2.7 ULTRAVIOLET OBSERVATIONS OF TITAN FROM OAO-2

J. J. Caldwell

Introduction

I would like to briefly discuss some broad-band photometry measurements from OAO-2 and how they reflect on atmospheric models of Titan. These data extend the observed reflectivity of Titan down to 2600 Å and thus further clarify geometric albedo variations in the ultraviolet.

Observations and Interpretation

Figure 2-31 summarizes several sets of measurements of the reflectivity of Titan in the wavelength range 0.26 - 1.1 μm. In deriving geometric albedos from broad-band photometry data, both Harris (1961) and Caldwell (1973) used observations of solar-type stars to effect the necessary division of the Titan data by the Sun, rather than using an absolute calibration. Instrumental sensitivity is effectively canceled by this technique. In the reduction of the OAO-2 photometry, Titan's radius was taken to be 2425 km (Dollfus 1970) and the solar visual magnitude (V_0) was taken to be -26.74 (Johnson 1965). The geometric albedos of Harris were modified slightly to incorporate these more modern fundamental data. No correction was made for the slightly different solar colors used in the two analyses: the effect of such a correction would have been to raise the Harris albedos slightly relative to the OAO-2 points. Also shown are the relative reflectivity measurements of McCord et al. (1971), scaled to match the other data in the blue and ultraviolet. The OAO-2 results are summarized numerically in Table 2-6, and UBVRI colors in Table 2-7.

For the purpose of this discussion, the most important point to note is the extreme drop in albedo toward the ultraviolet. The measurements of Barker and Trafton (1973) (see also Section 2.3) are in very good agreement with the present results. The OAO-2 data extend the wavelength range slightly over the ground-based range, and emphasize that the albedo does not begin to turn up again, at least for wavelengths longer than 2600 Å. (The shortest wavelength data point originally published by McCord et al. at 3000 Å, is considered to be unreliable, and has been suppressed.)

It has been emphasized elsewhere (e.g., Veverka, Section 2.4) that this trend in the albedo is inconsistent with the expected Rayleigh scattering of the amount of a molecular atmosphere invoked by Trafton (1972) to explain Titan's spectroscopic properties. For example, note the ultraviolet Rayleigh scattering of 2 km-atm of CH_4 shown in Figure 2-31. It may be concluded that there is an additional absorbing constituent in the ultraviolet. Furthermore, this absorption must occur high in the atmosphere, if it is to mask the Rayleigh scattering.

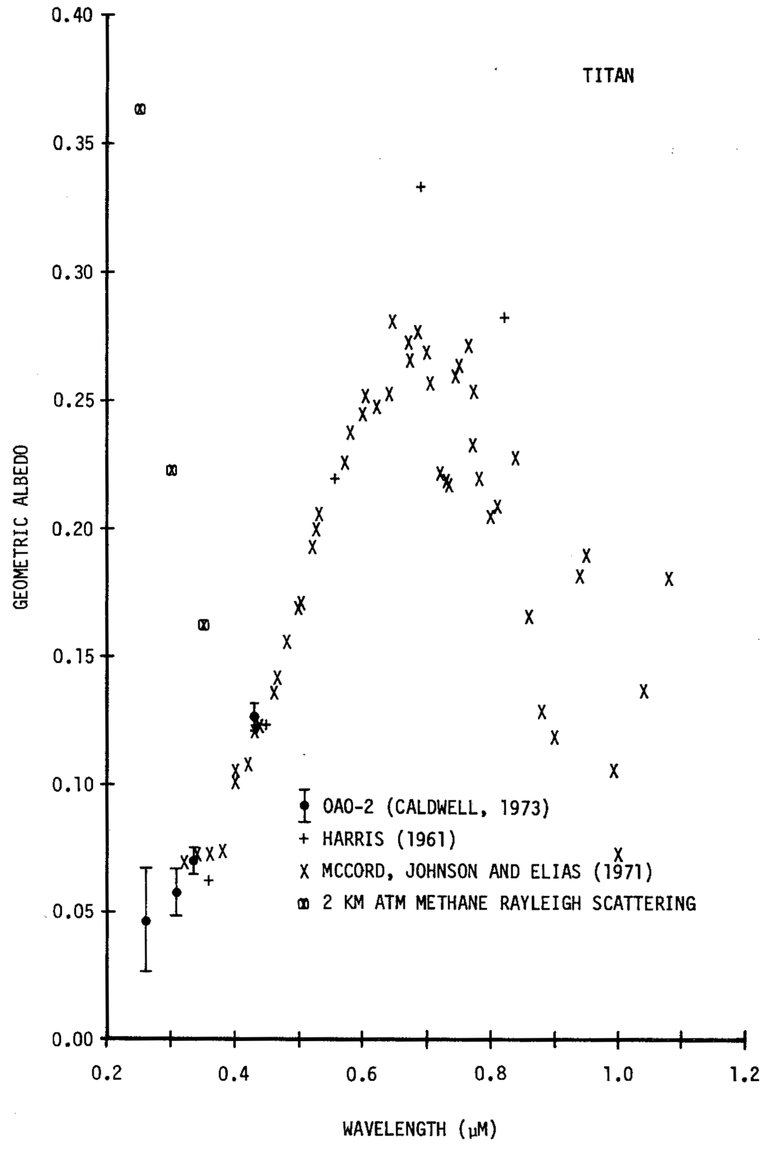

Figure 2-31. Geometric albedos derived from broad-band photometry from OAO-2, together with ground-based data by Harris (1961). Harris' data have been adjusted to $V_0 = -26.74$ (Johnson, 1965) and Titan radius = 2425 km (Dollfus, 1970). The relative reflectivity determined by McCord et al. (1971) has been scaled to the other blue and ultraviolet measurements. Also shown is the calculated geometric albedo for 2 km-atm of CH_4.

Table 2-6. OAO-2 Titan Ultraviolet Geometric Albedos

EFFECTIVE WAVELENGTH (Å)	ALBEDOS
4300	0.126 ± 0.006
3360	0.070 ± 0.005
3075	0.057 ± 0.001
2590	0.047 ± 0.018

Table 2-7. Photometric Colors

	TITAN	SUN
U-B	0.75	0.21
B-V	1.30	0.65
V-R	0.88	--
R-I	0.11	--

Summary

High altitude deposition of energy in Titan's atmosphere can have a significant effect on the spectral distribution of emitted thermal radiation from the satellite. This reasoning led to the prediction (Caldwell *et al*. 1973) of emission peaks at wavelengths corresponding to allowed bands of CH_4 (7.7 μm) and trace photolysis products such as C_2H_6 (12.2 μm). The subsequent publication (Gillett *et al*. 1973) of intermediate resolution infrared spectrophotometry has encouraged this interpretation of the infrared properties of Titan, and provided the basis for an initial, detailed model, presented in the following paper by Danielson *et al*.