Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

PCG33-P11 Room:Convention Hall Time:May 25 15:30-17:00

Mercury's sodium tail distribution and the source processes of the exosphere

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Mercury has a thin atmosphere. In the past, Mercury has been observed by Mariner 10 and MESSENGER, and ground-based observations have also been carried out. H, He, O, Na, Mg, K, and Ca were detected in its atmosphere. Solar-photon-stimulated desorption, sputtering by impacting solar particles, and meteoroid vaporization are considered to be the source processes of Mercury's exosphere. However, the primary process among these three processes is unknown as yet. Sodium atoms are excited by the energy from sunlight, and they return to the ground state by emitting energy isotropically. The resonance scattering constitutes exospheric sodium emission. This emission well suited for study by ground-based observations because of its high intensity. The sodium atoms are accelerated in the anti-sunward direction due to their isotropic scattering. This is called sodium tail. Past observations have shown that the intensity distribution of exospheric sodium emission changes with time. This study aims to make ground-based observations of exospheric sodium emission, to determine the distribution of the sodium tail, and to consider the source processes of Mercury's exosphere.

We have observed Mercury's sodium exosphere at the Haleakala Observatory since April 2011. The observations were made using a 40 cm Schmidt-Cassegrain telescope, a high-dispersion spectrograph, and a CCD camera. In this term, the telescope system at the Haleakala Observatory was remotely-operated in Japan. At this observation, the slit of spectrograph was set on Mercury, and its direction was set parallel to the anti-sunward direction. The slit width is 2.5 arcsec, and apparent diameter of Mercury was from 5.0 to 10.4 arcsec. The sodium distribution was scanned by changing slit position. Exposure time was 50 second, and it took 30 minutes to get a whole image of the sodium tail.

We analyzed observational data collected from April 27, 2011, to May 30, 2011, and from June 24, 2011, to August 5, 2011. The observation times were from Mercury rise to before sunrise in the former observation period, and from just after sunset to Mercury set in the latter observation period. We determined the intensity distribution of exospheric sodium emission by using the observational data. We compared the intensity distributions on May 18, June 24, and July 1. These distributions have two characteristics. The first is temporal variation of the intensity of sodium emission from the equator of Mercury changed. The second is the emission from the northern part of Mercury was not detected on June 24.

In this study, we discuss the variation of the sodium emission of the equator of Mercury changed. Sputtering by impacting solar particles, one of the source processes of Mercury's exosphere, is that solar wind ion arrives at the surface of Mercury from cusp region of Mercury's magnetosphere. So we think that change of solar wind magnetic field causes change of variation of the sodium distribution. The magnetic reconnection in the case of northward interplanetary magnetic field is different in the case of southward interplanetary magnetic field. This causes change place where solar wind ion arrives at the surface of Mercury. We compared our observational data with the data of solar wind magnetic field observed by MESSENGER. In this presentation, we discuss between the sodium distribution and the variation of solar wind magnetic field.

Keywords: Mercury, Sodium, Ground-based observation