かぐや搭載LRS/WFCで観測された太陽風ー月相互作用に起因するプラズマ波動

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Plasma Waves Related to Solar Wind - Moon Interaction Observed by WFC onboard KAGUYA

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The waveform capture (WFC) [1] is one of the subsystems of the Lunar Radar Sounder (LRS) [2,3] on board the KAGUYA spacecraft. The WFC measures two components of electric wave signals detected by the two orthogonal 30 m tip-to-tip antennas from 100Hz to 1MHz.

Because the moon is basically non-magnetized, the solar wind particles directly hit the lunar surface and a plasma cavity called the "lunar wake" is created behind the moon. Around the terminator of the moon, sudden density decrease derived from local plasma frequency was observed by WFC when the moon was in the solar wind. In addition, because of the difference of thermal speed between ions and electrons, electrons first attempt to refill the cavity, which causes an electric field at the boundary region of the wake and ions are assumed to be accelerated by the DC E-field. The wake boundary, therefore, could be a source region of plasma waves caused by this instability [4].

On the other hand, there are several magnetic anomalies on the lunar surface and it was suggested that a kind of mini-magnetosphere might be constructed as a result of interaction between the solar wind and these magnetic anomalies. According to our plasma wave observation, intense wave activities below several kHz were frequently observed over these magnetic anomalies. It was found that the spatial distribution of plasma wave clearly corresponds to the magnetic anomalies, especially around the South Pole Aitken basin, and also to the solar wind parameters [5].

Another topic is the lunar ionosphere. The lunar ionosphere is known to be extremely tenuous but there was a report on the existence of dense ionosphere at altitudes of 5-10 km with a radio occultation technique from the Soviet Luna 19 and 22 [6]. While the radio occultation technique is an indirect method for measurement of an electron density profile on the lunar surface, we proposed a new measurement method using the propagation characteristics of AKR originating from the Earth [7]. We could also achieve a direct measurement of in situ electron density by detecting the local plasma frequency in the last few days before the spacecraft impact to the moon.

The WFC revealed many interesting wave phenomena which are closely related to the plasma physics around the moon. It is indispensable to perform collaborative study with magnetic field and particle data in the near future for further investigation.

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