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SPECTROPHOTOMETRY OF FAINT COMETS: THE ASTEROID APPROACH

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Abstract

This is a short description of observing programs at optical (0.35-0.8 micron) and near-infrared (1.1-2.4 micron) wavelengths, directed at the acquisition of reflection spectra of faint and distant comets. The ultimate goal is to obtain spectrophotometric measurements of comets for which a significant part of the light is expected to be reflected by the solid surface of the nucleus.

Faint ($V > 15$ mag) comets at large ($r \gtrsim 2$ Au) distances to the sun, show relatively little gas and dust activity. Spectra obtained by Degewij (1980) and S. M. Larson (private communication) display a dominant solar continuum with a width comparable to the seeing disk diameter. However, the TV acquisition system used for guiding, having $V_{lim} \sim 18 - 20$ mag, showed in all cases a relatively faint coma. The CN(0,0) emission at ~ 3880Å is barely visible in the coma (see Figure 1) and it looks like the light in the coma is mainly due to reflection from dust particles.

In the following text, programs are described which are aimed at direct spectrophotometric observations of cometary nuclei. I would like to call these efforts the "asteroid - approach", because asteroid type remote sensing techniques are used. These techniques are designed and successfully tested for the acquisition of mineralogical information related to the surfaces of solid bodies in the solar system. Figure 2 shows the difference between the 0.3 - 2.4 micron spectra of the three main mineralogical classes of asteroids. In particular at near-infrared wavelengths the H and K filters are sensitive for water frost, which apparently is not present on the outer surfaces of the distant satellites J6 Himalia and S9 Phoebe.

A program by C. R. Chapman and J. Degewij with the ISIT Videocamera behind the 224 cm telescope of the Kitt Peak National Observatory, is aimed at the acquisition of the reflection spectrum of a cometary nucleus. We use a sequence of about a dozen filters (see Figures 3a, b) centered at CN(0,0) and C_2(0,0) emissions, and wavelengths which are not or only slightly affected by emissions. We extrapolate the dust and gas cloud profiles at the nuclear condensation, to obtain a 0.35 - 0.8 micron reflection spectrum corrected for the contamination by the coma. This spectrum can be compared with spectra of other small bodies in the solar system to find evidence for their possible interrelation.

A program by D. P. Cruikshank, W. K. Hartmann, and J. Degewij with the InSb photometer behind the 3 meter NASA InfraRed Telescope Facility on Mauna Kea, is aimed at 1.1 - 2.4 micron JHK broad-band photometry of faint comets. Also a V magnitude is obtained with a different photometer. Hartmann (1980) found the Jupiter-region bodies (distant asteroids and satellites) to split up at JHK wavelengths (see Figures 2 and 4) in H_2O - icy bodies and dark - stony bodies. If comets have water frost on their surfaces, then this will show up in their JHK colors.

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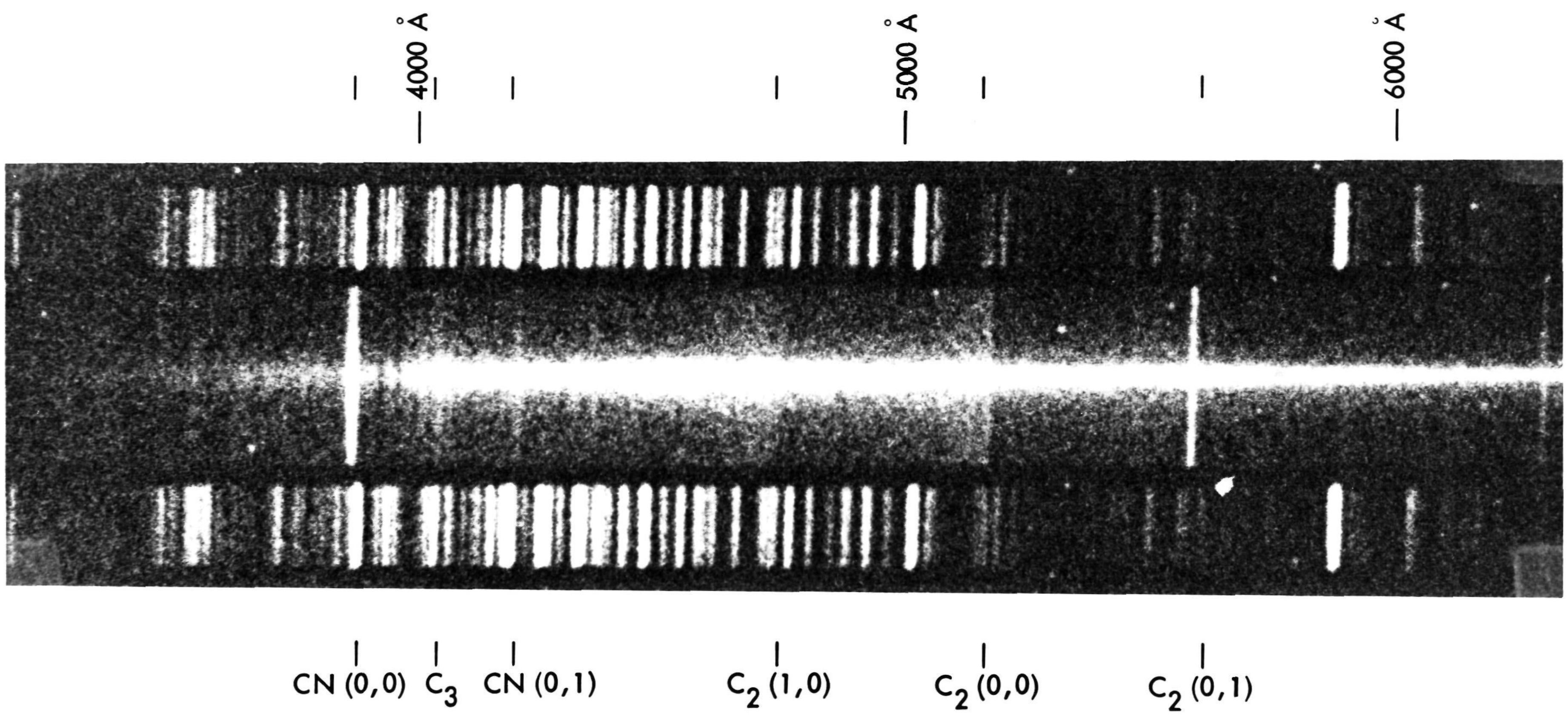

Figure 1a. Spectrum of bright (V ~ 10) Comet Meier 1978f on 31 May 1978 UT. (reproduced from Degewij 1980).

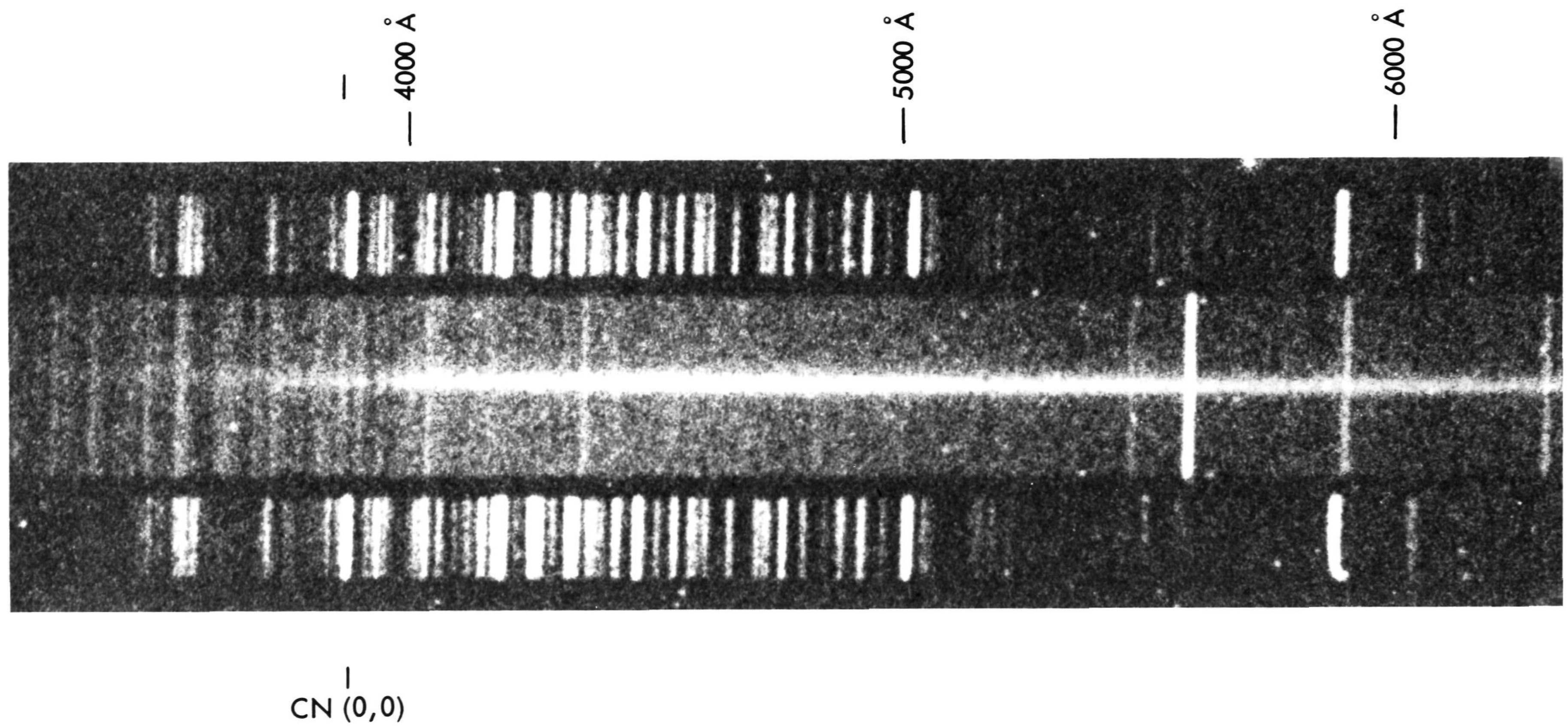

Figure 1b. Spectrum of faint (V ~ 18) Comet van Biesbroeck 1954 IV on 1 June 1978 UT. The CN(0,0) emission is barely visible. (reproduced from Degewij 1980).

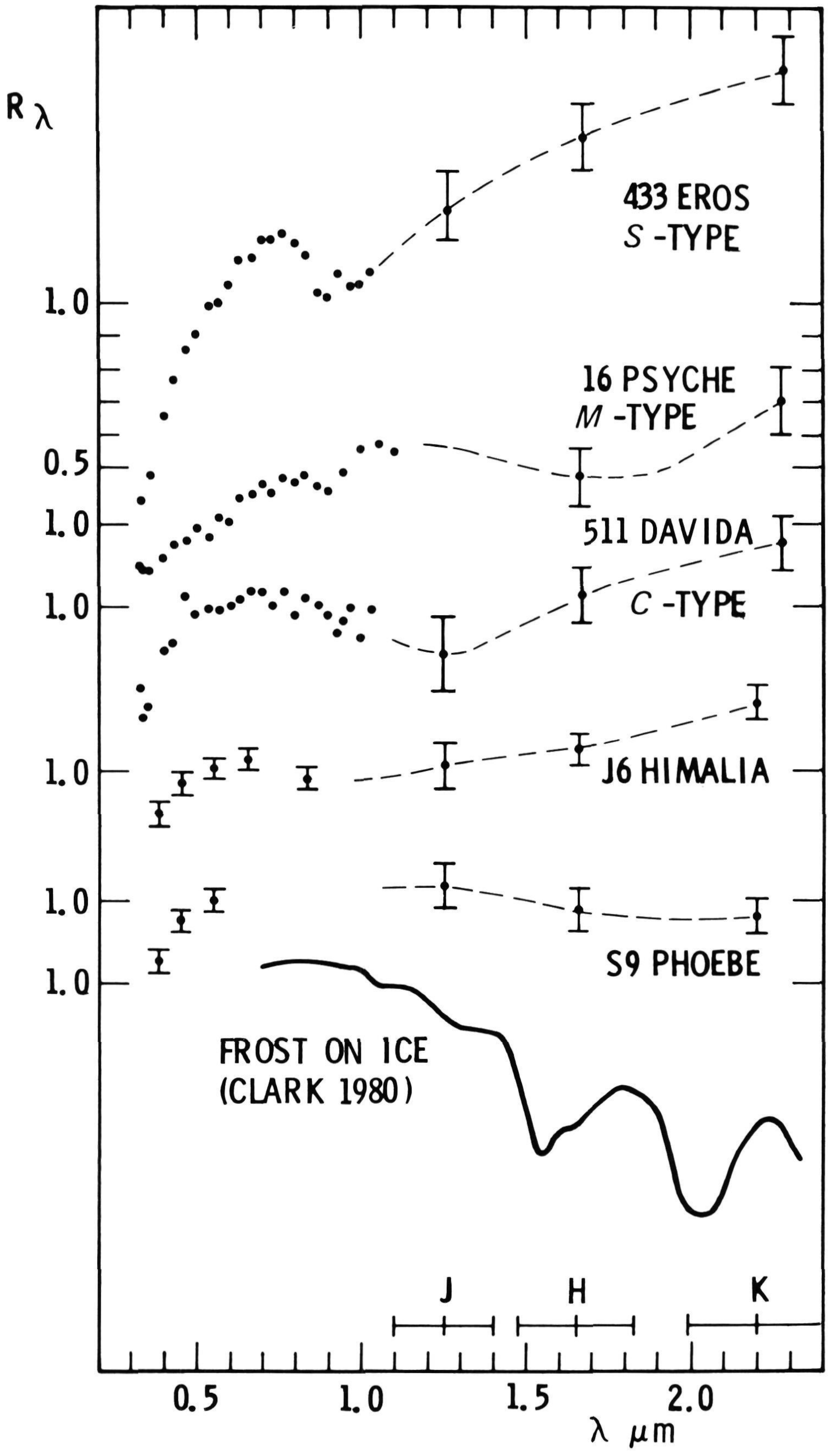

Figure 2. Reflectances for J6 and S9, scaled to unity at 0.55 micron, compared with those of typical asteroids. The "frost on ice" curve is from Clark (1980). (reproduced from Degewij _et al._, 1980).

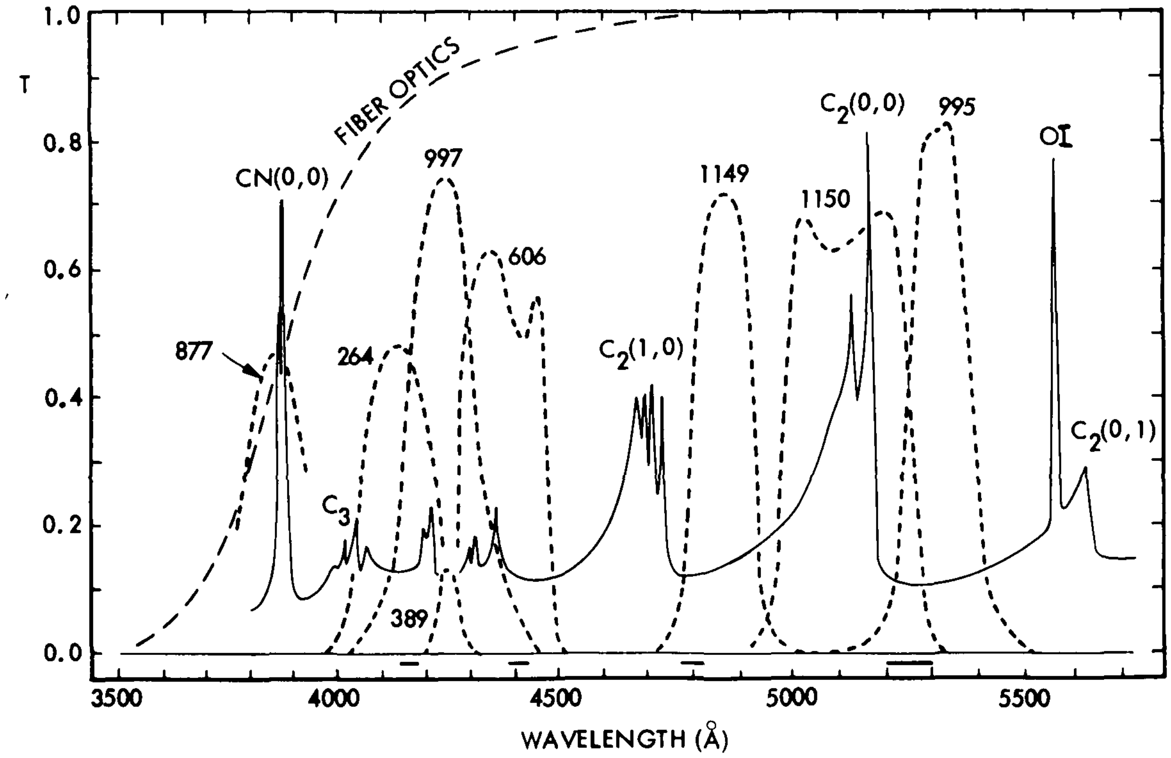

Figure 3a. Transmittance curves of selected KPNO filters are plotted together with the relative distribution (arbitrary scale) of comet 1969g (O'Dell, 1971) and the uv cutoff of the fiber optics in the KPNO RCA 4849/H ISIT video camera tube. The horizontal bars just above the wavelength scale are windows free from molecular emission lines (Arpigny, 1972).

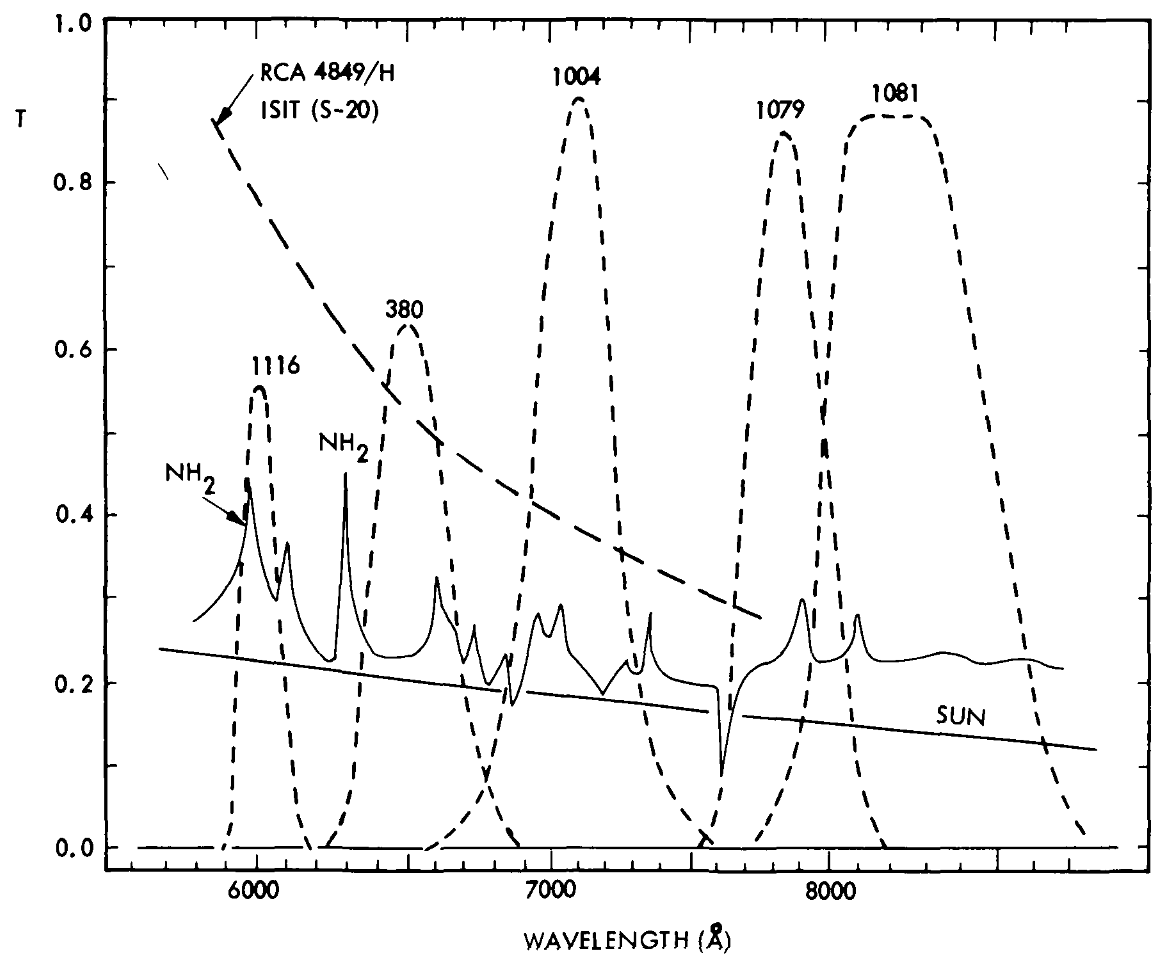

Figure 3b. As Figure 3a but for the red part of the spectrum.

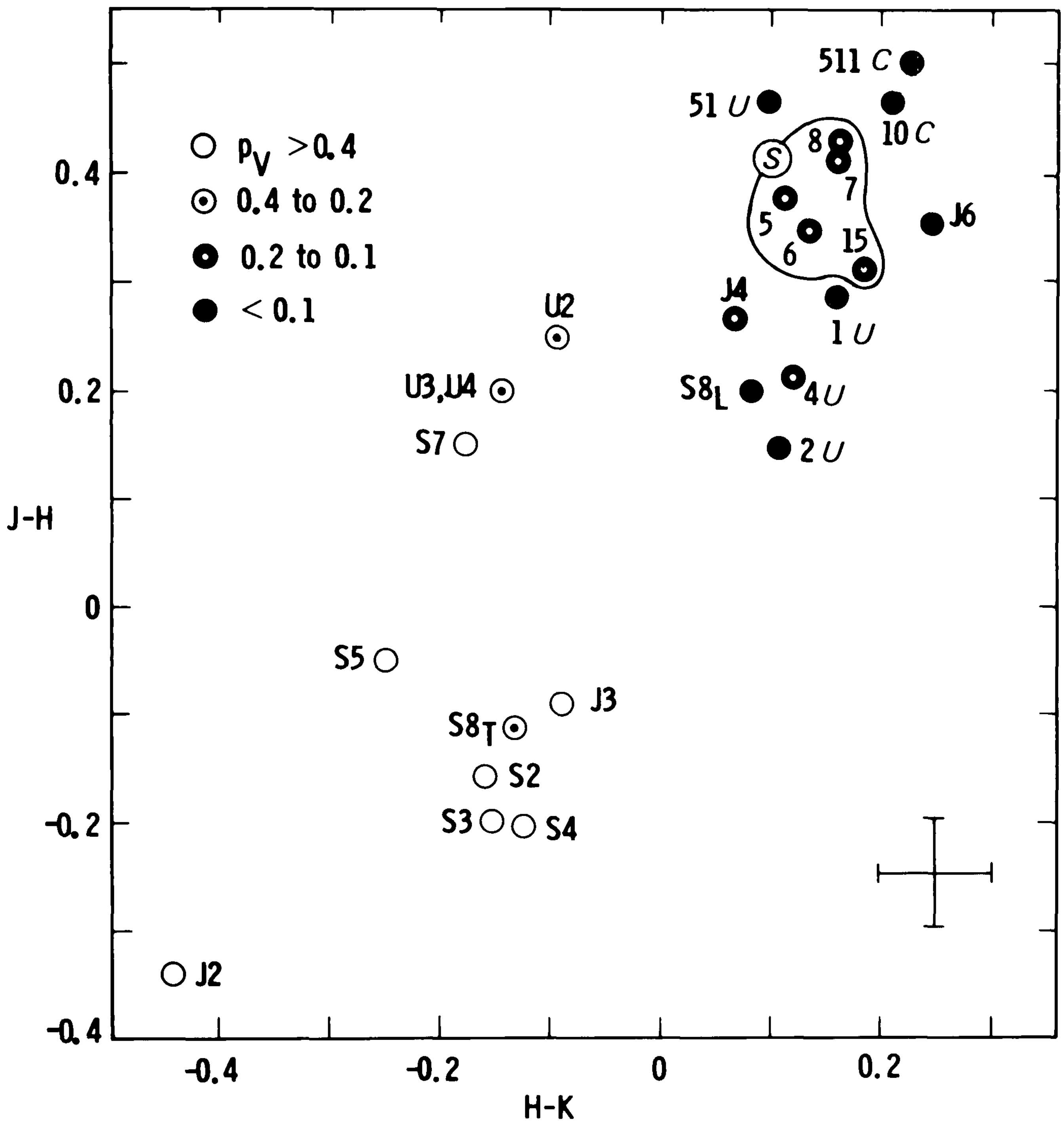

Figure 4. This plot of geometric albedo and JHK colors for asteroids (numbered), satellites of Jupiter (J2 - J6), satellites of Saturn (S2 - S8), and satellites of Uranus (U2 - U4), emphasizes that smaller bodies in the solar system divide into objects with dark (•) stony surfaces and bright (o) icy surfaces. The asteroid types are (Bowell et al., 1978): S = Silicaceous, C = Carbonaceous, and U = Unknown. The figure is adapted from the original figure by Hartmann (1980), and is reproduced from Degewij et al. (1980).

References

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