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Study on the plasma waves around the Moon in the Earth's magnetosphere via KAGUYA spacecraft observations

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The moon is essentially unmagnetized. However, recent spacecraft observation revealed the existence of the localized magnetic field which is the so-called magnetic anomaly. Furthermore, the body of the moon is the dielectric. The charging of its surface strongly depends on the surrounding space plasma and the sunlit conditions. KAGUYA spacecraft has investigated the electromagnetic environment around the moon since its launch in 2007. In the present paper, we focused on plasma wave phenomena around the moon during its stay inside the geomagnetic tail region based on plasma wave data observed by the KAGUYA spacecraft.

We surveyed plasma wave activities and examined the difference of plasma wave features in the different plasma regimes in the geomagnetic tail regions considering the sunlit condition for the moon. The KAGUYA plasma wave data showed the generation of the Electric Cyclotron Harmonics (ECH) over the magnetic anomaly in the nightside, as well as that of the Langmuir waves in the earthside of the moon. We also analyzed the particle data obtained by PACE (Particle Angle and Composition Experiment). The PACE data showed the existence of the electron loss cone distribution with the low energy electron beam. By comparing the plasma wave data with the electron data, we found the good correlation of the ECH waves with the electron loss cone velocity distribution. In order to understand the generation mechanism of ECH waves, we calculate the linear growth rate by solving the kinetic plasma dispersion relation. Our linear analyses showed that the electron loss cone distribution with the low energy electron beam destabilize the ECH waves. Based on the spacecraft observations and linear analyses, we succeeded in establishing the generation model of the ECH waves in the view point of the moon-magnetosphere interaction.

Keywords: Space electromagnetic environment, Space plasma, Plasma wave, Geomagnetic tail region, KAGUYA spacecraft (SELENE)