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Feasibility of the exploration of the subsurface ocean of Jupiter's icy moon by Jovian decametric radiation spectra

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Subsurface liquid ocean of the Jupiter's icy moons, which is suggested by several studies, is one of the most important targets in the Jovian exploration missions. We propose a new method for determination of the depth of the boundary between the icy crust and liquid ocean below the icy crust by using interference patterns found in the spectrogram of the Jovian decametric radio emissions (DAM). If we can operate an wave receiver onboard the icy moon orbiter, we can obtain spectrograms of the DAM propagated from Jupiter. Because the emissions directly from Jupiter can be interfered with the emissions reflected at the icy moon's surface and subsurface boundaries, we will find interference patterns in the measured spectrograms. In case of the Moon, the lunar orbiter SELENE detected the interference patters in the spectrograms of auroral kilometric radiation (AKR) [Ono et al., 2010]. Because the interference occurs between AKR directly from the earth and AKR reflected at the lunar surface, the amplitude of the interference patterns are almost constant. In case of Jupiter's icy moons, DAM directly from Jupiter, DAM reflected at the icy crust surface, and DAM reflected at the boundary between icy crust and liquid ocean are interfered with each other. Due to slight phase difference between DAM emissions reflected at the surface and subsurface boundaries, the amplitude of the interference patterns will be modulated. The depth of the liquid ocean can be determined the frequency width of the modulation. Assuming that the frequency of DAM is ˜25 MHz, the permittivity of the icy crust is 3, permittivity of the liquid ocean is 87, loss rate in the icy crust is 1 dB/km, and the depth of the ocean is 5 or 10 km, spacecraft and receiver's specifications needed for measurement of the interference patterns in the spectrogram are as follows: (1) Spacecraft height below 200 km, (2) Receiver bandwidth of $<$1 kHz, and (3) Receiver level resolution of $<$5 dB. In addition, the following two issues have to be considered in actual application of this method: (a) DAM itself has band structures in the spectrogram due to anisotropy of the emission at the source. (b) The roughness of the surface and subsurface boundaries have to be within the wavelength (˜10 m) in order that the interference occurs.

Keywords: Jupiter's icy moon, Subsurface ocean, Jovian decametric radiation, Interference