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# Long-term temporal variation of Mercury's sodium exosphere

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Mercury has a very thin atmosphere. It has been observed by space probes Mariner 10 and MESSENGER, and by ground-based observations, to have hydrogen (H), helium (He), oxygen (O), sodium (Na), potassium (K), and calcium (Ca) atoms in its atmosphere. These atoms emit light, with resonance scattering caused by energy from sunlight. Because of its high intensity, the emission of sodium atoms is well suited for studies by ground-based observations. The source processes of Mercury's exosphere are considered to be solar-photon-stimulated desorption, "sputtering" by impacting solar wind particles crashing into Mercury's surface and releasing atoms, and interplanetary dust vaporization. Combination of these three processes is considered to arise, but the primary process among them is unknown as yet.

At the Haleakala Observatory in Hawaii we have observed daily variation of Mercury's sodium exosphere. The observations were performed using a 40 cm Schmidt-Cassegrain telescope, a high-dispersion spectrograph, and a charge coupled device (CCD) camera. During observation seasons, elongation between Mercury and sun is more than 15 degrees, and observation time varies from 30 min to 1 h before sunrise or after sunset. The exospheric emission observed from the ground is part rather than entire dayside. The ratio of the observed emission varies by phase angle. Thus, we estimated the number of sodium atoms above entire dayside, using the exospheric model and assuming constant exospheric temperature.

Interplanetary dust is known to be distributed densely to the plane called dust symmetry plane, but the detailed distribution in the vicinity of Mercury is not known. To verify the contribution of interplanetary dust impact to exospheric yield, model parameters which maximize correlation coefficient was derived, based on simplified dust distribution model by Kelsall et al. [1998]. Inclination and ascending node in this model are based on observation of zodiacal light by Helios 1, 2. This model fitting shows that the number of sodium atoms correlates highly with interplanetary dust density. The correlation coefficient is 0.856. This result indicates that interplanetary dust vaporization may contribute significantly to the exospheric yield.

The impact of interplanetary dust mixes grains at the surface and replaces depleted grains with fresh grains. This is known as gardening effect. In addition, interplanetary dust contains sodium and therefore supplies sodium atoms to the surface, which increases the source rate by other processes.

Keywords: Mercury, exosphere