The search for whistler-mode chorus emissions related to the Moon using ARTEMIS

*Wataru Sawaguchi[1], Yuki Harada[1], Satoshi Kurita[2]

1. Graduate School of Science, Kyoto University, 2. RISH, Kyoto University

Whistler-mode chorus emissions are narrow band emissions observed mostly on the dawn and day side in the Earth’s inner magnetosphere [Burtis and Helliwell, 1969; Burtis and Helliwell, 1976]. Their frequency band is typically from 0.2 f_{ce} to 0.8 f_{ce}, where f_{ce} is the electron cyclotron frequency at the magnetic equator. They are also found in the magnetospheres of Jupiter [Coroniti et al, 1980], Saturn [Hospodarski et al, 2008] and Mars [Harada et al, 2016], but their presence has not been confirmed near unmagnetized bodies without dense atmospheres.

The generation of whistler-mode waves is based on the linear theory in which the free energy source of waves is provided by the temperature anisotropy of electrons with respect to the background magnetic field [e.g., Tsurutani et al., 1979]. However, it does not explain the characteristic chirping of chorus. Therefore, nonlinear theories were proposed and it was shown that whistler-mode waves in an inhomogeneous medium could effectively trap cyclotron-resonant electrons [Dysthe, 1971] and then resonant current could strongly amplify waves [Nunn, 1974; Omura et al,1991]. The incoherent waves occur first based on the linear theory, then the wave field traps cyclotron-resonant electrons, and eventually the amplitudes of the waves increase nonlinearly.

The Moon is an unmagnetized and airless body. Various kinds of plasma phenomena occur as a result of the interaction of solar wind and magnetospheric plasmas with the Moon’s exosphere, surface, and crustal magnetic field [Halekas et al,. 2012]. For example, electron anisotropy caused by the absorption on the lunar surface drives cyclotron resonance of waves traveling toward the Moon with electrons reflected from the lunar surface by magnetic mirroring, leading to generation of whistler-mode waves [Harada et al., 2014]. As the amplitudes of the whistler-mode waves are comparable to those of chorus emissions in the Earth’s inner magnetosphere, it may be expected that chorus-like waves are possibly present in the vicinity of the Moon.

We searched for and identified chorus-like events with discrete rising tone elements from the magnetic field data obtained by the ARTEMIS mission, and tested whether they are consistent with the nonlinear model by Omura et al. (2008) and whether they are Moon-related waves by two point measurements.

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