

Moon Believed Found for Pluto . . .

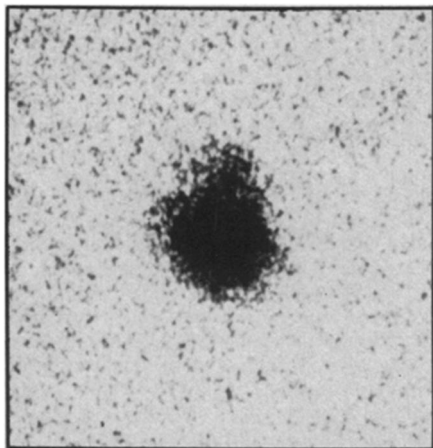
Scientists wandered the halls of the U.S. Naval Observatory in Washington, asking if anyone knew which room had been designated for the event. Reporters were directed first to one room, then to another, then back again. But the confusion was understandable: "The last time we had a press conference here," quipped one astronomer, "was 101 years ago." At that time, the event was Asaph Hall's discovery of Phobos and Deimos, the moons of Mars. Last week's announcement concerned a planet that, nearly 50 years after its discovery, is in many ways even less known than the Mars of a century ago.

In the charts of many astronomy textbooks, Pluto is represented by a row of blanks. Its atmosphere, its surface, its density, even its size — almost nothing is certain about what is (at least for most of its unusual orbit) the solar system's most distant world. Its mean distance from the sun is nearly 40 times that of the earth, giving it an orbit so long that less than one fifth of a Plutonian year has passed since Clyde Tombaugh found the planet in 1930. Of at least one significant detail, however, the Naval Observatory astronomers are now almost certain: Pluto has a moon.

Its discovery was an accident. On June 22, James W. Christy of the observatory was examining some photographs of Pluto taken in April and May through the observatory's 1.55-meter astrometric telescope in Flagstaff, Ariz., as part of the routine task of refining data on the planet's orbital motion (even *that* is imperfectly known). On photos from two evenings, Christy noticed, Pluto seemed to be elongated, bulging out to the side by an amount far too great to be due to a mere surface bump — or even, for that matter, to a Plutonian Mt. Everest or Olympus Mons.

On the premise that it could indeed be a moon, Robert S. Harrington, also of the USNO, calculated an orbital period for the bulge by measuring the times when it appeared to be pointing in different directions. Christy, meanwhile, had looked back through the observatory's files and found the same elongation in a number of photos taken with the same instrument in June of 1970 and in April and May of 1965. The proposed period matched, and was further confirmed in a series of plates taken for the purpose from June 30 to July 4 of this year. It was verified again, this time from the southern hemisphere, in observations made on July 5 by John A. Graham of the Cerro Tololo Observatory in Chile.

Harrington's calculations and the subsequent photos indicate that the presumed moon circles Pluto every 6 days, 9 hours and 17 minutes. Curiously, this is exactly the same as the rotational period



Pluto and possible moon (near top).

of Pluto itself, as calculated a few years ago from the planet's "light curve" — cyclic changes in brightness as the planet turns on its axis. The implication is that the moon is always over the same spot on the planet's surface. (It is possible that the light curve is dominated by the presence of the moon, so that Pluto's rotational period is not really being measured at all, but Harrington believes that the moon is so much fainter than Pluto that it accounts for only about half of the observed brightness change.)

The moon also offers keys to the difficult study of its host planet, although, as is usually the case with distant objects, some assumptions are required. Pluto and its moon appear from the photos to be about 20,000 kilometers apart (center to center), Harrington says, which yields (from Keplerian theory) a total mass for the two bodies. The assumption that the objects have the same surface reflectivity gives their relative size, and the assumption of equal density leads to the ratio of their masses. The absolute sizes, however, depend heavily upon what the surface reflectivity actually is, since a small, shiny body can reflect as much light as a larger, darker one. In 1976, a group of astronomers at the University of Hawaii reported the spectral detection of substantial amounts of methane ice, or frost, on Pluto's surface (SN: 4/10/76, p. 228). Prior to that time, Pluto's most-cited diameter was about 5,800 km, but the Hawaii researchers estimated that the actual figure might be less than 3,500 km, smaller even than the earth's moon. With part of Pluto's brightness reassigned to its moon, the planet looks smaller still, perhaps as little as 3,000 km, with its moon about 1,200 km across. Again assuming equal densities, the moon would then have about 5 to 10 percent of the mass of Pluto, making it by far the largest moon in the solar system in comparison to its planet. (Earth's moon

has about 1.2 percent of the earth's mass.)

Even with its newly reduced size, Pluto now appears to have a density only slightly greater than that of water, suggesting that it could be a dirty iceball or an ice-rock mixture incorporating some frozen gases. Whatever its true nature (some have suggested that it is not a "planet" at all, but an escaped moon of Neptune), it is likely to draw many new eyes in the future.

. . . and for an asteroid

On June 7, the asteroid 532 Herculina passed between the earth and a star known as SAO 120774. The occultation was clearly observed from at least three locations on earth, but in addition, two of the observers saw something else. Edward Bowell of Lowell Observatory in Arizona, recording the star's light with a photometer, detected a second occultation, lasting about 5.1 seconds, shortly before the main one. Meanwhile, James McMahon, an experienced amateur observer who works for the U.S. Navy in California, was visually observing the event and noted *six* lesser occultations — four before the star disappeared behind Herculina and two more after it reemerged. Corrected for observing location, the third of those six (which lasted about 4.0 seconds from McMahon's viewpoint) matches the one recorded by Bowell to within 0.2 second. The tentative conclusion, says Bowell: that Herculina, a mere asteroid little more than 200 km across, has a moon.

Given the recent spectacular discovery about Uranus (SN: 5/27/78, p. 342), the first inference from McMahon's additional sightings would be rings. Bowell points out, however, that neither he nor the third observer saw those events, and it has proven virtually impossible to construct a ring geometry that could have been seen by McMahon but missed by the others. Furthermore, adds David Dunham, president of the International Occultation Timing Association, the timings suggest that if even the event seen by both Bowell and McMahon represented a ring, that ring would be about 50 km wide and about 2,000 km across, probably bright enough to be at least faintly visible by its own reflected light.

Is it, then, a moon? The wide separation between the observers means that it was certainly not a bird flying in front of the telescope. It seems unlikely to have been just another asteroid, says Bowell, since Herculina's part of space is sparsely populated, and a nearer asteroid would probably be known. Finally, the object seemed, in the admittedly limited data, to be moving along with Herculina.

There is one oddity, however. Though

Continued on page 47

BOOKS

BOOKS is an editorial service for readers' information. To order any book listed or any U.S. book in print please remit retail price, plus 25% handling charge for each book to **Book Order Service**, Science News, 1719 N Street, N.W., Washington, D.C. 20036. All books sent postpaid. Domestic orders only.

AAAS SCIENCE BOOK LIST SUPPLEMENT — Kathryn Wolff and Jill Storey — AAAS, 1978, 457 p., \$16.50. A selected and annotated guide to reference texts and recreational reading in science and mathematics for junior and senior high school students, college undergraduates, teachers and nonspecialist adults. A supplement to the AAAS Science Book List, 3rd ed., 1970.

CATASTROPHE THEORY — Alexander Woodcock and Monte Davis — Dutton, 1978, 152 p., illus., \$9.95. Catastrophe theory, a controversial new way of thinking about change, is a mathematical language that uses geometrical shapes (called catastrophes) to transform abstract concepts into concrete visual pictures. The theory is explained for the general reader and examples are given as to how this theory can be used to understand problems in economics, biology, politics and history.

HEART ATTACK! A Question and Answer Book — Oscar Roth with Lawrence Galton — Lippincott, 1978, 262 p., \$8.95. A cardiologist answers those questions that have been most frequently asked by his patients. Intended to help patient and family comprehend coronary heart disease and stimulate them to ask more questions of their physician.

INSECT MAGIC — Kjell B. Sandved and Michael G. Emsley — Viking Pr, 1978, 128 p., color plates, \$16.95. Spectacular color photographs of insects,

highly magnified, including a wasp bailing out water from its nest, fossil insects embedded in amber, worker ants starting to build a nest, along with an interesting and lively commentary on insects.

LORIES AND LORIKEETS: The Brush-Tongued Parrots — Rosemary Low — Van Nos Reinhold, 1977, 180 p., color plates, \$18.95. Lories are among the most beautiful of the world's birds and, to some, among the most intelligent. Native to south-eastern Asia, Australia and Polynesia, these nectar-eating birds play a major role in the pollination of trees and flowering plants.

MAGIC, SCIENCE, AND CIVILIZATION — J. Bronowski — Columbia U Pr, 1978, 88 p., \$6.95. From the time in the Renaissance when humans ceased to believe in magic, they have been scientifically inclined. This is the focus of these four essays.

MOSQUITOS, MALARIA AND MAN: A History of the Hostilities Since 1880 — Gordon Harrison — Dutton, 1978, 314 p., illus., \$15. Humankind's first war against another species—the malaria mosquito—is reconstructed from a military, social and ecological perspective.

THE NEW BASIC BOOK OF THE CAT — William H. A. Carr — Scribner, 1978, 253 p., illus., \$9.95. Intended to make it easy for the average cat owner to provide the kind of care that will enable the cat to live for many, long healthy years. Discusses also various breeds, cat shows and breeding. Includes a bibliography.

PEDIATRIC PSYCHOPHARMACOLOGY: The Use of Behavior Modifying Drugs in Children — John S. Werry, Ed. — Brunner-Mazel, 1978, 416 p., \$19.50. The aim is to bring together in one volume the usable, formal knowledge in this rapidly expanding field. The text is medical, the emphasis is scientific with clinical information included.

PLANTS AND ANIMALS OF THE PACIFIC NORTHWEST: An Illustrated Guide to the Natural History of Western Oregon, Wash-

ington, and British Columbia — Eugene N. Kozloff — U of Wash Pr, 1978, 264 p., illus., paper, \$8.95. Concentrates on the lowland portions of the Northwest that lie west of the Cascade Mountains. Includes more than 400 species of plants and animals, nearly all of which are illustrated either by drawings, black and white or color photographs. Originally published in hardback in 1976.

THE PROCESSING OF MEMORIES: Forgetting and Retention — Norman E. Spear — LEA (Halsted Pr), 1978, 553 p., illus., \$29.95. Contains the evidence that the author feels is most important for the understanding of the processes of retention and forgetting. Research on both humans and animals is presented.

THE SCREWWORM PROBLEM: Evolution of Resistance to Biological Control — R. H. Richardson, Ed. — U of Tex Pr, 1978, 151 p., charts & graphs, paper, \$6. Examines the possible causes for the resistance to factory-reared flies and the potentially disastrous problems that could result in the now-successful control program. The articles present several new genetic and ecological aspects of the screwworm and its relatives.

STALKING THE WILD TABOO — Garrett Hardin — Wm. Kaufmann, 2nd ed., 1978, 284 p., \$11.95; paper, \$4.95. "Thought taboos" can keep a society from ever confronting the consequences of its actions, says this eminent human ecologist. The essays discuss such contemporary "taboos" as abortion, spread of nuclear power, population and learning from failure. Seventeen new essays are included in this revised edition.

WILD FLOWERS OF THE NORTHEASTERN STATES — Frederick W. Case, Jr. — McGraw, 1978, 40 color slides, 34 p., illus., \$18.95. Wild flowers, says the author, display fascinating structural and behavioral adaptations for survival. For those interested in wild flowers and their habitats, attractive color slides of familiar wild flowers are provided, with information about each plant in its surroundings.

WILDNESS IS ALL AROUND US: Notes of an Urban Naturalist — Eugene Kinkead — Dutton, 1978, 178 p., drawings, \$9.95. Essays of special interest to those who live in urban areas for the author tells of some wild creatures and plants that not only survive but prosper in cities and suburbs.

... Moon

the photometric data are "noisy," Bowell says that the light from the star seemed to take an unusually long time — about a second instead of one-third of a second — to disappear completely and also to re-emerge to its full brightness. "I'm still wrestling with that one," he says.

Both he and Dunham, meanwhile, tentatively opt for a moon. If it had not been detected by two observers, however, neither would probably have "opted" for anything at all. Irreproducible results are commonly ignored by scientists, or at least filed away along with whatever private opinions they may have inspired.

Combined with the rings of Uranus, however, which were also discovered from multiple occultation observations, the possible moon of Herculina strongly suggests reason to look back at some largely ignored "anomalies" in past observations.

Consider the asteroid 6 Hebe, which occulted a star on March 5, 1977 (only five days, ironically enough, before the occultation by the rings of Uranus). An experienced amateur from Houston named Paul Maley, using only his eye and a 13-cm refractor with a 20-power eyepiece, was out of position to see Hebe's own occultation, but he did see a separate event in which the star disappeared from view for about 0.5 second. Maley makes no claims of moons; it would be unreasonable from a single observation. But at the time, there had been no twice-observed occultation

near Herculina, no rings of Uranus to give the idea some credence.

The large asteroid Pallas occulted the star SAO 85009 this past May 29. Just after the main event, a photometer being operated by Richard Radick of the Prairie Observatory in Illinois recorded another occultation. In fact, says Thomas Van Flandern of the U.S. Naval Observatory (who is now compiling a list of such anomalies), a close look at the photometer strip-chart suggests that the single secondary event could represent an object 1 km across.

A particularly striking example was the Jan. 24, 1975, occultation by the asteroid Eros, noted by many observers in the New England area. "All sorts of people saw things," says Clark Chapman of the Planetary Science Institute in Arizona, who helped to coordinate the results, and at least two observers published references to secondary events, though without drawing conclusions. No one has formally checked the timings for match-ups. Chapman says, but "it probably ought to be done."

Even without occulting stars, other asteroids have produced interesting results. One called 44 Nysa, says Van Flandern, has a light curve shaped remarkably like that of an eclipsing binary star, and 624 Hektor has been theorized from its light-curve to be two large bodies in contact.

Could asteroids with moons be not merely extant, but common? □

GRAVITATION: SOLVING THE RIDDLES

by S. ELTON

Advanced presentation of Gravitational Spin, Gravitational Charges and the Relativity of Gravity. Goes beyond General Relativity into "really relativistic physics." No advanced math. Crucial low-cost experiments. Observational testing.

153 pp. \$5. THE ANNEX, Box 3142, Redondo Beach, CA 90254

MURPHY'S LAWS!

Incomparable "scientific" wit. Colorfully lithographed on 8" x 10" heavy Parchment for framing. A great business or personal gift! Only \$3 (4/\$10). Four Corners Press, Dept. SAH, Hanover, Mass. 02339.

AUTHORS WANTED BY NEW YORK PUBLISHER

Leading book publisher seeks manuscripts of all types: fiction, non-fiction, poetry, scholarly and juvenile works, etc. New authors welcomed. For complete information, send for free booklet T-8. Vantage Press, 516 W. 34 St., New York 10001