Development of Energetic Neutral Atom Analyzer for BepiColombo/MMO

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Under the Mercury environment, the planet itself occupies relatively large volume in the magnetosphere, because of an weak intrinsic magnetic field. Therefore, a magnetic mirror force is not efficient to reflect precipitating charged particles back to the magnetosphere. Hence a large part of the precipitating particles can impact onto the planetary surface without any collisional interactions with the atmospheric particles, since the Mercury atmosphere is expected to be pretty faint.

When energetic particles, which are considered to be originated from the solar wind as well as the magnetosphere, impact onto the Mercury surface, a part of surface constituents is emitted to the exosphere as sputtered particles. Since the sputtering process involves a momentum transfer from the precipitating particles to the sputtered ones, a part of the sputtering particles can get quite high energy (larger than a few tens of eV), in comparison with other possible emitting processes of particles from the Mercury surface, such as a photon-stimulated desorption, an electron-stimulated desorption, and a thermal desorption.

No light emission due to auroral activities is expected under the Mercury environment because of the faint atmosphere. Therefore, we cannot get information about large-scale structures of the magnetospheric plasma via observations of the auroral activities. However, if we can measure the sputtered particles, still we can monitor the magnetosphric plasma processes occurring on the magnetic field line which is connected to the source area of the sputtered particles on the planetary surface.

In order to measure the sputtered particles, we should measure the high-energy neutral atoms, since almost all the sputtered particles is in the neutral state just after the emission. This fact would help us to measure the sputtered particles unambiguously, since, in the Mercury magnetosphere, a generation mechanism of energetic neutral atoms due to charge-exchange interactions of megnetospheric energetic ions with the exospheric neutrals is expected to be less efficient than that in the terrestrial magnetosphere because of the faint exosphere. Note that, it would not be so difficult to determine the source area of the sputtered particles, since the source area has to be on the planetary surface. This situation is different from the measurement of energetic neutral atoms in the terrestrial magnetosphere in which a line-of-sight integral has to be taken into account for the source area determination.

We are developing an energetic neutral atom analyzer which is capable of the measurement of the high-energy component of the sputtered particles. In order to analyze particle energy and mass, the incident neutral atoms are ionized. However, the expected energy range of the sputtered particles is too low to pass through an ultrathin foil which is used by conventional energetic neutral atom analyzers. Therefore, a surface ionizing technique, which requires a surface flatness in a nano-meter range (RMS), will be adopted. Another technical problem for the sputtered particle measurement is rejection of extereme-ultravoilet photons, since the Mercury is located near the Sun. We will use multiple deflection of particle trajectories for the photon rejection.