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N94-16217

MODELING THE REFLECTANCE OF CO_2 FROST WITH NEW OPTICAL CONSTANTS: APPLICATION TO MARTIAN SOUTH POLAR CAP SPECTRA; Gary B. Hansen, Univ. of Wash./Jet Propulsion Lab 183-601, Pasadena, CA 91109; Terry Z. Martin, Jet Propulsion Lab 169-237, Pasadena, CA 91109

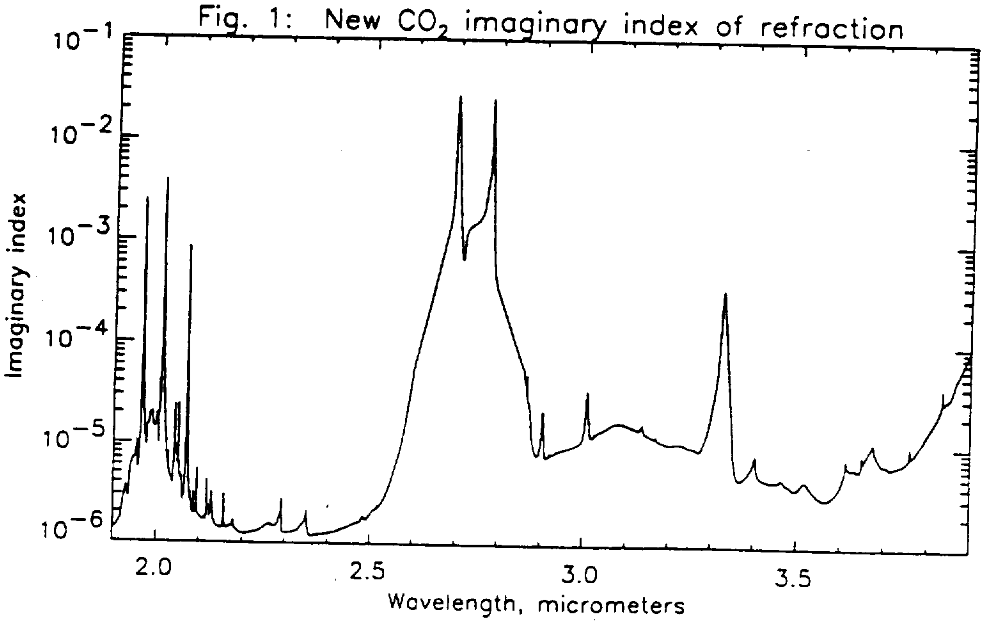
New measurements of the absorption coefficients of CO_2 ice, in most of the spectral range 0.2 to 3.9 µm where absorption coefficients are below 1.5 per cm, have recently been made [1]. Although these measurements are preliminary, they contain spectral detail not seen previously in the literature. Therefore, it is useful to combine these new data with older data from spectral regions of stronger absorption [2] and reformulate models of the albedo [3] or reflectance [4] of CO_2 frost. These models can then be adjusted in an attempt to match measurements of Martian polar deposits, such as the set of spectra returned by the IRS instrument on Mariner 7 (1969) [5,6].

The new absorption coefficients of CO_2 ice were measured on several samples of 41-mm thickness at 150-155 K. A portion of the spectrum from 1.9 to 3.9 µm wavelength is shown in Figure 1 in the form of imaginary coefficient of refraction (= linear absorption × wavelength / 4π). The data above about 3×10^{-5} are obtained from [2], except for the absorption line at 3.32 µm, which is extrapolated in a way that is consistent with laboratory frost measurements [7], but the peak level is still highly uncertain.

This new imaginary coefficient, combined with the real coefficient from [2], can be immediately applied to the models for hemispherical albedo used in [3], resulting in markedly different results from those in that study. The results for an infinite optical depth layer and solar incidence of 60° are plotted in Figure 2 for a range of mean particle radii from 0.03 to 3 mm.

Although this is an albedo model and not a bidirectional reflectance model, it can still be qualitatively compared to measured spectra of the Martian polar cap, such as the set of near- to middle-infrared spectra taken of the south polar cap in spring (L_S = 200°) by the IRS instrument on Mariner 7. The albedo model degraded to the resolution of the IRS is compared to two of these spectra in Figure 3. They are scaled to 1.0 at their maximum reflectance near 2.2 µm. The regions from 2.2 to 2.6 and from 3.0 to 3.9 µm are substantially free of atmospheric gas absorptions and can be compared directly. Note the coincidence of the characteristic absorption features of the ice at 2.28, 2.34, 3.00, 3.32, and 3.67 µm, and the albedo/reflectance maximum at 3.57 µm. (The wavelength calibration used for the IRS spectra is not yet accurate for the 2.2-2.6 µm region.)

Fig. 1: New CO_2 imaginary index of refraction



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NEW MODEL REFLECTANCE OF CO_2 FROST: Hansen, G.B., and T.Z. Martin

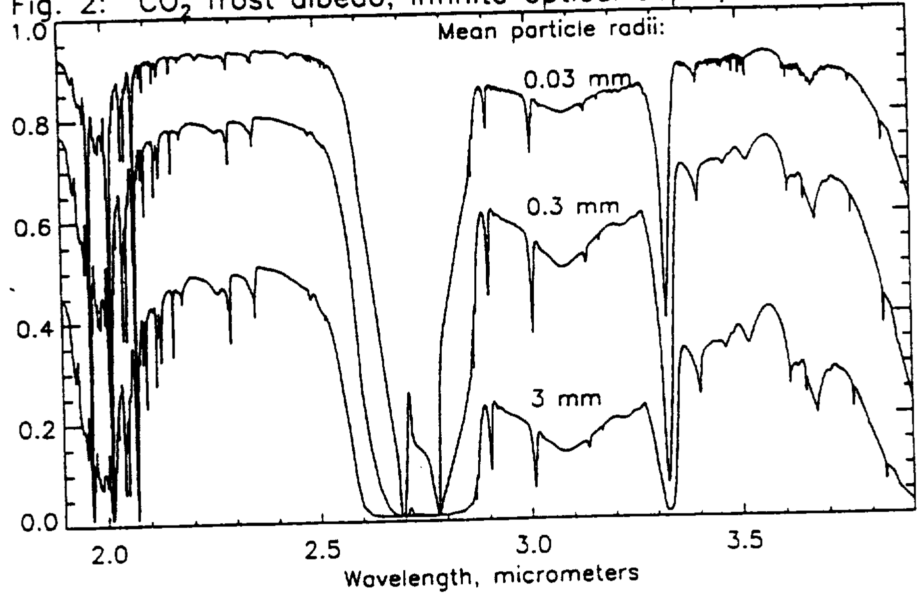

Fig. 2: CO_2 frost albedo, infinite optical depth, 60° incidence

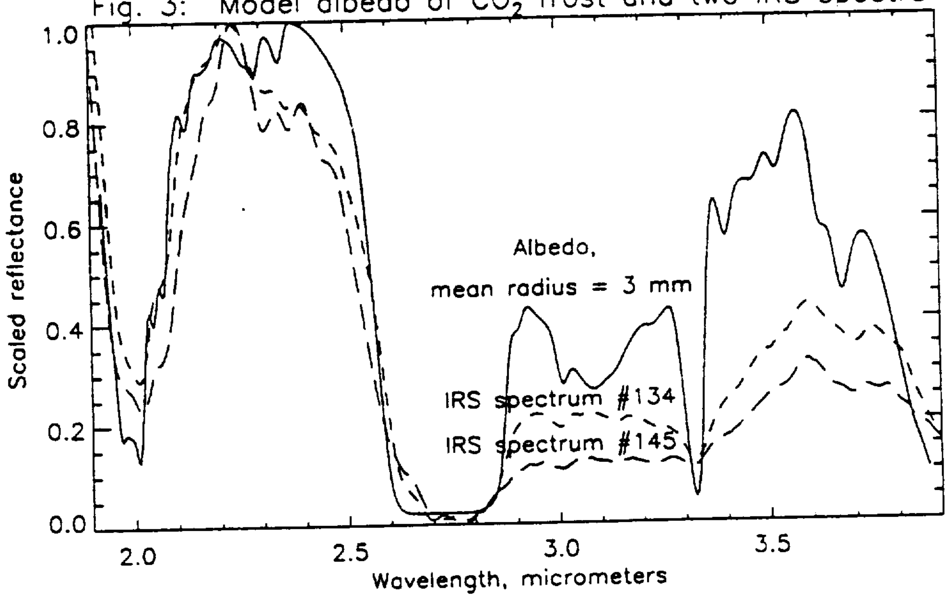

Fig. 3: Model albedo of CO_2 frost and two IRS spectra

The use of a reflectance model as well as the addition of water ice and/or dust contamination will be addressed in an effort to better match the observed spectra in this data set. In particular, the maximum at 2.2 µm, the slope from 2.3-2.6 µm, and the depression and muting of features at wavelengths longer than 2.9 µm are characteristic of water ice contamination as illustrated in [3].

This is a cooperative project of the University of Washington, Seattle, WA, and the Jet Propulsion Laboratory, Pasadena, CA, and is supported partly by a grant from NASA and partly by the Caltech President's Fund.

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