

## SpeX Spectroscopy of Mercury: 0.8 – 5.2 $\mu\text{m}$

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**Abstract.** Spectra of Mercury were obtained at the Infrared Telescope Facility on Mauna Kea, HI using SpeX. There is no indication of any absorption feature associated with FeO in Mercury's regolith. There is a 5  $\mu\text{m}$  excess in thermal flux similar to that observed from the Kuiper Airborne Observatory (KAO) using HIFOGS. Spectra from varying locations do exhibit different slopes and flux indicating different surface temperatures at different locations.

### 1. Introduction

In order to continue the search for any evidence of oxidized iron on Mercury's surface we have obtained very high signal-to-noise (S/N) ratio spectra between 0.8 and 5.2  $\mu\text{m}$  using SpeX at the Infrared Telescope Facility (IRTF) on Mauna Kea, HI. This is of interest because we wish to know the surface composition of Mercury to get clues to its formation and cooling history. Every other terrestrial planet in our solar system has at least several percent oxidized iron on its surface. So far, no search for FeO by any observational group has discovered its unambiguous presence by observing the reflectance absorption centered near 0.9 or 2.2  $\mu\text{m}$ .

### 2. Observations

Observations were obtained in clear daytime on three consecutive days in June, 2002. We show spectra from 23 June 2002 in this paper. The spectrograph slit was placed across the illuminated disk of the planet at several different locations.

### 3. Near Infrared Spectral Mapping With SpeX

SpeX operates in several modes with slightly different resolving power ( $R = 1000 - 2000$ ). For these observations we use SXD from  $0.8 - 2.4 \mu\text{m}$  and LXD from  $2.2 - 5.4 \mu\text{m}$ . Because there are some telluric  $\text{H}_2\text{O}$ ,  $\text{CO}_2$ , and  $\text{N}_2\text{O}$  bands in this spectral region that cause spurious features if proper correction is not obtained, we have in some cases removed sections of the data from the spectra displayed. Fig. 1 (left) shows the entire spectral range for about 250 degrees longitude on Mercury's surface.

Because the S/N is very high in these data, it is possible to divide the data along the slit into several sectors. This has the advantage of providing increased spatial resolution in the data to search for variations in composition with respect to latitude. At the IRTF using SpeX the spatial resolution is seeing limited in the  $0.8 - 5.5 \mu\text{m}$  spectral region. Our seeing for the days observations was about 1 arcsecond. We thus chose to divide the slit into 4 sectors, each covering slightly less than 2 arcseconds across Mercury's surface. It is advantageous to divide the spectra by a thermal model of Mercury for the location of the slit to remove the steep slope caused by Mercury's thermal emission. We use the thermal model developed specifically for Mercury spectral data analysis (Emery et al. 1998). It includes the effects of slow rotation, a rough cratered surface, and the orbital and geometric parameters of the observations. After data are divided by the thermal model, any spectral features become more apparent.

Previous observations made from the KAO with HIFOGS (Emery et al. 1998) found an excess of emission in the  $5 \mu\text{m}$  spectral region. These data corroborate that discovery. The excess is clearly seen relative to the thermal model but the lack of space in this brief article precludes the inclusion of an illustration.

A different set of previous observations of Mercury around the  $5 \mu\text{m}$  region were made with BASS (Sprague et al. 2002) at a resolving power of about 150. In those spectra there were some spectral features in the  $5 \mu\text{m}$  region that were interpreted as indicative of pyroxene in the surface material. We do not see similar unambiguous features in this data set.

The wavelength region of the SXD mode has also been observed previously by McCord and Clark (1979). Other observers have also obtained spectra from about  $0.4 - 1.2 \mu\text{m}$  but we do not discuss those here. The scatter in the McCord and Clark spectra near the  $2.2 \mu\text{m}$  absorption (indicative of oxidized iron in pyroxene and olivine) permitted calculating an upper limit of at most 6% FeO. Their spectrum shows no indication of absorption owing to oxidized iron centered at  $0.9 \mu\text{m}$ . At the Moon this absorption band is ubiquitous at varying depths. Our SpeX data show no evidence for FeO at either absorption band. Serendipitously the region observed by McCord and Clark was centered on the same side of Mercury and near  $250^\circ$  longitude. While our spectra are longitudinally resolved to about 1 arcsecond, that of McCord and Clark is a disk integration within a circular aperture encompassing the entire Earth-facing disk of Mercury. The comparisons are shown in Fig. 1 (right).

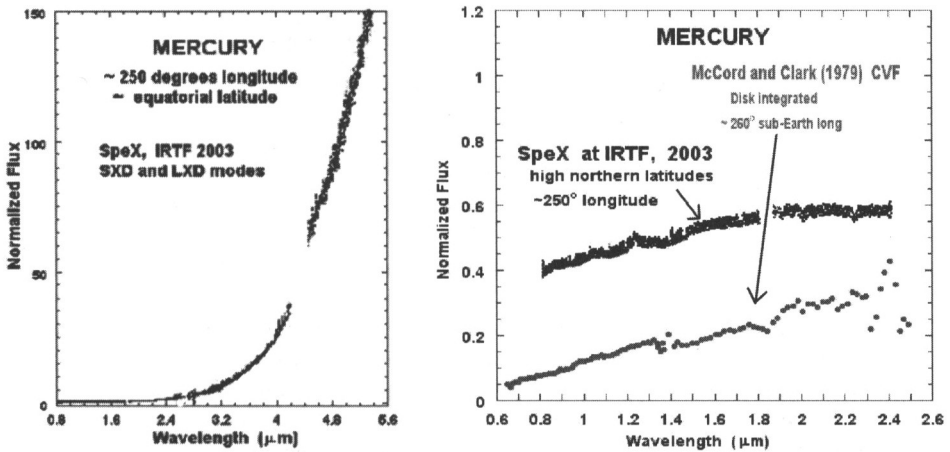


Figure 1. (left) Full range of SpeX data from Mercury before division by a thermal model. (right) SpeX data plotted along with data of McCord and Clark (1979). See text for explanation.

#### 4. Conclusions

The  $5 \mu\text{m}$  excess is an outstanding spectral feature in this data set. It appears in every spectrum at all locations examined so far. The fact that the emission is enhanced above the theoretical prediction made by our rough surface thermal model indicates something of very high emissivity in Mercury's regolith. This high emissivity is likely a clue to the composition of the material responsible but we do not have enough information to identify it at this time.

The data show no evidence whatsoever for the absorption bands of FeO at  $0.9$  and  $2.2 \mu\text{m}$ . The reason for this must be the absence of oxidized iron. This does not preclude iron blebs in the surface regolith caused by aeons of meteoritic bombardment and other space weathering.

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