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NEW SPECTRAL OBSERVATIONS OF CALLISTO AND LEADING/TRAILING HEMISPHERE DISTINCTIONS W. M. Calvin, R. N. Clark, and T. V. V. King, U. S. Geological Survey, Denver

In December, 1989 and January, 1990 new observations of the leading and trailing hemispheres of Callisto were made from the NASA Infrared Telescope Facility on Mauna Kea in Hawaii. Using the Cooled Grating Array Spectrometer spectral coverage was obtained from 1.89 to 2.46 μm and 2.8 to 4.2 μm for both the leading and trailing hemispheres. In addition, spectral coverage of the leading hemisphere was obtained from 1.30 to 2.55 μm and from 4.2 to 4.8 μm.

In the wavelength region from 1.9 to 2.5 μm, both Clark *et al.* [1] and Pollack *et al.* [2] noted that the trailing hemisphere spectrum was suppressed relative to the leading hemisphere near 2.2 μm. That is, the peak at 2.2 μm associated with the long wavelength edge of the 2.0 μm water ice absorption feature was not observed on the trailing hemisphere. (We believe the labels for leading and trailing hemispheres are reversed in the Pollack *et al.* paper.) However, data presented by Roush *et al.* [3], and the observational data presented here in Figure 1, indicate the spectra of the leading and trailing hemispheres are quite similar in this spectral region, with at most a slight slope change between the two. Variations in orbital phase cannot account for the difference in the data sets. A re-examination of the Clark *et al.* data indicates that errors in standard star data may have eliminated a 2.2 μm peak from the spectrum of the trailing hemisphere. It is not known if the Pollack *et al.* data are subject to the same uncertainties.

The longer wavelength coverage of the leading hemisphere allowed for a model removal of the ice signature and indicates a possible absorption feature from 1.8 to 1.9 μm, associated with hydrous mineral phases. This is consistent with the modeling study of Calvin and Clark [4], which indicated a large adsorbed water band at 3 μm in the non-ice material on the surface. Unfortunately, this feature occurs where absorption by water in the terrestrial atmosphere is quite strong, and it may in fact be a remnant atmospheric feature. In the short wavelength spectral region (Figure 1), these high resolution data show no other spectral features except those which can be assigned to water ice. The slight difference in slope between the trailing and leading hemispheres can be attributed to variations in ice grain size or grain size distribution. The shallower slope on the trailing hemisphere indicates larger ice grain sizes, consistent with the interpretation of spectra at longer wavelengths discussed below.

In the spectral region from 2.8 to 4.2 μm several distinctions between the leading and trailing hemispheres are observed (Figure 2). A broad absorption from approximately 3.1 to 3.6 μm is present on the leading hemisphere. The trailing hemisphere also exhibits a different spectral slope with respect to the leading hemisphere from approximately 3.0 to just beyond 3.1 μm. Problems with extinction corrections in the region from 3.18 to 3.33 μm yielded data that are noisy and the resulting bad data points have been deleted in Figure 2.

The broad absorption band centered over 3.4 μm on the leading hemisphere can be seen in data presented by Pollack *et al.* [2] and Roush *et al.* [3], but at a much poorer resolution and signal-to-noise ratio. This feature was not discussed in either of those papers. The high resolution data presented here indicate that this feature can be attributed to a very small amount of fine-grained water ice present on the leading hemisphere. Spectral modeling has shown that 0.5 to 1.0 wt% ice at grain sizes near

30 to 50 μm can account for the presence of this absorption feature. The depth of this feature varies from near 35% in the earliest observations to approximately 10% in the present data. This variation is evidence of preferential erosion through sublimation of the finest ice grains on the surface. Such grains are created by meteroid bombardment and the competition between the two processes appears to be dynamic on decade-like time scales.

The spectral shape of the trailing hemisphere can be modeled reasonably well using a broad adsorbed water band with the addition of some large-grained ice. The modeling suggests that there may be additional absorption near 3.1 μm, particularly on the leading hemisphere. A model removal of the ice signature in this wavelength region shows an absorption that is very similar to that seen in the spectrum of the asteroid Ceres (Lebofsky *et al.* [5] and King *et al.* [6]). This absorption on Ceres has been interpreted as being caused by NH_4-bearing clays [6]. Unfortunately the model ice removal in this spectral region is subject to a greater uncertainty than in other wavelength regions as both the index of refraction and the absorption coefficient are at extreme values and varying rapidly near 3.1 μm. Such uncertainty may affect the slopes of modeled spectra and thus precludes a definitive identification.

[1] Clark, R. N., R. B. Singer, P. D. Owensby, and F. P. Fanale 1980. *Bull. Am. Astron. Soc.,* **12**, 713–714. [Abstract] [2] Pollack, J. B., F. C. Witteborn, E. F. Erickson, D. W. Strecker, B. J. Baldwin, and R. T. Reynolds 1978. *Icarus,* **36**, 271–303. [3] Roush, T. L., J. B. Pollack, F. C. Witteborn, J. D. Bregman, and J. P. Simpson 1990. *Icarus,* **86**, 355–382. [4] Calvin, W. M., and R. N. Clark, 1991. *Icarus,* in press. [5] Lebofsky, L. A., M. A. Feierberg, A. T. Tokunaga, H. P. Larson, and J. R. Johnson 1981. *Icarus,* **48**, 453–459. [6] King, T. V. V., R. N. Clark, W. M. Calvin, G. A. Swayze, and R. H. Brown 1990. *Bull. Amer. Astron. Soc.,* **22**, 1123. [Abstract]

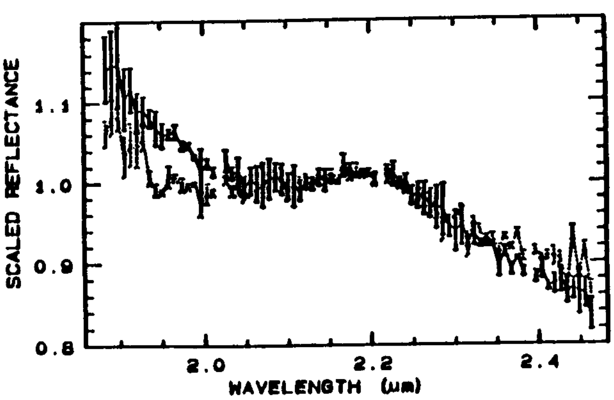

Figure 1: New observations 1.9–2.5 μm.

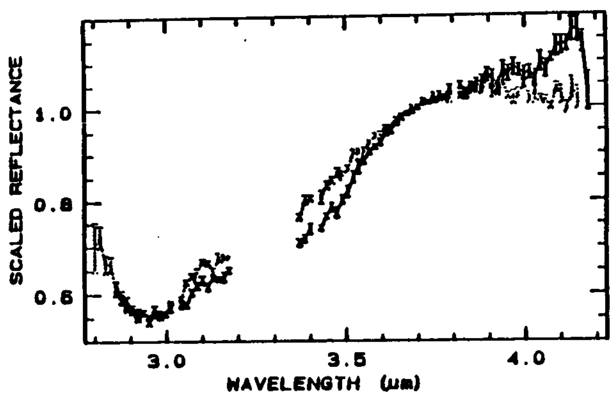

Figure 2: New observations 2.8–4.2 μm.

Leading hemisphere is the solid line, trailing hemisphere is the dotted line.