

月周辺のホイッスラーモード波動の励起過程に関する考察

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Study of the generation process of whistler-mode waves near the Moon

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Whistler-mode waves at the frequency of several Hz have been observed by WIND [Farrell et al., 1996] and Geotail [Nakagawa et al., 2003] when the spacecraft was magnetically connected to the lunar wake. Lunar Prospector [Halekas et al., 2006, 2008] and Kaguya [Nakagawa et al., 2011; Tsugawa et al., 2011] also detected the waves at about 100 km orbits around the Moon in the solar wind. Recently we clarified that the broadband whistler-mode waves are closely associated with the magnetized crusts of the Moon [Tsugawa et al., 2012]. However, the generation process has not been discussed in detail.

In the present study, we discuss the generation process of the waves by referring the properties of energetic particles responsible for plasma instabilities around the Moon through the solar wind interactions. To reveal the requirements for the wave generation, we consider the amount of the Doppler-shift modification because the spectra measured in the spacecraft frame of reference are largely Doppler shifted due to the relative motion between the spacecraft and the solar wind. The result of the analysis shows that the waves are oblique whistler-mode waves in the frequency range of 10-100 times higher than the local proton cyclotron frequency and close to the lower hybrid frequency in the plasma rest frame. Based on the estimated original wave spectra in the solar wind frame of reference and the observation results of velocity distributions near the wave sources, we propose that the energy source of the waves would be related to the ions and electrons reflected by the lunar crustal field.