N89-13366

LABORATORY SIMULATIONS OF COMET SURFACES

John R. Stephens
Los Alamos National Laboratory
Los Alamos, NM

Bo A. S. Gustafson
Space Astronomy Laboratory
University of Florida
Gainesville, FL

The geometric albedos of frozen mixtures consisting of colloidal silica and carbon black mixed with water have been measured over the wavelength range of 400 to 800 nm to compare with recent observations of Comet Halley. Data were obtained as a function of sample temperature, scattering angle, and wavelength as the frozen samples warmed to 0 degrees C in a vacuum. Scattering from water ice, flat black paint, and Kodak white reflectance paint were also measured.

A schematic of the apparatus is shown in Figure 1. The sample is frozen onto a quartz plate in thermal contact with a copper block that has been cooled with liquid nitrogen. The front surface of the deposit is warmed and allowed to freeze again to provide a smooth surface and a uniform 2 mm sample thickness. The assembly was placed in a vacuum chamber with the deposit surface vertical and the surface normal 20 degrees from the incident source beam. The chamber vacuum and sample temperature are monitored throughout the experiment. The intensity of the source is monitored prior to the experiment. The deposit is illuminated using a Xe arc lamp, and the scattering intensity measured, over the spectral range of 400-800 nm, as a function of scattering angle as the sample is warmed to 0 degrees C.

The albedo of pure water, mixtures of 1% carbon plus 10% colloidal silica in water, and 10% colloidal in water were measured. The generalized geometric albedo at each angle is calculated by normalizing the intensity of scattered light at each angle to the source intensity and dividing the result by the intensity of light scattered from a lambert surface. Kodak white reflectance paint, which has a published reflectance of greater than 98% from 200 to 2500 nm, was used as the lambert surface in calculating the geometric albedos. Since the angular dependence of the generalized geometric albedos was small, the albedos were averaged over all angles to yield an average (angle integrated) general geometric albedo for each sample.

The geometric albedos were only weak functions of scattering angle and were flat from 400 to 800 nm within the 15% precision of the experiments. The apparent angle integrated albedo for the water ice sample was 0.05. The low apparent albedo for the water ice sample was 0.05. The low apparent albedo resulted from the high transmission of the sample. Angle integrated albedos were 0.05 for the $C/SiO_2/H_2O$ mixture and from 0.3 to 0.6 for the SiO_2/H_2O mixtures. Flat black paint had an albedo of 0.05. Due to transmission of the SiO_2/H_2O mixture, the albedo of an optically thick deposit may be as much as 30% higher than the above figures. The $C/SiO_2/H_2O$ mixture showed less than a 20% increase in albedo as the sample warmed from –60 C, while the albedo the SiO_2H_2O mixture increased from 0.3 to 0.6 while warming from –40 to –20 C. In the SiO_2/H_2O deposit, a highly reflective layer of SiO_2 formed on the surface as the ice sublimed, leading to an increase in albedo and decrease in transmitted light.

The change in albedo of the samples show that sublimation of the water from the sample surfaces can have a major effect on the albedo of a particle/ice sample in the visible. Such processing may have a marked effect on the visible albedo of comet surfaces as well.

Figure 1

Schematic of Apparatus to Measure Surface Albedos