COMPARISON OF GROUND-BASED SODIUM OBSERVATIONS TO MEASUREMENTS OF MERCURY'S EXOSPHERE WITH THE MESSENGER ULTRAVIOLET AND VISIBLE SPECTROMETER DURING THE FIRST MERCURY FLYBY.

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Introduction: Ground-based observations of the sodium exospheric emission taken at the McMath-Pierce Solar Telescope at Kitt Peak, Arizona, are compared with concurrent observations taken with the Ultraviolet and Visible Spectrometer (UVVS) on the Mercury Atmospheric and Surface Composition Spectrometer (MASCS) instrument [1] onboard the MESSENGER spacecraft [2] during the first flyby of the planet, January 14, 2008. The flyby trajectory is illustrated in Fig. 1 (blue), along with planned trajectories for two subsequent flybys and the planned orbit (white), all superimposed on an image of the sodium exosphere and its extended antisunward tail [3]. In addition to Na, the UVVS will observe H in the tail region; S, Ca and K in the nightside exosphere; and H, O, Ca and K in the dayside exosphere, as illustrated in Fig. 2. Additional details of the instrument and flyby observations are given in companion papers [4, 5].

Observations: Ground-based observations taken with the echelle spectrograph on the McMath-Pierce solar telescope between January 9 and January 19, 2008, are compared with UVVS observations taken during the first Mercury flyby by the MESSENGER spacecraft on January 14, 2008. Planned observations of UVVS during the flyby are illustrated in Fig. 2. Observations of H (Lyman α) and neutral Na will be taken in the antisunward tail region. Following this, the elements Na, Ca, S and K will be observed looking out through Mercury's shadow. The dayside surface will be observed followed by limb scans of Na and S close to the planet and H, O, Na, Ca and K at high altitudes. The distribution of the other elements will be compared with those of sodium. These observations will be used to determine the loss mechanisms for volatiles at Mercury.

Of particular interest is the morphology of the sodium exosphere, which has been observed at times to be peaked near the subsolar point (Figure 3) and at other times peaked at one or both poles (Figure 4). The cause of the high-latitude enhancements in the sodium exosphere has been ascribed to solar wind ion-impacts [6] or surface compositional and physical differences [7, 8]. In situ observations of the surface and magnetospheric environment are planned to determine the cause of the exospheric variability, which is not yet known. For the January 2008 flyby the true anomaly angle of Mercury is 285°, so that the exospheric tail is expected to be weak and short [9]. The geometry of the observations is such that MESSENGER will take measurements across the morning limb. Over the course of the mission, a goal is to determine the partitioning of Na and other species between the thermal and non-thermal components [10, 11] so as to increase knowledge of the desorption processes from surface materials.

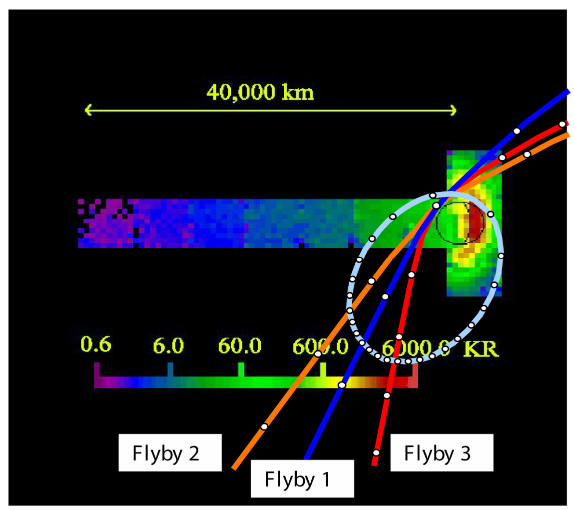

Figure 1. The trajectories of the MESSENGER flybys and the MESSENGER orbit are superimposed on an image of the sodium exosphere and tail [3]. The flyby trajectories (orange, blue and red) are near the equatorial plane and should be imagined coming out of the plane of the figure. The Sun is to the right. The MESSENGER orbit (light blue) is near polar and precesses about the planet as Mercury orbits the Sun. Note the high-latitude emission off both poles.

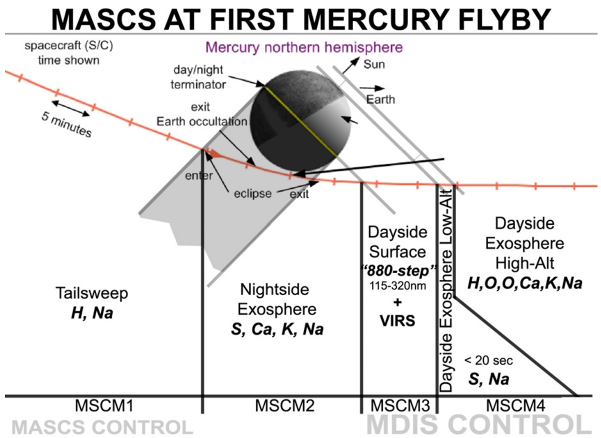

Figure 2. Sequence of planned UVVS observations during the MESSENGER flyby of January 14, 2008.

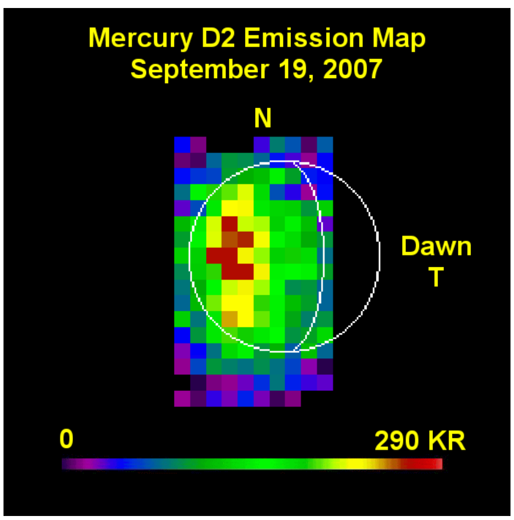

Figure 3. Observation of Mercury's sodium D2 emission taken September 19, 2007, showing emission peaked at the subsolar point. There is very little high-latitude emission on this date. (Potter and Killen, McMath-Pierce Solar Telescope, National Solar Observatory, Kitt Peak, Arizona).

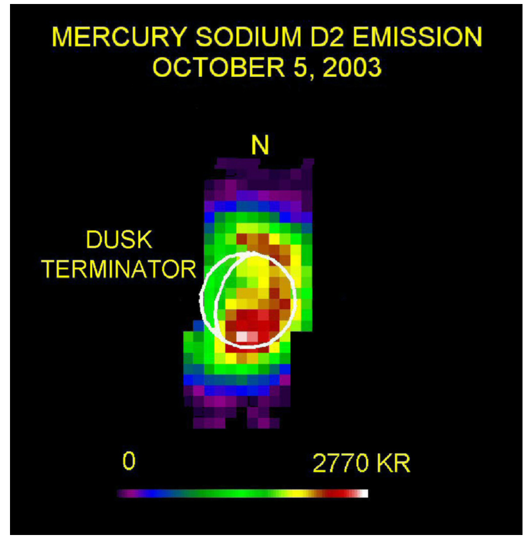

Figure 4. Observation of Mercury's sodium emission on October 5, 2003, shows high-latitude emission at both poles, peaking primarily in the southern hemisphere (Potter and Killen, McMath-Pierce Solar Telescope, National Solar Observatory, Kitt Peak, Arizona).

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