Spectrometric and Photometric Analysis of Titan

Jessica M. Dooley and Ralph D. Lorenz
Lunar and Planetary Laboratory, University of Arizona

We used the University of Arizona Campus 21" telescope, a CCD camera and a variety of filters to take an assortment of photometric and spectrometric images of Saturn's moon, Titan. Unlike other satellites in our solar system, Titan possesses a significant (1.5 bar) Nitrogen based atmosphere, making it of special interest.

Researchers have found evidence for sparse cloud cover on Titan by taking measurements at different infrared wavelengths capable of penetrating the photo-chemical haze layer. Clouds would provide evidence for a liquid CH_4 cycle on Titan similar to H_20 cycles on Earth. With these possibilities, Titan's dynamic atmosphere is an ideal candidate for spectrometric analysis. By revealing brightness variations with wavelength, spectrometry can detect absorption bands in Titan's spectrum and provide evidence for clouds. Unfortunately, due to the limitations of the CCD and telescope available, spectroscopy proved difficult using the slitless technique we attempted. While spectra of relatively brighter Uranus was obtained, Titan spectra were smudged and unrecognizable due to the long exposures required.

We attempted instead a program of systematic photometric monitoring with 750nm, 790nm and IR filters. After a 4-month observing period, flat fields and dark frames were used to preprocess the photometric images in order to correct for CCD properties and Earth's atmospheric conditions. Using data collected from the standard star, Pi2 Orionis, a transfer function was obtained for calculating absolute flux. Theoretically, a plot of Titan flux in the 750nm filter which probes to the surface versus time should show a trend due to the changing Earth-Titan and Sun-Titan distance, with a small (few %) pseudo-sinusoidal lightcurve superimposed. This is caused by changes in longitudinal brightness due to surface features. The 790nm filter, in a methane band which does not reach the surface, should show no lightcurve. Irregular brightening at 750nm, shown by higher flux values not possible for a surface feature, would depict a cloud or some temporary atmospheric feature.

Analysis is ongoing, but it appears that the errors and noise in the data are too large to confidently identify what composed the "normal" brightness pattern of Titan. Therefore, it was impossible to identify abnormalities caused by changing weather conditions such as clouds.

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