alternative explanation of non-unit emissivity at 1.1-1.3mm, we prefer the interpretation that Pluto is colder than expected. Our preliminary solution gives 40±5K. If so, then we conclude that: (i) Pluto's phase integral exceeds unity; (ii) CH_4 cannot supply the microbar pressure levels detected by the 1988 stellar occultation observations and is therefore only a trace constituent in the atmosphere; and (iii) the long-detected CH_4 spectroscopic features on Pluto (Cruikshank, et al. 1976) are produced by solid rather than gas phase absorptions.

16.03

Pluto-Charon Mutual Eclipses: CCD Observations and Modeling

B. J. Buratti, R. S. Dunbar, E. Tedesco, J. Gibson, R. Marcialis (JPL and Palomar Observatory/Caltech), F. Wong (U.of CO), A. Dobrovolskis (NASA/AMES)

The challenge of observing the most distant and smallest known planet in the Solar System was made considerably easier by the occurrence in 1985-1990 of a series of occultation-transit events between Pluto and its satellite Charon. These events occur once every 124 years as the orbital plane defined by Pluto-Charon coaligns with an observer on Earth. A series near perihelion - such as the recent one - occurs only every 248 years. Determination of the contact times and depth of the lightcurve yields estimates of the objects' sizes, geometric albedos, orbital elements, and combined density. Inversion of lightcurves formed by occultation of different surface areas on the Earth-facing hemispheres of the two bodies yields an albedo map with far greater spatial resolution than is possible with HST.

Observations of 15 Pluto-Charon mutual events were obtained with the 60-inch telescope at Palomar Mountain during the eclipse season lasting from 1985 until 1990. A CCD camera and Johnson V-filter were used for the observations. We observed two events in their entirety, and three pairs of complementary mutual occultation-transit events. Preliminary results obtained by fitting the model of Dunbar and Tedesco (A. J. 92, 1201, 1986) with the observations shows that the southern polar region of Pluto is about 27% brighter than the northern polar region. This result suggests an additional similarity between Pluto and Triton. Analysis of Voyager images of Triton, obtained at wavelengths near the V filter, shows that the southern polar area of Triton is about 30% brighter than the northern polar region. It is thus the case for both Triton and Pluto that the regions which are currently in insolation show the least evidence of sublimation.

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16.04

Frost Transport, Albedo Changes, and Bulk Atmosphere Freezeout: Short-term Predictions for Pluto

E.F.Young and R. P. Binzel (MIT)

Recent reflectivity maps [Young and Binzel, 1992; Buie et al., 1992] of Pluto based on photometry of the Pluto-Charon mutual events have converged to show that Pluto has an extremely bright south polar cap, but lacks a similar cap in the north (north defined here by the spin angular momentum vector). The north pole was most recently in constant shadow, so one might expect it to be the site of bright N_2 or CH_4 frost deposits. The results of the albedo maps thus motivate an investigation into a volatile transport model for Pluto.

Pluto, like Triton, has a globally uniform atmosphere near perihelion. As Pluto recedes from the sun its atmosphere freezes out by approximately 50% every ten years. We estimate the sublimation driven winds emanating from Pluto's subsolar point will reach supersonic speeds approximately 70 years after perihelion. We model Pluto's volatile transport system in the transition between the Triton- and Io-like regimes. The model suggests explanations for the lack of a north polar cap and the south polar cap's ability to survive constant sunlight during Pluto's approach to perihelion. We find that the amount of frost transported from region to region is on the order of 50-100 g/cm^2 over timescales of 50 years.

16.05

Masses and Densities of Pluto and Charon Determined From HST Observations

G. W. Null, W. M. Owen, Jr., S. P. Synnott (JPL/Caltech)

We have analyzed Hubble Space Telescope WF1 CCD images of Pluto, Charon, and a 14th-magnitude field star, acquired on seven HST visits over a 3.2-day span in August 1991, to observe Pluto's motion about the Pluto system barycenter in order to determine the individual masses and densities of Pluto and Charon. Instrument aberrations were determined to 6th order using five overlapping plate exposures of open cluster NGC 1850, and scale exposures were used to verify that the instrument scale varied insignificantly from visit to visit. Pluto's motion was used to determine the absolute scale and the orientation for each exposure. Solution residuals from the instrument calibrations and from least squares joint solutions for Pluto and Charon masses and other relevant solution parameters were roughly 2-3 mas for stars and Pluto and 6-9 mas for Charon. Although Charon's image fell within the wings of the Pluto image, their cores were easily resolved; this resolution, difficult to obtain from the ground, was the key HST capability which enabled the mass and density solutions.

Least-squares solution results for a wide variety of modelling assumptions and data sets cluster around significantly different densities of 2.1 and 1.4 gm/cm^3 for Pluto and Charon, respectively. These densities assume body radii of 1151 km and 593 km for a = 19640 km (Tholen and Buie, *BAAS* **22**, 1129, 1990). Density solution values were relatively insensitive to image overlap between Pluto and Charon, to the choice of *a priori* values and *a priori* standard errors for Charon's orbital elements, and to Pluto albedo variations obtained from either Buie, Tholen, and Horne (1992, submitted to *Icarus*) or Buie and Tholen (*Icarus* **79**, 23, 1989). Detailed solution values and error estimates for masses, densities, and other important solution parameters will be presented. This work was performed by the Jet Propulsion Laboratory, California Institute of Technology, under contract with NASA, with partial support from the Space Telescope Science Institute.

16.06

Heating of the Lower Stratosphere on Uranus and Neptune

M.S. Marley (Univ. of Ariz.), J.B. Pollack, and C.P. McKay (NASA/Ames)

We have examined stratospheric heating in the atmospheres of Uranus and Neptune with a one dimensional radiative/convective equilibrium model. The model includes scattering by molecules, stratospheric hazes and tropospheric clouds, pressure induced absorption of hydrogen, helium, and methane, and absorption in the visible, near infrared, and infrared by CH_4, C_2H_2, and C_2H_6, and aerosols. From approximately 1 mbar to the model top at 10^{-3} mbar, methane heating controls the temperature structure with haze, acetylene, and ethane playing more minor roles. Methane absorption of downwelling infrared radiation from the relatively hot upper atmosphere is important above ~10 mbar. Temperature increases as large as 20K over models employing a cold mesosphere are seen above 1 mbar. Below 1 mbar only extreme increases in aerosol radii and number densities over the baseline Voyager-derived haze model significantly affect temperatures. Since such extreme haze models are incompatible with a variety of observations, we have begun a detailed reanalysis of the role near-infrared methane bands play in the energy budget of the stratosphere below 10 mbar. The revised model employs more accurate exponential sum fits to the available data on these bands, with particular care applied to the weaker lines. For the 2.3μm band we also employ a line listing which includes many lines not recorded on the HITRAN database previously used in this region. We report on the sensitivity of the calculated thermal profile to these model improvements and present new thermal models for Neptune, comparing the stratospheric energy budgets for the two planets. For Neptune we include absorption by CO and discuss its importance to the planet's stratospheric temperature profile.