Locating Uranus' Auroras

Painstaking analyses reveal an outer glow

By JONATHAN EBERHART

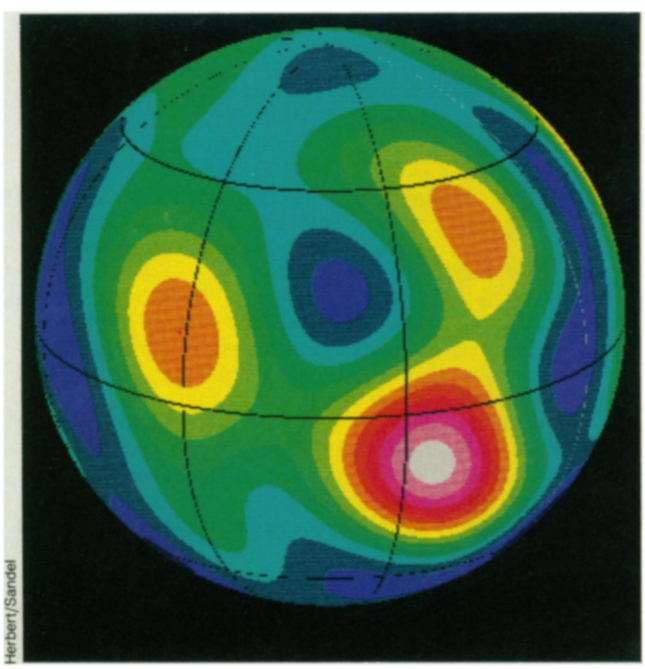
Auroras shimmer not only above Earth's far northern and southern latitudes but also in the skies of Jupiter, Saturn, Uranus and Neptune. These displays result when electrically charged particles trapped by a planet's magnetic field spiral down field "lines" and hit molecules in the atmosphere.

Pinning down the precise locations of Uranus' auroras as anything more than vague, diffuse glows, however, has posed a particularly difficult task, even though Voyager 2 detected hints of their presence when it flew past the planet in January 1986. Now, after almost half a decade of analyzing and pondering data from the spacecraft's ultraviolet (UV) spectrometer, which recorded the presumed auroral emissions, two researchers from the University of Arizona in Tucson believe they have pinpointed the Uranian auroras.

Bill R. Sandel, a physicist at the University of Arizona, says dayglow – another kind of UV emission – contributed to his difficulty in finding the auroras. Produced by sunlight, the dayglow above Uranus is at least twice as bright as the planet's auroras. Also, according to Sandel and colleague Floyd L. Herbert, Voyager 2's route past Uranus proved a poor one for locating the auroras. Auroral glows form around a planet's magnetic poles, which is where the axis of its magnetic field intersects the atmosphere. But Voyager 2 discovered the Uranian magnetic axis tilts about 60 degrees away from its axis of rotation. This meant that the magnetic pole exposed to the craft during its approach was almost over the planet's horizon.

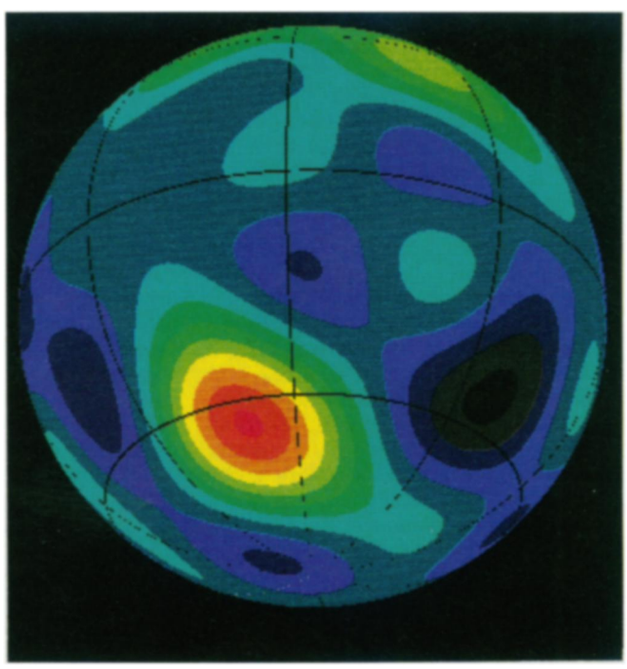
The faintness of Uranian auroras made the search harder still. They glow with a brightness of approximately 3 billion watts, Sandel found. Though about 10 times brighter than Earth's, these Uranian auroras exhibit only about one-

Dayside: Map shows the sunlit side of Uranus centered near the planet's north magnetic pole. The Uranian atmosphere shows three bright areas that researchers believe to be part of a single large aurora. An additional bright area is barely visible along the map's upper right edge. White dotted line indicates the 0-degree meridian of longitude. False colors indicate the brightness intensities of the auroras, with black the dimmest and white the brightest.



Herbert/Sandel

Nightside: A smaller aurora appears in the atmosphere above the planet's other hemisphere. White dotted line at the map's bottom edge marks the south end of the 0-degree longitude meridian on the planet's dayside; black continuation of the same line marks the 180-degree meridian.



thousandth the brightness of Jovian auroras, and one-seventh that of Saturn's. But Neptune's auroras shine only about one-sixtieth as bright as Uranus', he notes.

Variations in the planets' auroral brightness result primarily from differences in the processes energizing the aurora-causing ions caught on each planet's magnetic field, Sandel explains. Also important, he adds, are the differing numbers of ionized particles and the strength of each world's magnetic field.

Locating the Uranian auroras finally required integrating the entire series of Voyager 2's spectrometer measurements, made at angles that changed continuously as the craft flashed past the planet. Herbert described the results of his and Sandel's analysis on Aug. 24 in Annapolis, Md., at a NASA-sponsored symposium on magnetospheres of the outer planets.

Herbert originally mapped the Uranian auroras onto a rectangle — a familiar projection with horizontal and vertical axes. Sandel describes Herbert's more recent versions (shown on facing page) as "round pictures showing auroral brightnesses on the surface of a spherical planet." Because Herbert chose to approximately center the UV-bright areas — representing the auroras — in the middle of their hemispheres, and because auroras on the night- and daysides do not mirror each other, these two maps do not portray the skies over diametrically opposite sides of Uranus.

Three bright areas dominate the dayside auroral zone (left map), the view of Uranus facing the sun as Voyager 2 swung past the rotating planet. This auroral zone proved "the biggest in angular extent [relative size] in the solar system," Sandel says. It forms an oval somewhere between 60 and 90 degrees across and centered (middle purple spot) on Herbert's map at 60 degrees west, 30 degrees north. By comparison, the dayside auroral zones of Earth, Jupiter and Saturn are more compact, usually reaching no more than 10 to 20 degrees beyond their magnetic poles, Sandel says.

The dayside map also includes a fourth diffuse, bright region, located on the upper right horizon at about 30 degrees north by 320 degrees west — an area near neither magnetic pole. "That I don't understand," Herbert says. According to the standard magnetic-field model — a technical description widely used by scientists including himself and Sandel — "you can't have charged particles coming down the field lines and hitting the planet there."

Furthermore, Herbert adds, this generally accepted model of the Uranian magnetic field predicts the dayside's larger auroral zone should form a long ellipse, with only two bright areas, whereas the three detected by Voyager 2's UV spectrometer give the auroral zone a more circular appearance.

The nightside auroral zone (right map) is "pretty well confined" to a single fuzzy area spanning about 10 to 15 degrees on the map and centered at about 240 degrees west by 50 degrees south, Herbert and Sandel found. Because of the low resolution of the spectrometer's data, the Arizona researchers cannot tell whether the area has a hole in the middle — as the researchers think the bright area should if it represents an aurora encircling the magnetic pole.

Analyzing the spectrometer's data did not produce images like photographs. The maps depicted here portray an integration of all the brightness intensities recorded by the spectrometer. Herbert and Sandel say the actual auroral zones are the only two stable features (besides the unexplained aurora at 30 degrees north, 320 degrees west) that show up in all the computer analyses of the UV data obtained as Voyager 2 flew past Uranus.

The spectrometer showed the planet's UV brightness at such low resolution that Herbert admits "maybe either this reconstruction is wrong, or the magnetic-field model needs adjustment." Sandel adds that the study is still not finished, and stresses that the precise locations of the mapped auroras "could change somewhat" as he and Herbert refine their analytical techniques. □

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Polymeric plot line?

In the "Star Trek" episode titled "Return to Tomorrow," extraterrestrials were building artificial bodies to live in. Scotty could not understand how the "globs of jelly" they were using could work like a muscle. Well, after reading "Polymers that shrink from light" (SN: 9/1/90, p.143), now we know!

Stephen Salgaller
Los Angeles, Calif.

Garlic bliss

In "Garlic medicine: Cures in cloves?" (SN: 9/8/90, p.157), the researchers seem to overlook the obvious. Garlic may not have any direct chemical effect on hypertension, heart disease and cancer. But garlic's ability to repel other human beings may.

For instance, I use at least three cloves of garlic a day. The result is that my boss will not come into my office to abuse me. When I go to a bank or retail store, my transactions are handled quickly and efficiently, even abruptly, and any questions or complaints I have are always granted. Neighbors bid me hello from across the street or not at all.

I am blissfully happy and healthy. The only people with whom I have any real concourse are other garlic eaters, and these are equally blissfully happy and healthy.

Therefore, in my experience, garlic counteracts the stress and morbidity of unnaturally dense human populations. It does so by repelling unhealthy and unhappy individuals and by attracting healthy and happy ones.

Martin Donovan
Salem, Mass.