Model study on the contribution of various physical processes for generation and dissipation of Mercury's exosphere

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Mercury has tenuous atmosphere (~1e-10 Pa), which escapes into space due to weak gravity and constant exposure to strong solar photo pressure and solar wind.Since exosphere directly connects with ground surface, the amount of generated and dissipated atmosphere drastically variesdepending on the environment.

Exosphere contains several elements such as Na, Mg, H, K, Ca, He. H and He are derived from solar wind, while other species are thought to be supplied owing to desorption from ground surface. For example, thermal desorption, charged particle sputtering (CPS), photon stimulated desorption (PSD) and meteorite impact vaporization (MIV) are suggested as desorption process. The amount of thermal desorption depends on the surface temperature, which is a function of the distance between the Sun and Mercury due to revolution. The amount of CPS changes owing to flares and the intensity of solar wind. Variation of PSD amount is due to fluctuation of solar radiation. MIV is dominated by the amount of dust around Mercury. Therefore, estimating how much each process contributes to generation of atmosphere encourages understanding the environment of inner solar system.

Velocity distribution of emitted particles is different from process to process. Thus, contribution of each process is often presumed by temperature of emitted particles which can be estimated by density profile obtained by the observation of MESSENGER spacecraft. However, the accuracy of estimating the abundance of high-temperature component gas is not enough, and besides it is hard to make an estimate of the dominant process in high latitudes in northern hemisphere and mid-latitudes owing to geometry of the spacecraft’ s orbit.

Thermal desorption dominates the distribution of sodium atoms on ground surface since particles emitted by thermal desorption has small energy and return to the surface only in a short time (~10min). CPS is thought to generate the majority of atmosphere in high latitudes of northern hemisphere and mid latitudes.

In this research, the behavior of neutral sodium particle from generation to escape focused on thermal desorption and CPS is simulated using Monte Carlo method. In addition, the contribution of those processes will be discussed by comparing with the MESSENGER/MASCS/UVVS observation.

Keywords: Mercury, tenuous atmosphere , exosphere, thermal desorption, charged particle sputtering

