What Will Voyager 2 Find at Uranus?

Much of the discussion of Uranus and its rings at the meeting of the Division for Planetary Science (DPS)* concerned what Voyager 2 will find as it approaches its 24 January encounter with the third most distant gas giant. Richard French, Julie Kangas, and James Elliot of the Massachusetts Institute of Technology predicted the exact spot where Voyager might discover a satellite. To make the prediction, the MIT group observed that the locations of all but two of Uranus's nine rings fit predictive models to within 200 to 1000 meters.

The gamma and delta rings, on the other hand, fit no closer than several kilometers. French and his colleagues used that poor fit to estimate the location of a satellite that could gravitationally perturb the delta ring in the observed fashion. The perturbing satellite would be 150 to 200 kilometers across and located closer to the outermost ring than to the innermost known satellite, Miranda. The group prefers a satellite to other explanations of the poor fits; Voyager should have no trouble testing the calculations.

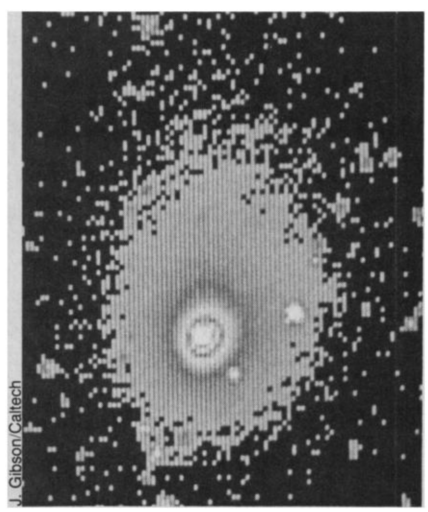
Preencounter predictions about Uranus's magnetic field now seem to fall into two categories: it is either one of the biggest in the solar system or it is nonexistent, or nearly so. John Clarke of the Marshall Space Flight Center in Huntsville, Alabama, and his colleagues described 4 years of observations of ultraviolet emissions from Uranus that require an aurora whose source is as powerful as that at Saturn. Elsewhere, auroras require a magnetic field to gather the energy of the solar wind needed to drive them. But Michael Kaiser and Michael Desch of Goddard Space Flight Center in Greenbelt, Maryland, reported that Voyager has yet to detect the radio emissions typically associated with a strong magnetic field. Voyager will directly measure Uranus's magnetic field, if any, and determine whether the planet is a particularly efficient aurora generator or a poor emitter of radio waves in Voyager's direction.

As much as it bothers him, Glenn Orton of the Jet Propulsion Laboratory in Pasadena has yet to find a way around the conclusion that Uranus has more helium in proportion to hydrogen than Saturn, Jupiter, or even the sun. According to his analysis of Earth-based infrared observations, the helium/hydrogen ratio of Uranus's atmosphere has been increased to 28 percent or more. If true, Uranus must have formed differently than Jupiter or Saturn, perhaps by incorporating enough hydrogen-poor carbon, such as a carbon monoxide ice in a comet-like form, to soak up hydrogen through the production of methane. If Voyager finds a lot of helium and as much as 3 to 5 percent methane, says David Stevenson of the California Institute of Technology, such an addition of carbon might well have occurred.

*Annual meeting of the Division for Planetary Science of the American Astronomical Society, 28 October to 1 November, Baltimore, Maryland.

More Gas, Less Dust, Found at Halley

All eyes are on Halley, although in October it was still little more than a lopsided smudge in even the largest of telescopes. One after another, astronomers at the DPS meeting flashed their observations on the screen: images of Halley—usually recorded in the garish false colors of the charge-coupled device detector—and spectra of its light from its growing coma of gas and dust. Analyses of new data proved less frequent in the talks, due in part to unfamiliarity of newcomers to the field with instruments and data reduction techniques. But a few facts came out.


J. Gibson/Caltech

Comet Halley on 26 September

This computer-enhanced image shows Halley's tail beginning to form.

Halley seems to be brightening about as fast as expected, but Paul Feldman of Johns Hopkins University, reporting for the team observing Halley through the International Ultraviolet Explorer satellite, announced that the icy nucleus at the heart of the comet is two to three times more active than expected on the basis of 1910 observations. On 19 October, the sun's heat was releasing 7.8×10^{28} molecules or about 2 tons of water per second. That is rather active for a comet 310 million kilometers from the sun, but it roughly fits earlier estimates, considering the more indirect estimates made in 1910.

Susan Wyckoff and Peter Wehinger of Arizona State University and their colleagues reported that Halley's dust production is only a few percent by mass of the sublimating water that is carrying the dust off the nucleus. That places Halley's dust-to-gas ratio among the lowest known. Still, the total amount of dust that the Giotto spacecraft must plow through to attempt its close-up pictures of the nucleus remains about as predicted. That is, Giotto's chances of destruction remain about 50:50.

Where Are All the Satellites of Asteroids?

A few years ago, possible satellites of asteroids seemed to be popping up everywhere, but not a single candidate has been confirmed. Methods of detection that produced early tantalizing suggestions of bodies circling asteroids are now turning up negative results. The latest blow to asteroid companions is the theoretical demonstration that most candidates suggested on the basis of their varying brightness cannot be binary asteroids.

Stuart Weidenschilling of the Planetary Science Institute in Tucson reported at the DPS meeting that the rotation of two bodies about each other in the fashion suggested by some astronomers cannot be stable. Variations in brightness of some asteroids had suggested that they were in fact binary asteroids, one temporarily dimming the total reflected light of the system as it orbited in front of the other. To match the observed light variations, each member of the suggested pairs must rotate synchronously, keeping the same face toward its companion in the way the moon does as it revolves about Earth.

Weidenschilling pointed out that not every pair of asteroids can maintain synchronous orbits indefinitely. If one of the pair is very small, the dissipation of tidal energy will either drive it outward from its synchronous orbit, where eclipses will be few and thus brightness variations uncommon, or inward, where the small secondary would crash into its primary. If the pair consisted of roughly equal-sized bodies, synchronous orbits could be stable, but they would be so close to each other, nearly touching, that the variation of brightness would be difficult to distinguish from that of a single, rotating, ellipsoidal body. Thus tidal effects make asteroidal binaries less likely, but they would also act to conceal any that did exist.

Orbital instabilities can rule out some specific asteroids as being binary. A. Cellino of the Astronomical Observatory of Torino and his colleagues had suggested ten asteroids as possible binaries, but only three—63 Ausonia, 216 Kleopatra, and 624 Hektor—could remain in the required orbits for any length of time, according to Weidenschilling.

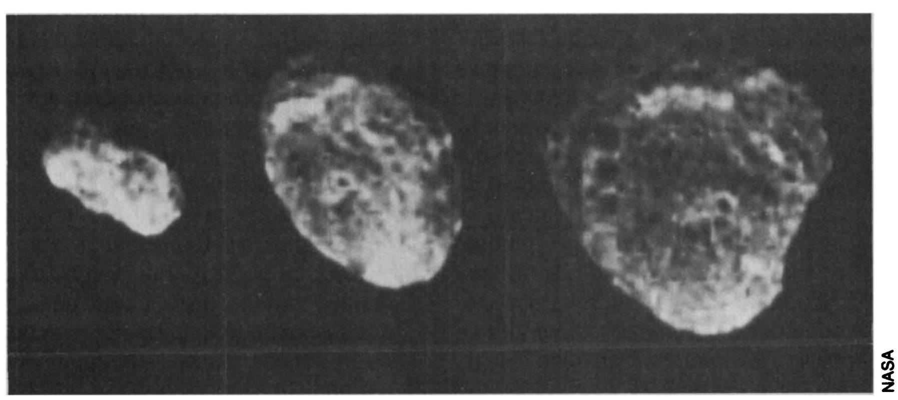
This severe theoretical constraint is only the latest problem for binary asteroids. Possible stellar occultations, in which an asteroidal companion passes in front of a star, first prompted the current interest in satellites of asteroids, but no apparent occultation has yet met the criteria demanded of a confirmed event. The application of speckle interferometry, a telescopic technique that increases resolution, to the search produced some tentative positive results, but they have been withdrawn. Other speckle searches have found nothing.

Jonathan Gradie, Heidi Hammel, and Carl Pilcher of the University of Hawaii reported at the meeting that they had searched around 12 likely asteroids using a sensitive charge-coupled device as a detector and a mask to block out the bright asteroid itself. They found nothing larger than 1 kilometer in size in orbits larger than 7500 kilometers. And Richard Binzel of the University of Texas at Austin has not yet been able to confirm the short-period brightness variations superimposed on month-long variations of the asteroid 1220 Crocus that suggested Crocus's pole of rotation was precessing under the influence of a companion.

The search for satellites of asteroids is not over. Considerable space within the glare of asteroids remains unsearched by imaging. A satellite might still be caught blocking out a star, although fruitless searches for such occultations have become numerous. If companions to asteroids do exist, a search by the soon-to-be launched Space Telescope may be the simplest way to prove it. In the meantime, they are proving elusive.

The Rotation of Saturn's Hyperion Looks Chaotic

New observations strongly support the prediction that Saturn's potato-shaped satellite Hyperion is tumbling wildly rather than rotating with a regular, predictable period. The solar system's grand clockwork-like design would seem to have a small glitch in it.



Three perspectives of Saturn's satellite Hyperion

The Voyager 2 spacecraft recorded these three views of this 360 by 210 kilometer, hamburger-shaped satellite at decreasing distances.

In 1983 Jack Wisdom, who is now at the Massachusetts Institute of Technology, and his colleagues predicted that the combination of Hyperion's odd shape and the stretching of its orbit by the gravitational tugs of the larger satellite Titan would prevent Hyperion from rotating regularly. Instead of keeping one face toward Saturn as its neighbors do, and as the moon faces Earth, Hyperion would rotate chaotically. It would tumble one way then another, slow down and then speed up, in a fashion impossible to predict in any detail from its preceding behavior.

Since then, Peter Thomas of Cornell University and his colleagues have reported analyses of the brightness of Hyperion in Voyager spacecraft images that indicate a regular 13-day period of rotation during 61 days of Voyager 2's encounter with Saturn. Stanton Peale of the University of California at Santa Barbara and Wisdom countered that determining a period from 14 brightness observations scattered over several supposed rotations could not determine whether the rotation is chaotic or not. They found many periods by similarly sampling a numerically generated, chaotic light curve.

Richard Binzel, Jacklyn Green, and Chet Opal of the University of Texas at Austin reported at the DPS meeting that the light curve of Hyperion they observed last April is "highly inconsistent with a 13.1 day rotation period . . . ." On 16 and 17 April, Hyperion's magnitude was at a maximum for the 14-day observing period; it faded by 1 magnitude by 21 April and was no brighter 13 days after the first observations. It should have become 1 magnitude or 2.5 times brighter if it had a 13-day period. Although these observations do not prove chaotic rotation, the group reported, "they provide strong evidence in favor of the hypothesis." To say much more, astronomers will have to observe Hyperion nightly for many weeks, something that those dealing out telescope time have been reluctant to do.

—RICHARD A. KERR—