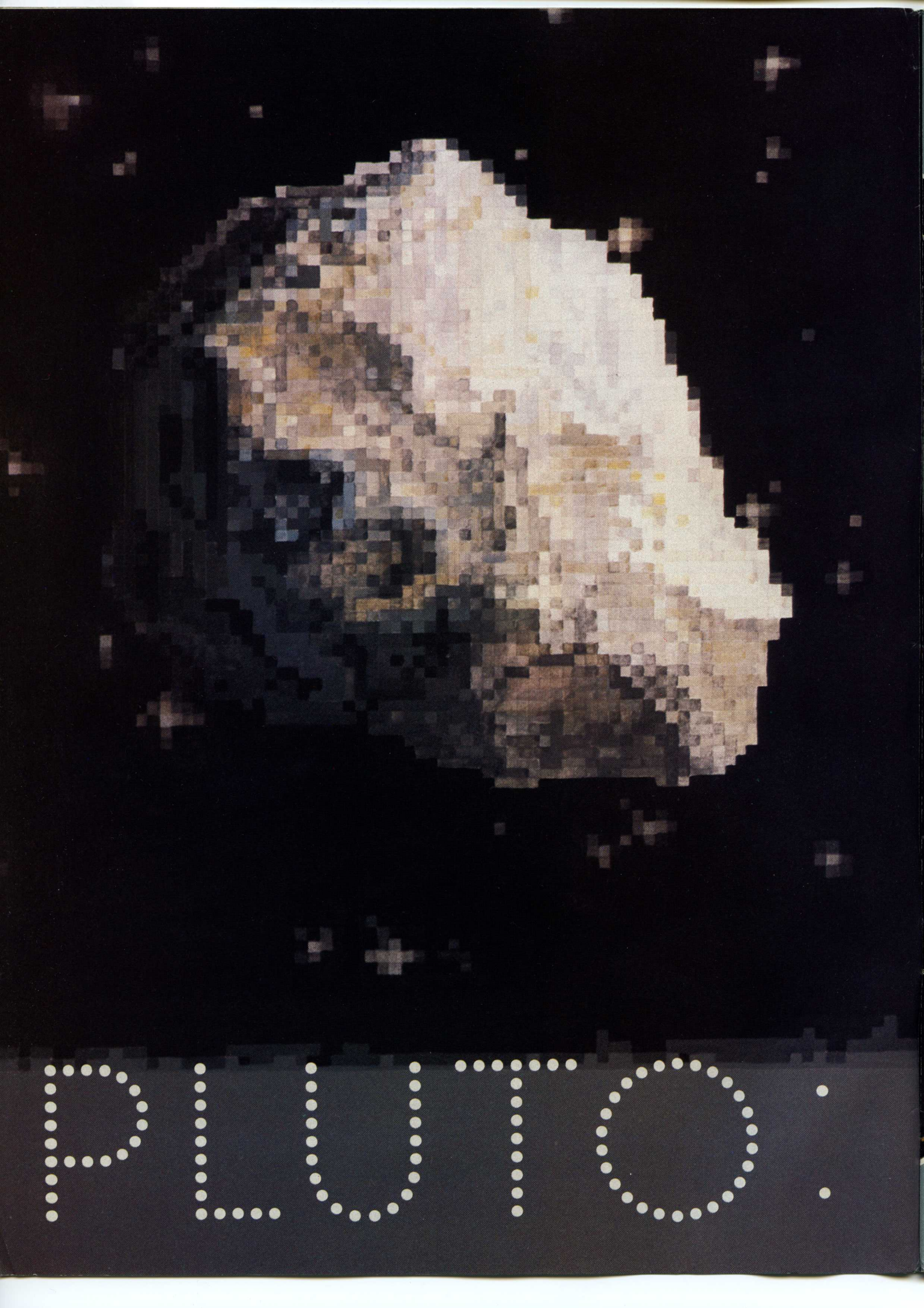
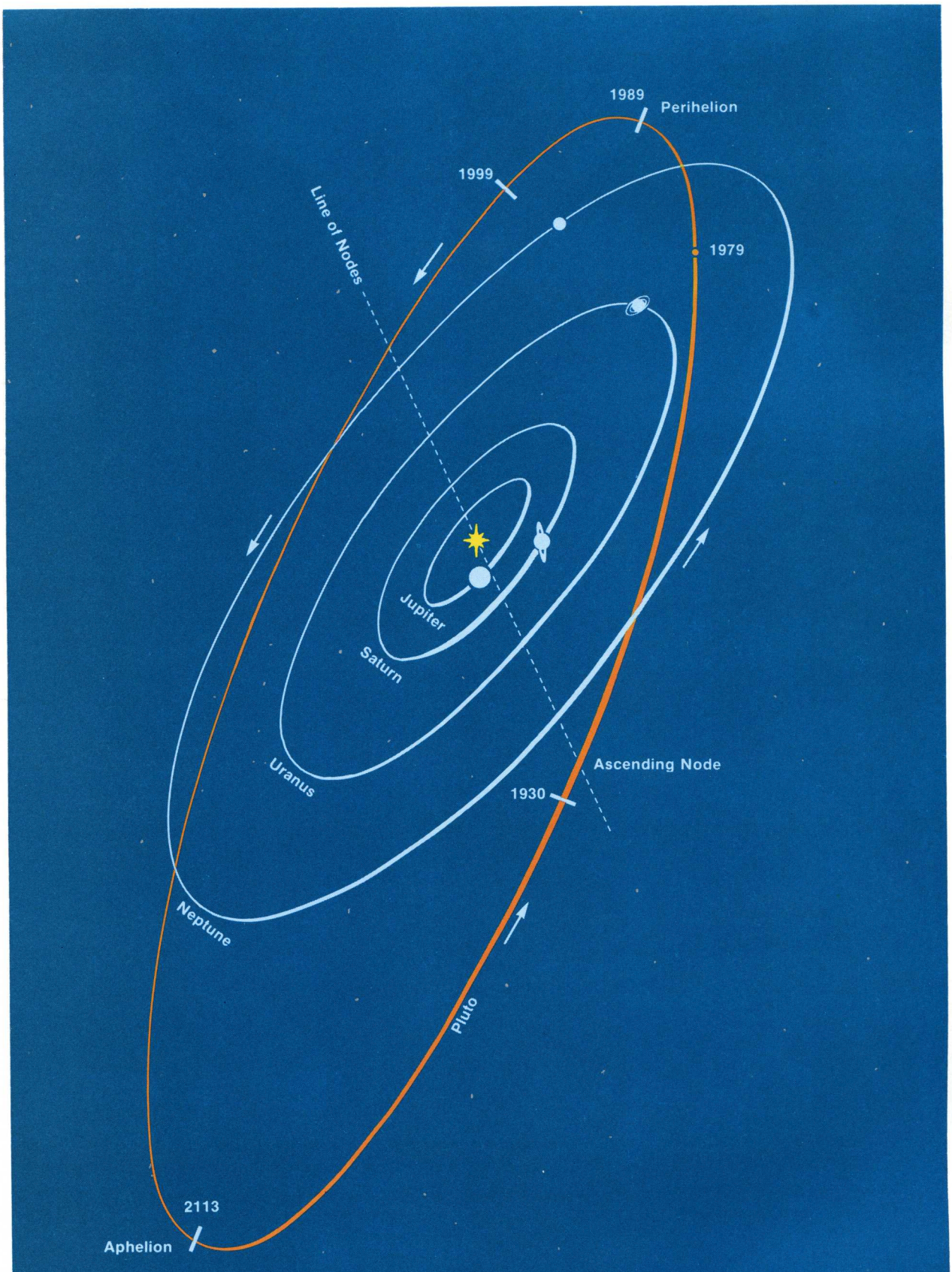

PLUTO:

Pluto (left) and its newly discovered moon, Charon, are seen in this artist's conception of the image returned by a future space probe on a mission to the outer reaches of the solar system. Square picture elements, known as "pixels" to space scientists, have been computer processed to produce a close-up view of Pluto as an icy, irregular body. Charon, seen in the distance at upper right, also appears to be nonspherical. The actual shapes of Pluto and Charon are uncertain at present. Artwork by Anne Norcia.

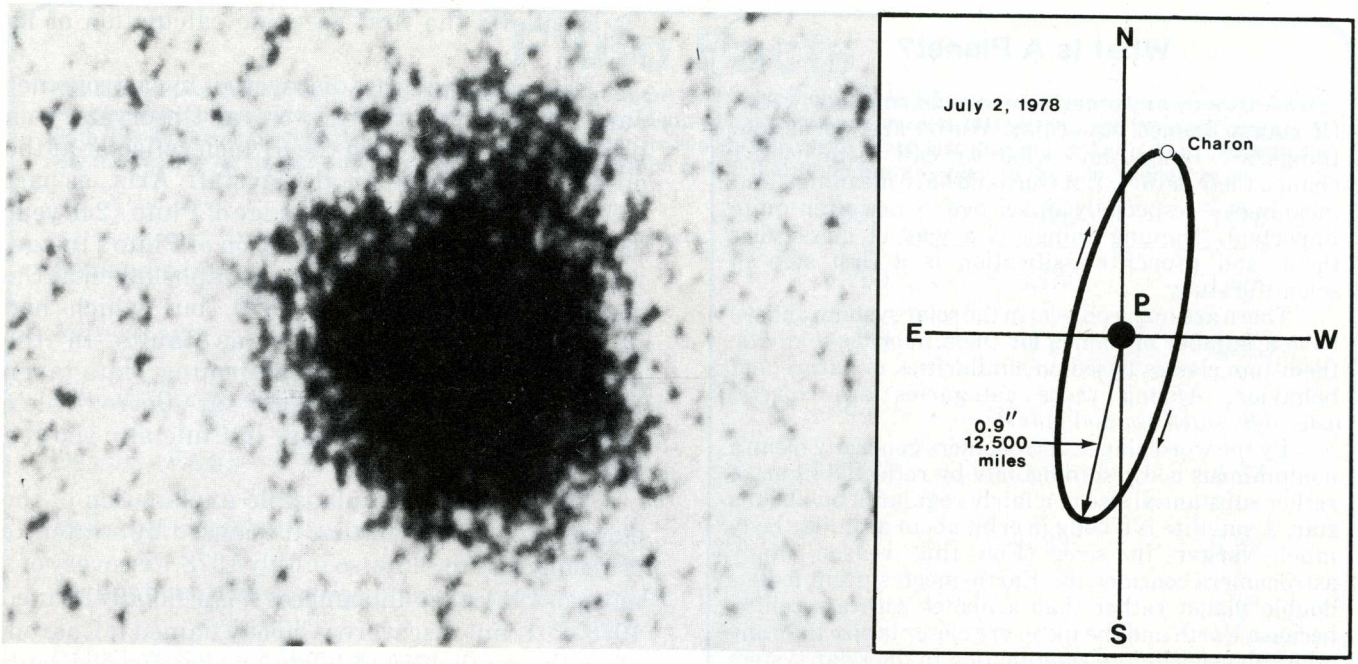
AN 78

Planet or Imposter?

by Ian Ridpath



This diagram shows the orbits of the outer planets as they would appear to an observer far outside the solar system in the direction of the constellation Leo Minor. The position of each planet is shown for January 1979. Although the orbits are shown to scale, the apparent size of each planet is greatly exaggerated! The inner orbits are too small to be shown — even that of Mars which is only 1/4 inch across on this scale. The dramatic irregularity of Pluto's orbit, more eccentric and inclined than that of any other planet, is obvious. From January 1979 until 1999, Pluto will be nearer to the sun than Neptune, although it is clear that Pluto cannot ever approach Neptune closely. Aphelion occurs in 2113, and Pluto will not return to the position where it was discovered in 1930 until 2178.



This photograph (above left) taken on July 2 with the U. S. Naval Observatory's 61 inch reflector at Flagstaff, Ariz., shows Pluto's satellite as a slight elongation of the image. The chart at right shows the true relative sizes of Pluto, Charon and Charon's orbit at the time of the photograph. The image is obviously blurred, demonstrating the difficulty of making accurate observations of Pluto! U. S. Naval Observatory photograph.

How many major planets are there in the solar system? Most people would say nine, which is the accepted number. Some might say ten, thinking that there could be another undiscovered planet at the outer edge of the solar system. But perhaps the real answer should be eight, for it is becoming increasingly clear that Pluto is not a true planet at all! Certainly, it is too small to have caused the supposed gravitational effects on the motions of Uranus and Neptune which led to its discovery!

To see what's behind the Pluto mystery, let's go back to the turn of the century when astronomers were speculating about the possibility of a ninth planet beyond Neptune. Neptune had been found in 1846 as a result of mathematical predictions based on irregularities in the motion of Uranus, which some astronomers realized could be due to the gravitational effect of an unknown body. But after the discovery of Neptune, it was found that Uranus (and Neptune as well) still didn't seem to be keeping to schedule. Was this because of the perturbing effect of yet another unknown planet?

Percival Lowell, of Mars fame, certainly thought so, and set about trying to predict the position of this unknown body. So, too, did William H. Pickering of Harvard, using a different method. But photographic searches in the predicted areas revealed nothing. Eventually, astronomers at Lowell Observatory in Arizona began an around-the-ecliptic search. Shortly after this search started, Pluto was discovered (in 1930) by Clyde Tombaugh, an observatory assistant hired for the job. He subsequently shot to fame and eventual success as a professor of astronomy.

But Pluto was a disappointing planet. Faint and evidently quite small, it was not the gas giant 6.7 times the mass of Earth that had been predicted by Lowell. Tombaugh continued his photographic search around the ecliptic, but no other planets were found, even though the search would have permitted discovery of Neptunelike planets up to about seven times Neptune's distance from the sun, or 200 astronomical units. Earthlike planets would have been found out to 100 astronomical units, according to Tombaugh.

Here was a paradox: Pluto was evidently not massive enough to have caused the perturbations that supposedly led to its discovery, yet there was no sign of a planet that could cause such perturbations. Most astronomers now believe the apparent irregularities in the orbits of the outer planets were unreal, caused mostly by observational errors and uncertainties in the orbits of Uranus and Neptune, and in star positions against which the planets' motions were measured. The discovery of Pluto seems to have been nothing more than a lucky fluke, a tribute to the thoroughness of the Lowell Observatory search rather than a vindication of any calculations.

To underline this conclusion, every time the size and mass of Pluto were measured, the planet seemed to get smaller and lighter. The best previous values suggested a diameter of 3,700 miles (5,900km) and a mass 0.11 that of Earth. There were two sources for the diameter estimate: visual observations by Gerard Kuiper with the 200 inch reflector in 1950, and a near occultation of a star by Pluto which placed an upper limit on its size. The mass estimate came from a study of the motion of Neptune, assuming it is still being slightly perturbed by the pull of Pluto.

What Is A Planet?

"A rose by any other name would smell as sweet." Of course Romeo was right: Words are words and things are things, and what we call them doesn't change their nature. But words do have meanings, and meanings — especially in science — are often quite important. Naming things is a way of classifying them, and proper classification is a first step in scientific study.

There are many objects in the solar system, and we have a number of names for them in order to divide them into classes based on similarities in nature and behavior. Among these categories are *comets*, *asteroids*, *satellites* and *planets*.

By the word planet, astronomers generally mean a nonluminous body (shining only by reflected light) of rather substantial size in a fairly regular orbit about a star. A satellite is a body in orbit about a similar body much larger in size. (For this reason many astronomers consider the Earth-moon system to be a double planet rather than a planet with a satellite, because Earth and the moon are closer in size than any other planet-satellite combination in the solar system — with the exception, now, of Pluto and Charon.)

But possession of a satellite is not necessarily an indication of planetary status. Mercury has no known satellites, and at least one asteroid — Herculina — appears to have a satellite. There are probably others.

Asteroids are planetlike bodies which are far too small to be considered planets; the very name asteroid means "starlike body" — one too small to show a discernible disk in a telescope. When the largest asteroid, Ceres, was discovered in 1801, it was thought to be a planet, especially since it was found to occupy the apparent gap between the orbits of Mars and Jupiter. But once its small size (diameter: 480 miles) became known and many other objects like it were found in the same region, it was obvious that Ceres did not rate the title planet.

Another property shared by planets seems to be a certain orbital regularity: All the planets (with the exception of Pluto) follow nearly circular orbits which lie in nearly the same plane (see the diagram on page 8). But Pluto's orbit is both rather eccentric (elongated) and inclined at 17 degrees to the orbital plane of Earth. And now, our latest discoveries about Pluto call its status as a planet even more into question.

"If you call a tail a leg, how many legs does a dog have?" Abraham Lincoln is said to have asked. "Five?" came the reply. "No, *four* — *calling* a tail a leg doesn't *make* it a leg!"

If you call Pluto a planet, how many planets does the sun have?

But new observations have meant that the accepted diameter and mass of the planet have had to be revised dramatically downward once again, as a result making Pluto the smallest and lightest planet in the solar system — even smaller than our own moon! The first part of the evidence concerns infrared observations published last year (reported in ASTRONOMY, February 1977) which show that Pluto's surface is brighter than has previously been estimated, and thus its size must be smaller than currently assumed, to account for its dimness. And, most importantly, a satellite of Pluto has recently been discovered (see Astro-News, September 1978) which allows the first accurate calculation of its mass.

The satellite was discovered by astronomer James Christy of the U.S. Naval Observatory on photographs taken with the 61 inch reflector at the observatory's outstation at Flagstaff, Ariz., as part of a program to refine knowledge of Pluto's 248 year orbit. Christy noted an elongation of Pluto's image, which was also visible on photographs taken at the observatory in 1965 and 1970, but which had previously been dismissed as faults in the photographic emulsion. A confirming plate taken with the 158 inch reflector at Cerro Tololo Inter-American Observatory in Chile also showed the elongation.

There seemed no plausible explanation of the elongation other than that it's caused by a satellite orbiting close to Pluto, so in July 1978, discovery of a moon of Pluto was announced. It is officially termed 1978-P-1, but discoverer Christy named it Charon, after the mythological boatman who ferried souls into the underworld, of which Pluto was god.

According to Dr. Robert S. Harrington of the U.S. Naval Observatory, the satellite orbits at about 10,500 miles from the center of Pluto every 6.4 days, which is the same time as the planet spins on its axis. Therefore, Charon must hang over one point on Pluto like a geosynchronous satellite does over a point on Earth.

Charon's diameter is estimated from its brightness to be 40 percent that of Pluto, making it larger in proportion to its parent planet than any other moon in the solar system. But most important of all, a study of its orbit has allowed Harrington to calculate an accurate mass for Pluto: 0.002 that of Earth, or 40 times lighter than currently estimated! Combined with a diameter of 1,500 miles measured by the infrared observations, Pluto appears to have a density slightly more than that of water. Therefore it can be nothing more than a low density snowball of frozen gases. This is consistent with the infrared observations which *did* detect plentiful methane frost on its surface.

Several of Saturn's satellites are believed to have low densities similar to Charon's. The similarity of Pluto to the satellites of the outer planets has seemed to add some weight to the supposition that Pluto is an escaped moon of Neptune. This theory, first proposed by Prof. Raymond Lyttleton of Cambridge University, supposes that Pluto once orbited Neptune every 6.4 days, until it suffered a close encounter with another moon, Triton. During this event, Triton was thrown into its current retrograde orbit while Pluto was ejected to pursue its own course as an independent planet. (As a matter of interest, the latest diameter estimates of Triton suggest it is twice the size now measured for Pluto.) But how can we account for Pluto's own moon with this theory?

Pluto Facts

This table shows the dramatic changes in our knowledge about Pluto which have taken place in recent years. Estimates of its mass and diameter have declined sharply, while much that was unknown has now been learned. Not so long ago the great mystery of Pluto was its seemingly high density, but we now know that its density is in reality much less than that of Earth. Together with the new low figures for its size and mass, this raises the question of whether Pluto has any right to the title "planet" at all!

	1960	1975	1978
Diameter (miles)	3,700	3,700	1,500
Mass (Earth = 1)	0.7(?)	0.11	0.002
Density (grams/cubic centimeter; water = 1)	36.8	5.75	1.5
Density (Earth = 1)	6.66(?!)	1.04	0.27
Period of rotation	?	6.39^d	6.39^d
Inclination of equatorial plane to plane of orbit	?	?	57°
Effective surface temperature	-230°C.	-230°C.	-230°C.
Atmosphere	?	?	none
Satellites	0	0	1
Orbital period of satellite	---	---	6.39^d

No satellite of the solar system is known to have a moon of its own, although there is suspicion that some asteroids may have companion bodies.

A new theory being advanced by Thomas Van Flandern of the U. S. Naval Observatory and Harrington supposes that Pluto is a former satellite of Neptune. When a hypothetical planet nearly collided with Neptune long ago, its satellite system was disrupted, and Pluto was ejected. During the encounter, tidal forces ripped a chunk off Pluto, which continues to orbit as the moon. The intruder planet was itself highly perturbed by the encounter and was thrown into an orbit far from the sun. The theory supposes it now orbits there, too faint to be seen. Thus, Harrington and Van Flandern have revived the prospect of a 10th planet, but for a different reason than to account for the motions of Uranus and Neptune.

They propose that this extra planet (if it exists) has a mass three or four times that of Earth and orbits 50 to 100 astronomical units from the sun. Some years ago, American astronomer Dennis Rawlins and the Englishman Max Hammerton calculated from the motion of Neptune that such a body might exist in the direction of the constellations Capricornus, Aquarius or Pisces. Perhaps, they suggested, it was missed in the Lowell search. If a new search in these areas reveals nothing, then the last hope of a major planet existing beyond Pluto will have evaporated.

But should Pluto itself be regarded as a major planet? For one thing, its orbit crosses that of another planet, which no other major planet does. From Jan. 22, 1979 until March 1999, Pluto will come closer to the sun than Neptune, meaning that the solar system temporarily has a "new" outermost planet. Pluto's orbit is in fact reminiscent of Chiron, the minor planet discovered last year by Charles Kowal at Mt. Palomar (see Astro-News, February 1978), which itself was hailed as the 10th planet before its true diminutive nature became clear. Chiron spends most of its time out beyond Saturn (where it is now), but for part of its orbit it crosses Saturn's path to come closer to the sun. Chiron seems to be an icy, low density body similar in nature to the outer moons of Saturn. Does this description sound familiar?

Although Chiron is only 100 miles or so across, which is 1/10 the size of Pluto, both Chiron and Pluto may well be examples of the building blocks of the outer planets which were never swept up. Phoebe, the outermost satellite of Saturn, has properties so similar that Phoebe seems almost a twin of Chiron that was captured to become a moon. Is it possible that, instead of being a moon of Neptune that escaped, Pluto is a potential moon that was never captured? And should it, like Chiron, be classified as a minor planet or asteroid?

As Pluto moves toward perihelion in 1989, astronomers will give increasingly close scrutiny to this controversial — and probably overrated — member of the solar system.