inferred in the Earth's auroral field lines. [Newell et al., 1997]. In the present study, we have performed further verifications of the Jovian IAR model through the determination of source altitude of the S-bursts based on the additional statistical analysis.

The eigen frequency of the IAR is determined by f_{IAR} = 1.2 v_{AI} / (2 pi h), where v_{AI} is Alfven velocity in the ionosphere, and h is scale height of the ionosphere [Lysak et al. 1988]. Assuming that the magnetic field at r = 1 Rj is 13 G, and the peak proton number density in the ionosphere is 2 x 10^5 /cc, the v_{AI} is 6.5 x 10^7 m/s. Based on the statistical analysis of S-burst spectrograms obtained since 1985, the eigen frequency of IAR f_{IAR} can be estimated from the average repetition frequency, which is about 35 Hz when SZA = 75 deg., and 10 Hz when SZA = 85 deg. By using the equation $lambda_{IAR}$=v_{AI} / f_{IAR}, we can estimate the wavelength of Jovian IAR to be 1800 km when SZA = 75 deg., and 6500 km when SZA = 85 deg. We have performed statistical analysis of emission frequency of S-burst. The results suggests that the average emission frequency of S-burst is 28 MHz when SZA = 75 deg., and 22 MHz when SZA = 85 deg. The emission frequency of Jovian decametric radiation indicates the local electron cyclotron frequency at the source. The altitude of the S-burst sources at 28 MHz and 22 MHz are 6400 km, and 12800 km, respectively. We can therefore point out that the S-burst sources are located about 2-4 Alfven wave length above the bottom of the Jovian IAR, where the conductivity is maximum in the Jovian ionosphere, and that the S-burst source altitude changes depending on the change of the Alfven wave length.

In order to confirm the hypothesis mentioned above, we are planning continuum observations of S-burst of Jovian decametric radiation in wide frequency range from 20 to 40 MHz with the wideband receiver. Initial results of the observations will be reported in the presentation.