No. 168 SPECTRAL ALBEDOS OF THE GALILEAN SATELLITES

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ABSTRACT

The wavelength dependence of the albedo of the Galilean satellites has been determined from wide-band photometric observations extending from 0.36μ to $3.4\ \mu$.

The author has observed Jupiter's Galilean satellites with two telescopes: the 60-inch on Site II, Catalina Observatory (el. 8450 ft = 2580 m); and the 40-inch on Site IV (el. 8580 ft = 2620 m). Two standard photometers were used, one for UBVRI (with two photomultipliers, a 1P21 and a RCA 7102); and one for JHKL, using a liquid N_2-cooled PbS cell. The data are summarized in Table I. This table gives the photometric band designation, the effective wavelength, and the mean observed magnitude for each satellite. In all cases, the quoted magnitudes are means of several independent measures obtained within a few days of the 1971 opposition. Two sets of UBVRI observations were obtained on three nights and an average of 4.2 JHKL measures on six additional nights.

The scatter in the individual measures, particularly in the infrared (JHKL), is larger than found for routine stellar observations; e.g., the spread is $0^m.2$ to $0^m.3$ in the K magnitude. The satellites are known to vary in the visual region (Harris 1961); our observations suggest that in the infrared the variations may be somewhat larger and may be correlated with orbital phase. Because of the number of measures obtained, the average JHKL magnitudes given in Table I should be good to better than $\pm 0^m.10$ (mean error). At shorter wavelengths, the errors will be smaller.

The observations were analyzed to determine the wavelength dependence of the albedo of these objects. The computed albedos, shown in Figure 1, are normalized to 0.5 in the visual band at 0.55μ.

TABLE I

MAGNITUDES OF GALILEAN SATELLITES

DESIGNATION EFFECTIVE λ (μ)	U 0.36	B 0.44	V 0.55	R 0.70	I 0.90	J 1.25	H 1.62	K 2.2	L 3.4
J I (Io)	8.19	6.38	5.33	4.61	4.13	3.75	3.44	3.44	3.42
J II (Europa)	6.60	6.18	5.32	4.72	4.37	4.26	4.68	5.26	7.30
J III (Ganymede)	6.11	5.60	4.78	4.16	3.79	3.65	3.77	3.85	5.67
J IV (Callisto)	7.27	6.71	5.86	5.24	4.86	4.54	4.26	4.24	5.16

The *albedos* followed from: (a) the observed fluxes derived from the measured magnitudes; (b) the incident solar fluxes for each satellite; and (c) the assumption that the reflected radiation is spread uniformly over a hemisphere. The satellite radii adopted are taken from Kaula (1968); the mean heliocentric and geocentric distances of Jupiter were 5.365 and 4.372 A.U., respectively; the magnitude and colors of the sun were taken from Johnson (1964); and the photometric calibrations from Johnson (1966). The albedo thus obtained is a simplified Lambert-type, not equal either to the Bond or the geometrical albedo commonly used (Kaula 1968). The wavelength dependence shown in Figure 1 is not affected, of course. The visual albedos ($\lambda = 0.55\mu$) relative to Io are:

$$\mathrm{J\,II/J\,I} = 1.32$$
$$\mathrm{J\,III/J\,I} = 0.71$$
$$\mathrm{J\,IV/J\,I} = 0.31$$

These ratios should also apply to the Bond and geometric albedos.

The curves of Figure 1 show a variety of features. For Io the albedo falls off rapidly to the ultraviolet, but remains high and nearly constant from the visual to $\lambda = 3.4\ \mu$; the high value at 3.4 μ does not favor a surface composition of NH_4Cl, but is compatible with a sulfur compound. The drop in the curves for Europa and Ganymede confirms earlier conclusions that H_2O ice is present on these satellites (Kuiper 1957), while the decrease seen at 3.4 μ for Callisto could be due to $NH_4 \cdot Cl$.

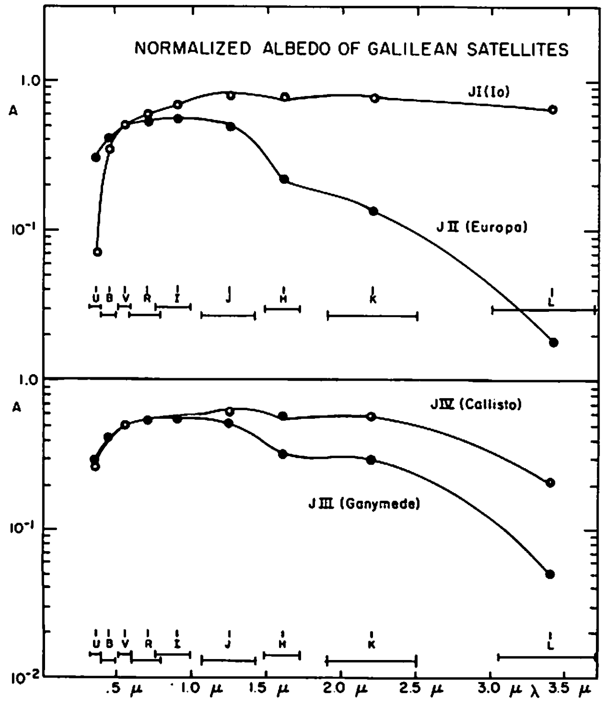

Fig. 1. Normalized Albedos of Galilean Satellites. The curves show the wavelength dependence of the albedo from $\lambda = 0.36\mu$ to 3.4μ. The various photometric band positions and their half widths are shown. The curves are normalized to $A = 0.50$ at 0.55μ.

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