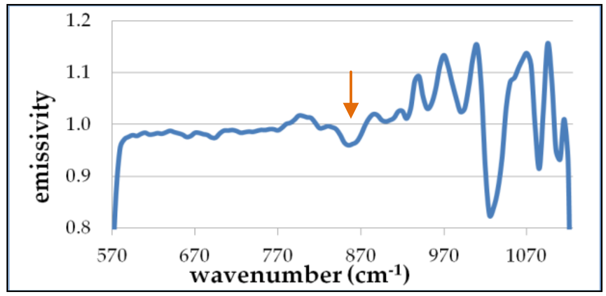
ICY SATELLITE SURFACE COMPOSITIONS FROM THERMAL INFRARED SPECTROSCOPY. C. L. Young[1], J. J. Wray[1], R. N. Clark[2], K. P. Hand[3], J. R. Spencer[4], [1]School of Earth and Atmospheric Sciences, Georgia Institute of Technology, [2]U.S Geological Survey, [3]Jet Propulsion Laboratory, [4]Southwest Research Institute.

Introduction: Spectroscopy of icy satellite surfaces can aid us in searching for the requirements of life on these worlds. Compositional studies of Saturn's icy satellites were one of the original primary science goals for Cassini's Composite Infrared Spectrometer (CIRS) [1]. However, to date, CIRS surface compositional studies have received less attention than measurements of atmospheres, surface temperatures and thermophysical properties across the Saturn system.

Cassini Visual and Infrared Mapping Spectrometer (VIMS) data from icy moons have shown tantalizing evidence for H_2O, CO_2, possible NH_3 and hydrous minerals, organics, metallic and oxidized Fe [e.g., 2-4], but the stronger fundamental spectral features in the mid-IR would allow confirmation of these constituents and more specific identifications. The spectral region covered by CIRS focal planes 3 and 4 is rich in emissivity features due to both simple and complex molecules [e.g., 5], but the study of emissivity variations in this region is often challenged by low signal-to-noise ratios for individual spectra. Our goal is to use Cassini CIRS to characterize the surface composition of icy moons. We present an approach to average CIRS spectra from the full icy moon dataset on the Planetary Data System (PDS) to increase signal-to-noise and use emissivity spectra to constrain surface compositions.

Methodology: Iapetus was selected as an initial case to test our approach, as its dark terrain appears spectrally complex to VIMS and has relatively high surface temperatures, which were expected to increase the IR signal. CIRS focal plane 3 (FP3) spectra from the PDS were obtained using the Vanilla software package. The Outer Planets Unified Search (OPUS) was used to select observations during which the dark material on Iapetus was illuminated by afternoon sunlight in order to assure the highest surface temperatures possible. Spectra from a single observation were selected in order to demonstrate the value of spectral averaging. The wavenumber form of the Planck blackbody equation was used to determine surface temperatures. Emissivities were calculated by dividing the CIRS average radiances by the blackbody radiance at each wavenumber.

Results and Discussion: The averaged emissivity spectra reveal a feature of interest at ~855 cm^{-1} (denoted by the orange arrow in the figure). This feature does not correspond to any known instrument artifact (D. Jennings, personal communication) and is the first FP3 spectral feature reported for an icy moon.



Elemental sulfur has a comparable spectral feature [6], but has another feature at ~660 cm^{-1} that is not observed in our CIRS spectrum. Some carbonates [7] and organics [5] absorb near 850 cm^{-1}, but both should also be detectable by VIMS and yet have not been reported to date. By contrast, across vast dust-covered regions of Mars, the only feature detectable at CIRS FP3 wavelengths is at ~840 cm^{-1} and is due to fine-grained silicate minerals, such as feldspars [8]. If silicates are present on Iapetus, then the extremely low thermal inertia values measured there [e.g., 9] are consistent with sub-micron-size grains [10].

Conclusions: We report the first tentative identification of a spectral feature from CIRS FP3 icy moon data, at ~855 cm^{-1}. Future studies will examine more data from Iapetus and other moons in search of emissivity features and will use laboratory analogs to identify ambiguous features. If no other features are found, we will use lab studies to assess what compositions would appear featureless in the mid-IR. Whether or not features are found will have implications for the suitability of mid-IR spectrometers to study icy moon surface compositions on future missions.

References: [1] Flasar F.M. et al. (2004) *Space Sci. Rev.*, *115*, 169–297. [2] Brown R.H. et al. (2006) *Science*, *311*, 1425–1428. [3] Cruikshank D.P. et al. (2008) *Icarus*, *193*, 334–343. [4] Clark R.N. et al. (2012) *Icarus*, *218*, 831–860. [5] Hand K.P. et al. (2009) in *Europa*, Eds. R. Pappalardo, W. McKinnon, & K. Khurana. Univ. of AZ Press. [6] Clark R.N. et al. (2007) USGS http://speclab.cr.usgs.gov/spectral.lib06. [7] Clark R.N. (1999) in *Manual of Remote Sensing, Volume 3, Remote Sensing for the Earth Sciences*, Ed. A. N. Rencz, John Wiley and Sons. [8] Christensen P.R. et al. (2004) *Science*, *305*, 837–842. [9] Howett C.J.A. et al. (2010) *Icarus*, *206*, 573–593. [10] Presley M.A. and Christensen P.R. (1997) *J. Geophys. Res.*, *102*, 6551–6566.