Pluto: Limits on Its Atmosphere, Ice on Its Moon

By JONATHAN EBERHART

Information about tiny, distant Pluto has come hard. Perhaps the most significant single discovery about it since its discovery in 1930 has been the 1978 finding that it has a moon. The satellite, since named Charon, appeared as little more than a bulge on a series of images of Pluto itself (SN: 7/15/78, p. 36).

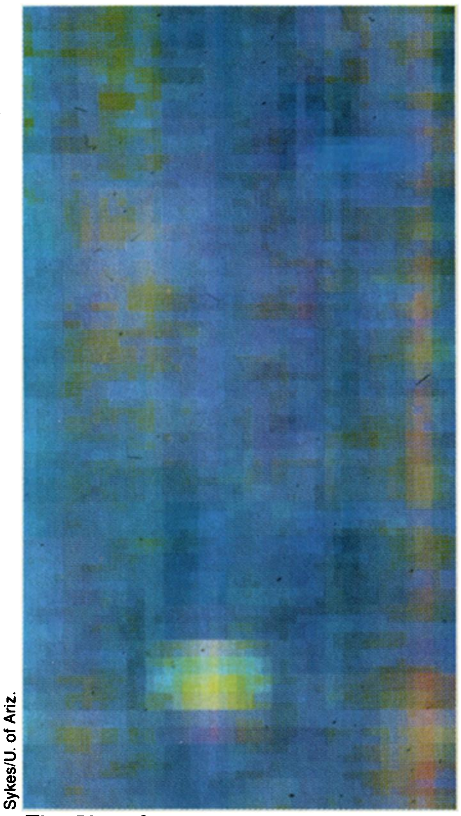
Little is known even about what Pluto looks like. Usually it is the most remote planet in the solar system, though its elliptical orbit presently has it inside the orbit of Neptune. Yet now researchers are taking the first gradual steps at learning about the appearance not only of Pluto, but of still smaller Charon as well.

The first contribution of Charon, which was detected by James W. Christy and Robert S. Harrington of the U.S. Naval Observatory, was to indicate that Pluto was smaller than had been thought. Once generally thought to be about 5,800 kilometers across, its apparent diameter had shrunk in 1976 with the finding that it was shiny with methane ice, meaning that a smaller object — perhaps less than 3,500 km across — could be producing the same observed brightness. Subsequently, Charon's discovery indicated that the spectral emissions were in fact coming from two objects, not one, and Harrington noted that Pluto might in fact be as little as 3,000 km across, with Charon at about 1,200 km.

Since that time, the estimates have come down still further, with Pluto and Charon perhaps as small as 2,290 km and 1,284 km, respectively. But as challenging as the two objects are as subjects for almost any kind of study, their story has become more of late than just a matter of littleness.

Since February 1985, Pluto and Charon have been in a rare relationship, as far as terrestrial astronomers are concerned — unique, in fact, in a human lifespan: the two objects eclipse each other. This would not be unusual, except that Charon's orbit is tilted so steeply (86°) as seen from earth that the satellite can pass in front of and behind Pluto only for a roughly six-year span every 124 years (half of Pluto's 248-year trip around the sun). In other words, astronomers are now able to watch the "mutual eclipses" of the Pluto-Charon system for the first time since the planet was discovered — the only chance (barring unforeseen spacecraft) that the present generation of earth-based observers will ever have.

On March 3 of this year, Robert Marcialis and his colleagues from the University of Arizona in Tucson pointed the Multiple Mirror Telescope of Arizona's Mt. Hopkins toward Pluto. They made infrared spectral measurements as Charon began to move behind Pluto, disappeared completely, and reemerged on the other side. The infrared spectrometer cannot distinguish two separate images during such observations, but the spectrum of Pluto alone — measured while Charon is hidden behind it — can be subtracted from spectra made when both objects are in view, resulting in a spectrum of Charon alone.



Sykes/U. of Ariz.

The Pluto-Charon system appears in the lower portion of this false-color "thermal image" produced from 12, 60 and 100-micron emissions recorded by IRAS. Pluto itself is only about one five-thousandth the size of the light-yellow region, far too small to show any actual details.

The resulting conclusion, the researchers report in the Sept. 11 SCIENCE, is that Pluto's infrared spectrum is "radically different" from Charon's. At a 2-micron wavelength corresponding to the presence of methane (already known on Pluto), the scientists were surprised to discover that Charon had relatively little methane. In fact, according to the team, comparison with laboratory measurements suggests that Charon's infrared spectrum is dominated by water-ice.

Even if Charon began with a methane-rich surface like Pluto's, the authors report, "escape of up to 22 km of methane from Charon can occur over the age of the solar system. After shedding several kilometers of methane, the surface of Charon would be expected to resemble a global 'moraine,' with the residuum composed of (cosmically abundant) water-ice and a 'slag' of darker carbonaceous or silicaceous impurities or both."

This conclusion is based in part on another group's finding that Charon's average albedo, or reflectivity, is only about half that of Pluto at visual wavelengths as well. This means that Pluto probably has a lower surface temperature, one consequence of which would be a tendency to hold on more tenaciously to its surface methane. (An assumed temperature of 50 kelvins for Pluto, according to Marcialis's team, suggests about 58 kelvins for Charon and would indicate a vapor pressure on Pluto of only 3.5 microbars compared with 59 on Charon.) Yet even with such a weak tendency for Pluto's methane to free itself from its icy state, it has been suggested in several reports that the cold little world may have a methane atmosphere — even a "significant" one, according to paper published several months ago on the basis of observations by the Infrared Astronomy Satellite (IRAS).

Now another research group has studied a "more sensitive" set of IRAS observations (involving multiple rather than individual scans of the Pluto-Charon system) and found that if indeed there is such an atmosphere, "significant" seems to be rather an overstatement of the case.

According to Mark V. Sykes and his colleagues from the University of Arizona's Steward Observatory and from the Planetary Science Institute, both in Tucson, "the atmosphere is thinner than originally thought." In fact, Sykes adds, the atmospheric column density on Pluto can be at best no more than about one nine-hundredth of earth's.

Reporting in the Sept. 11 SCIENCE, the researchers suggest that Pluto appears to have polar caps of methane ice, sometimes extending halfway to the planet's equator but changing as ice evaporates and refreezes while the highly tilted planet moves around the sun. Though there have been proposals in the past for various patterns of fixed ice patches, Sykes's team prefers the idea of "nonstatic ice caps whose coverage varies with time." □