25.10
Triton's Interior and Heat Flow

T. V. Johnson (CIT/JPL)

Triton is the largest satellite in the Neptune system. With a radius of ~1350 km, it is similar in scale to the Earth's Moon and Jupiter's satellite, Europa. It's density of ~2.07 gm/cm^3 makes it one of the densest outer planet satellites. Early tidal heating from circularizing its orbit plus accretional heat and contributions from short-lived radionuclides almost certainly resulted in early differentiation, leaving an internal structure with a core radius of ~1000 km and a mostly water-ice mantle ~350 km thick. Interior models yield a range of estimates for the silicate fraction of Triton: 1) Undifferentiated: 0.65, 2) Differentiated (Ice I/Ice II): 0.69, and 3) Differentiated (Ice I only): 0.75. Radiogenic heat from this large silicate fraction implies a current heat flow (chondritic radionuclides) of about 3.6 X 10^{-3} W/m^2 and upper crust temperature gradients of 0.31 to 0.37 K/km for a purely conductive ice crust. This places the modern level of H_2O/NH_3 eutectic melting at about 200 km depth--ignoring any other contribution from early heating. This may be sufficient to drive at least some of the geological activity evident on Triton's surface in recent geologic time and is consistent with the relatively subdued topography on Triton's surface (similar to or less than that found on other large icy satellites with evidence of geologic and tectonic acitivity, such as Ganymede).

This work represents one phase of research at Caltech's Jet Propulsion Laboratory under a contract with NASA.

25.11
Long-Term Seasonal Variations on Pluto

R. P. Binzel (MIT)

According to the mapping results of Young and Binzel 1990 (*BAAS*, this volume), Pluto's south pole has the highest albedo of any region on the planet. If Pluto's eccentric orbit causes annual (i.e. 248 year) cycles in the processing of methane between the surface and the atmosphere [Stern et al. *Icarus* **75**, 485, 1988], then the south pole - which was directed towards the sun as the planet approached perihelion - would be expected to be relatively depleted in fresh methane and show a lower albedo than the north pole. This is the converse of what is actually observed.
A key to understanding this anomaly may come from examining Pluto's long term dynamical evolution. While Pluto's obliquity remains relatively fixed over time [Dobrovolskis and Harris, *Icarus* **55**, 231, 1983], its longitude of perihelion regresses with a period of 3.7 million years. At the current epoch, as Pluto moves towards aphelion the north pole is continuously illuminated while the south pole is in continuous shadow. A resulting temperature asymmetry in which the south pole is the coldest region of the planet could allow preferential deposition of atmospheric methane. This preferential south polar deposition would make it a long-term (~1 million year) high albedo reservoir for the storage of "volatile methane," i.e. methane that can be involved in regular transfers between the surface and the atmosphere over the course of the planet's 248 year eccentric orbit. Because perihelion occurs with the sub-solar point near the equator, only a portion of this reservoir currently sublimates.
This model would predict that the north pole will become the brighter reservoir region in 2 million years.

25.12
Compositional Diversity in the Pluto–Charon System

R. L. Marcialis (JPL/Caltech)

The 1987 March 03 occultation of Charon by Pluto was monitored with three telescopes near Tucson. Wavelengths observed spanned 0.44–2.4 μm. Observing the same event ensured identical Sun-Pluto-Earth geometry for all sites. As reported previously, the spectrum of Pluto is dominated by methane; that of Charon is indicative of water frost. Now this photometry is used to derive the separate albedo *vs.* wavelength behavior of planet and satellite.

To test whether albedo and composition are correlated on Pluto, we undertook a program to observe Pluto in the near-infrared (Marcialis and Lebofsky, *Icarus* in press). Time-resolved spectrophotometry of the Pluto–Charon system was obtained on six nights in March and April of 1988. Observations include about 1/3 of the 6.4-day light curve, centered around minimum light, and span the wavelength region from 0.96 to 2.65 μm. The spectrum does indeed vary with rotational phase: depth of methane absorptions is least near minimum light. Dark regions on the planet seem both depleted in methane and redder in the continuum relative to brighter regions, at least for the longitudes observed. Our results are consistent with the observations of Buie and Fink (1987; *Icarus* **70**, 483), but conflict with those of Sawyer (1989; *BAAS* **21**, 986).

Since methane abundance varies on the surface of Pluto, it may prove difficult to disentangle the effects any atmospheric collapse (as Pluto recedes from perihelion) from a methane-enriched north polar cap becoming less foreshortened (as sub-Earth latitude marches northward between apparitions). In either case, the continuum slope of Pluto is predicted to become *bluer* over the next few decades. It is recommended that the near-infrared spectrum be monitored synoptically at a *discrete set* of longitudes, and at the highest practical spectral resolution, during this time interval.

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25.13
A Singular Value Decomposition Map of Pluto Based on Mutual Event Data

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

We construct an albedo map of Pluto's sub-Charon hemisphere from a set of mutual event lightcurves obtained over the interval 1985-1990. Our model uses a nonlinear least squares fitting algorithm to independently solve for the single scattering albedo and phase coefficient for subdivisions of Pluto's surface. We use a singular value decomposition implementation of the the least squares method to make sure that the fitted parameters are well determined by the coverage of the mutual events. Among the benefits of this technique is a covariance matrix which allows us to rigorously examine and evaluate the uniqueness of our solution.
We find that Pluto has a high albedo south polar cap, approximately 40° in radius. In contrast, the albedo of the north pole is lower and is not well differentiated from the average albedo of the entire northern hemisphere. The southern equatorial region has the lowest albedo of any area in our mapping solution.
That Pluto's south pole should apparently have the highest albedo of any region is an anomaly in light of Pluto's orientation during the past half orbit. It is Pluto's south pole that has been oriented towards the sun during the planet's recent approach to perihelion.