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月周辺の太陽風中で観測されるホイッスラーモード波動の様々な形態
Various appearances of whistler-mode waves observed near the Moon in the solar wind

津川 靖基 [1*] ; 加藤 雄人 [1] ; 寺田 直樹 [1] ; 綱川 秀夫 [2] ; 高橋 太 [2] ; 渋谷 秀敏 [3] ; 清水 久芳 [4] ; 松島 政貴 [2]
TSUGAWA, Yasunori[1*] ; KATOH, Yuto[1] ; TERADA, Naoki[1] ; TSUNAKAWA, Hideo[2] ; TAKAHASHI, Futoshi[2] ; SHIBUYA, Hidetoshi[3] ; SHIMIZU, Hisayoshi[4] ; MATSUSHIMA, Masaki[2]

[1] 東北大学理学研究科地球物理学専攻, [2] 東京工業大学大学院理工学研究科地球惑星科学専攻, [3] 熊本大学大学院自然科学研究科, [4] 東京大学地震研究所
[1]Department of Geophysics, Tohoku University, [2]Department of Earth and Planetary Sciences, Tokyo Institute of Technology, [3]Department of Earth and Environmental Sciences, Kumamoto University, [4]Earthquake Research Institute, University of Tokyo

Narrowband whistler-mode waves whose frequencies close to 1 Hz have been observed near the Moon [Farrell et al., 1996; Nakagawa et al., 2003; Halekas et al., 2006; Tsugawa et al., 2011]. Broadband whistler-mode waves in the frequencies up to about 10 Hz with no preferred polarity have also been observed near the Moon [Halekas et al., 2008; Nakagawa et al., 2011, Tsugawa et al., 2012]. In addition, the lunar magnetometer (LMAG) aboard Kaguya detected right-hand polarized broadband waves, which is relatively weak and appears in the frequency range of several Hz. Since the angle between the wave vector and the sunward direction is large, the waves are not significantly Doppler shifted, indicating that they are whistler-mode waves. We also reveal the existence of harmonic waves whose fundamental waves appear in the frequencies near 1-2 Hz. The fundamental waves resemble the narrowband whistler-mode waves.

We construct criteria to select these waves and perform statistical analyses. Based on the statistical properties, we suggest possible scenarios of the generation and propagation of the four types of waves around the Moon. Whistler-mode waves in the frequency near the lower hybrid frequency generated through the reflection of ions by the Moon would be observed as (1) the narrowband waves in the spacecraft frame when the group velocity vector points to the sunward and is cancelled by the solar wind velocity, as (2) the broadband waves in the interaction region with various wave components, as (3) the right-hand polarized broadband waves when the wave vector points perpendicular to the sunward, and as (4) the harmonic waves in the same condition with NR with a large compressional component enough to be steepened.