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Neptune: A new page in the book of worlds

Scientists working with Voyager 2's closeup measurements of Neptune have barely begun their in-depth study of the data. This week, however, several presented their first reports of findings since the late August flyby, at a meeting of the American Astronomical Society's planetary division in Providence, R.I.

One striking result from the mission was the discovery on Neptune's big moon Triton of two towering plumes of gas, probably nitrogen, one leaping up about 8 kilometers from the surface (SN: 10/14/89, p.247). Scientists found photographic evidence of the plumes well after the Voyager flyby. Laurence A. Soderblom of the U.S. Geological Survey in Flagstaff, Ariz., suggested this week that the nitrogen may become heated by sunlight absorbed in dark material in Triton's surface ice and escape through vents or fissures in an ice layer 2 to 3 meters thick. Though the nitrogen has a pressure of only 1 millibar, he says, it would push up against a thin atmosphere with a surface pressure 100 times less than that.

A hallmark of any planetary encounter's early data analysis is the struggle to extract subtle details from photos of the surface, and Triton proved no exception. According to Voyager assistant project scientist Ellis Miner of Jet Propulsion Laboratory in Pasadena, Calif., many of the shapes visible on the surface are probably water ice, since ices of methane and nitrogen "would not retain the large vertical structures that we see," such as cliffs 100 to 300 meters high.

Triton and Nereid were Neptune's only known moons before the Voyager encounter, but the spacecraft's photos revealed six more. The number has not increased since, giving Neptune the fewest known moons of the four major outer planets. But Carolyn Porco of the University of Arizona in Tucson notes that photo interpreters are reanalyzing Saturn 2's pictures for signs of a small moon suspected outside Triton's orbit.

The researchers still seek to refine the length of Neptune's day. In August, scientists put it at 16 hours and 3 minutes. Now a Neptunian day appears a little longer, perhaps 16 hours and 6 to 7 minutes.

Since a deep atmosphere hides Neptune's surface, the key to fixing the length of a Neptunian day lies in analyzing the radio emissions produced by its magnetic field. Studying the emissions in detail, however, turns out to be tricky. Voyager 2 has detected both brief, or "bursty," emissions and longer-term smooth ones, says Michael L. Kaiser of NASA's Goddard Space Flight Center in Greenbelt, Md.

The bursty ones, he says, often appear in unusually narrow frequency bands, typically showing up in only one channel at a time of Voyager's planetary radio astronomy instrument, with each burst no more than 20 kilohertz wide. Uranus has some similarly narrow bursts but at much lower frequencies — below 0.1 megahertz at Uranus, compared with greater than 1 megahertz at Neptune.

One curious aspect of the radio signals, Kaiser says, is the intricate polarization pattern of the smooth ones, showing emissions with both left- and right-hand polarization even though they seem associated with just one of Neptune's magnetic poles — "the weak one, the north pole," according to Kaiser. Scientists would expect right and left polarization to go hand in hand with observations from two poles.

The planet displays a remarkably complex magnetic field. The simplest form of a planetary magnetic field is called a dipole, like that of a bar magnet. At Neptune, says Miner, the field is "not easily represented by a multipole model, or even by a dipole plus quadrupole plus octopole." *— J. Eberhart*

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ful electrophysiological studies [in these cells] to show that electrical responses can be generated in response to light," Lund says.

While Silverman has not yet provided that proof, other researchers using a different transplant technique recently reported evidence of electrical activity in their grafts. Robert J. Collier of the University of Rochester (N.Y.) and his colleagues looked at electroretinograms — tracings of retinal electrical activity that resemble the electrocardiograms used to measure heart functions — recorded from retinal tissue they had transplanted into rats.

Unlike Silverman, Collier's group grafted retinal cells into the front of rats' eyes — far from the retina where any functional transplant must ultimately reside but in a location that allowed the researchers to observe the transplanted cells more easily. At the annual meeting of the Association for Research in Vision and Ophthalmology in May, Collier showed electroretinograms indicating that the transplanted cells, like normal photoreceptors, conduct waves of electrical potentials in response to light.

Those results still don't show that transplanted cells, when placed in the rear of the eye, can grow the micron or so necessary to come within shouting distance of ganglion cells. "The retinogram tells you that these retinal cells are talking, but it does not yet tell you that they are talking to the brain," says Collier's co-worker Manuel del Cerro. Proof of that ultimate electrophysiological link, he says, will require measuring evoked potentials in the brain's visual cortex in response to illumination or to patterns shown on a screen.

No researcher has shown such responses in the brains of photoreceptor recipients, says Silverman, in part because rats have very poor visual acuity in the first place. Silverman says he's preparing to perform transplants in rabbits, cats and primates, which are easier to test for specific brain responses to visual stimuli.

Even if photoreceptor connections prove neurologically sound, researchers foresee other potential complications. For example, transplanted photoreceptors tend to grow abnormally into so-called rosette formations that create bumps on the normally smooth retinal layer. Rosettes are definitely a concern, says Silverman. "We'd expect any disruption to degrade the visual image."

Unfortunately, says del Cerro, "nobody is sure how photoreceptors orient themselves during development. We know the rosettes are linked to abnormal development, but since we do not know what normal is, it's very difficult to know what we should be doing differently in transplantation to avoid having rosettes."

Graft rejection remains another potential problem. Nervous tissue rarely triggers immune responses, making photoreceptors an ideal material for transplantation. But the presence of contaminating, non-neural retinal cells within a graft could trigger an immune response, warns del Cerro. In theory, that could lead not only to graft rejection but also to a sight-threatening antibody attack against the recipient's other eye.

So far, Silverman notes, no such complications have arisen. And even if immunosuppressant drugs become necessary in some cases — as they were in his recent successful transplants of human retinal cells into rats — they can be applied directly to the eye to prevent the side effects that go along with systemic use of such drugs.

Nobody knows to what extent photoreceptor transplants may restore vision in people with retinal diseases. However, del Cerro emphasizes, patients regard even poor vision as a vast improvement over no vision at all.

Before transplantation, "the rats we are working with cannot see anything at all; the transduction of light is totally demolished," he says. "So anything that can say to the retina, and eventually to the brain, 'Here there is light,' would be a considerable jump." □