MESSENGER’s Flybys of Mercury: Three Glimpses into the Workings of a Complex Exospheric System

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Mercury’s exosphere is unique in the solar system. The combination of an airless, terrestrial planet having an intrinsic magnetic field, in close proximity to the Sun, and in an eccentric orbit results in an exospheric system of high spatial and temporal variability. Observations of emission from exospheric species provide insight into the processes that generate and maintain the exosphere.

The Mercury Atmospheric and Surface Composition Spectrometer (MASCS) on MESSENGER obtained observations of the exosphere during all three flybys of Mercury. Observations include emission from three previously known species (H, Na, Ca) and two species (Mg, Ca⁺) discovered during the flybys. Whereas some observations are consistent with ground-based or Mariner 10 data, particularly when viewed in the global context of the system, the high spatial resolution and viewing geometry afforded by MESSENGER has revealed several features in the structure of the exosphere for the first time. Tailward of the planet, a strong enhancement in the Ca emission was observed in the dawn direction. Over both poles, a two-component altitude profile was observed for Na. Over the northern pole, the observed altitude profile for Mg exhibited highly unusual structure, showing very little fall-off at low altitudes before decreasing rapidly at higher altitudes. Finally, the distribution of Ca⁺ was concentrated in a narrow region tailward of the planet and toward equatorial latitudes.

A synthesis of the MASCS exosphere observations from the three flybys and their implications for the operation of the exospheric system provide a strong basis for the exospheric observing plans during MESSENGER’s orbital mission phase.