Eclipses by and of Pluto's Moon

It was nearly seven years ago that James W. Christy of the Washington, D.C.-based U.S. Naval Observatory, looking at images of Pluto made through the USNO's big astrometric telescope in Flagstaff, Ariz., noted a large bulge on one side of the planet. Too far from earth to be photographed clearly, the bulge seemed much too high to be a mountain. Christy, together with colleague Robert Harrington, concluded that the images were almost surely showing Pluto to have a moon, circling the planet about every 6.4 days (SN: 7/15/78, p. 36). Yet not until now have astronomers been able to detect either object passing in front of the other — eclipses.

Eclipses are important, because in distant Pluto's case, the images — which by now have been made with a charge-coupled-device camera, speckle interferometry and other techniques — still leave a lot to be desired, so that even the objects' sizes and the separation between them remain uncertain. Eclipses, monitored with photometers rather than imaging systems, offer the chance to see how much the combined light reflected from planet and moon decreases as the satellite either blocks out a part of Pluto's surface or disappears behind it. An analysis of the changing "light curves" over a period of time, combined with spectral measurements that have indicated the presence of methane ice or frost (which can mean that smaller objects reflect a given amount of light), should greatly improve the calculations.

To observers on earth, however, Pluto and its moon — unofficially named Charon by Christy — eclipse each other only about every 124 years. This is because Pluto takes about 248 years to circle the sun, and Charon's orbit is so steeply inclined relative to earth's (about 112°) that eclipses can be seen only during the two occasions per 248 years when earth is at the intersection of the two orbit planes. This should enable observations over perhaps three to four years at a time, after which the chance is lost for more than a century. But one of those viewing opportunities — sought unsuccessfully by astronomers since 1982 — seems to have just begun.

On Jan. 16, Edward Tedesco at the Palomar Observatory in California detected a dip in the light curve suggesting that Charon was grazingly passing in front of Pluto, but instrumental difficulties and other factors left the results uncertain. On Feb. 17, however, Richard Binzel at the University of Texas McDonald Observatory caught it clearly. Three days later another dip — this time apparently from Charon's passing *behind* Pluto — was detected from Mauna Kea Observatory by David Tholen of the University of Hawaii.

When the objects' diameters are better refined from additional observations, their calculated masses can be figured in to indicate their densities — a key clue to what they are made of. Some researchers have already speculated that Pluto and Charon may essentially be balls of ice (possibly frozen methane, even less dense than water ice). Ice is thought to have been a readily available structural material in the outer solar system and believed at the heart of most comets. In addition, the light curves' aid in establishing an orbit for Charon may win formal acknowledgment from the International Astronomical Union that Pluto's moon is now officially there. —*J. Eberhart*

Depression may be key to some learning disabilities

Studying learning disabilities can be almost as frustrating as having to cope with one of them.

"A learning disability," says psychologist David Goldstein of Temple University in Philadelphia, "is . . . hard to define, but you know it when you see it." Estimates of the proportion of elementary school children with these academic problems range from 3 to 30 percent.

The causes of learning disabilities are also elusive, but in a five-year study Goldstein and co-workers have found that reading or arithmetic problems in a substantial number of learning-disabled children are primarily the result of depression.

"We're a long way from saying depression definitely causes academic failure," cautions Goldstein, "but we have a promising lead on a subgroup of children whose basic problem may be depression."

The term "learning disability" encompasses a variety of problems — such as hyperactivity and an inability to read or understand arithmetic — that result in failure in school. The children have normal or near-normal intelligence.

This broad definition, says psychologist Judith M. Rumsey of the National Institute of Mental Health, describes only what the children are not doing — learning well in school. The trick is to find subgroups of children with specific strengths and weaknesses.

Goldstein says there is a subgroup — about one-third of 159 learning-disabled children he studied — in which emotional disorders appear to lead to academic failure. For the rest, he adds, depression is often the *consequence* of learning failures that may be caused by neurological problems.

His sample was screened from 300 children tagged by Philadelphia-area teachers as learning-disabled. The youngsters, whose average age was 9 years at the start of the project, were given a battery of depression tests annually. The researchers were looking for evidence of poor interpersonal relationships, inappropriate behavior or feelings, a pervasive mood of unhappiness and psychosomatic complaints.

All of the children were more depressed than previously tested samples of non-learning-disabled students, but depression appeared to account for disabilities in 50 cases. Depression scores for these children remained stable over time, while the same scores for the larger subgroup fluctuated. This indicates, says Goldstein, that children in the latter group reacted to periodic family problems or to other events. Depression and academic achievement were related only in the group with consistent levels of depression. Children identified as having depression as a cause of school failures improved markedly in reading and math over the study period after receiving special instruction in small classes and two hours of individual therapy per week.

Goldstein's contention that some learning disabilities are a result of depression is still open to interpretation, says Rumsey. Many researchers assume that the basis of learning problems is primarily biological, she notes. Some stress deficits in the brain's left hemisphere, which controls speech and language; others emphasize deficits in the right hemisphere, which regulates visual and motor skills.

But it is difficult to measure neurological problems in many learning-disabled children, says psychologist Lynne Feagans of the University of North Carolina in Chapel Hill. She and her colleagues have targeted 13 learning-disabled subgroups based on language and behavior problems. "It surprises me," she says, "that so many kids had a primary depression in Goldstein's study. But can you really say which comes first, depression or school problems?"

Responds Goldstein: "It's important to recognize the role that emotional disturbances play so that appropriate treatment can be given." —*B. Bower*