木星デカメータ電波Ｓバースト地上観測の統計解析にもとづく木星電離圏アルフベン共鳴モデルの検討

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Jovian ionospheric Alfven resonator model based on the statistical analyses of S-bursts of Jovian decametric radiation

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Jovian ionospheric Alfven resonator 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 ionospheric Alfven resonator (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 and IAR 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 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 the assumption 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 assumed 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 several parameters based on the statistical analysis results of the S-burst.

The fundamental frequency of the IAR is determined by f = 1.2 v_{AI} / (2 pi h), where v_{AI} is Alfven velocity in the ionosphere, and h is scale height of the ionosphere. The equation can be derived from the vertical profile model of the Alfven velocity $v_A = v_{AI} / ((v_{AI} / v_{AM})^2 + \exp(-z/h))$ and wave equation [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 the repetition frequency of the S-burst on the SZA at the Io footprint, the repetition frequency is about 35 Hz when SZA = 75 deg., and 10 Hz when SZA = 85 deg. The scale height h can be estimated to be 350 km when SZA = 75 deg., and 1200 km when SZA = 85 deg. From the v_{AI} and the repetition frequency of the S-burst, the wave length of the Alfven waves in the fundamental frequency mode of Jovian IAR is estimated to be 6500 km when SZA = 75 deg., and 1800 km when SZA = 85 deg. We have performed additional statistical analysis of the dependence of emission frequency of S-burst on SZA at the Io footprint. The results suggests that the emission frequency of S-burst is 28 MHz when SZA = 75 deg., and 22 MHz when SZA = 85 deg. Geocentric distances of the S-burst sources at 28 MHz and 22 MHz are 1.09 Rj, and 1.18 Rj, respectively. We can therefore point out that the difference in altitude of the S-burst sources, 6300 km, is similar with the difference between the Alfven wave lengths. These results suggests that the S-burst sources are located about 1 Alfven wave length above the bottom of the Jovian IAR, where the conductivity is maximum in the Jovian ionosphere, and that the Alfven wave length changes depending on the solar zenith angle due to the difference of the scale height.