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Characteristics of Jovian ionospheric Alfvén resonator observed by using wave modulations of L-burst emissions

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On June 4, 2008 UT, we observed Jovian decametric radio emissions at Iitate Observatory, Tohoku University, Japan, by using a waveform receiver developed by us. The observation frequency was between 21 and 23 MHz, and the Io-CML phase was the so-called "Io-A" phase. The waveform receiver used a digital down-converter chip; therefore, it could carry out continuous observations over a 12-h period. We detected negative spectra of quenched background L-burst emissions with a negative drift rate of approximately -5 MHz/s. We called these phenomena slow-drift shadow (SDS) events. Between 1859:18 and 1859:30 UT, sudden drift rate changes occurred in the leading and trailing edges of the SDS events. Such SDS slope changes occurred once or twice at a frequency between 21.4 and 22.1 MHz [Koshida et al., JGR, 2010]. Between 1938 and 2000 UT, the background L-burst emissions exhibited wave modulations (WMs). SDS-like phenomena were intermittently observed in this observation period; however, the WMs were observed four times every 7 min at 1938, 1945, 1952, and 1959 UT. The duration of each WM ranged from 3 to 10 s. We analyzed the modulation frequencies of the WMs by using Fourier transformation and the spectra of the WMs that were partially extracted from their dynamic spectra with a bandwidth of 50 kHz and durations of 3.4 or 6.8 s. The three-dimensional least squares method was used to stabilize the base power of the Fourier transformed spectra, and the applied frequencies ranged from 2 to 40 Hz. We defined the 98% significance level of the stabilized spectra according to the statistical distribution by using a method introduced in Arkhypov and Rucker [A&A, 2006]. We could detect the fundamental frequencies of the WMs, and their 1st harmonics; we could also detect some 2nd harmonics whose frequencies were odd multiples of the fundamental frequencies. The observations of decametric radio emissions have shown that the most frequent modulation period of the emissions is 7 min; in addition, the simulations of the Alfvén waves traveling along the Io flux tube have shown that the modulation period is equivalent to the round-trip period of Alfvén waves between the Jovian north polar region and the boundary of the Io plasma torus. Su et al. [JGR, 2006] estimated the characteristic frequencies of a Jovian ionospheric Alfvén resonator for varied scale heights and plasma densities. If the scale height and plasma density of the Jovian ionosphere are higher than a certain level in our observation period, the calculated characteristic frequencies are similar to our observational results. If the scale height is less than 1000 km, unrealistic dense plasmas are required. Therefore, the cyclotron maser instability must be damped. This gives rise to the question of the generation mechanism of Jovian L-burst radio emissions.