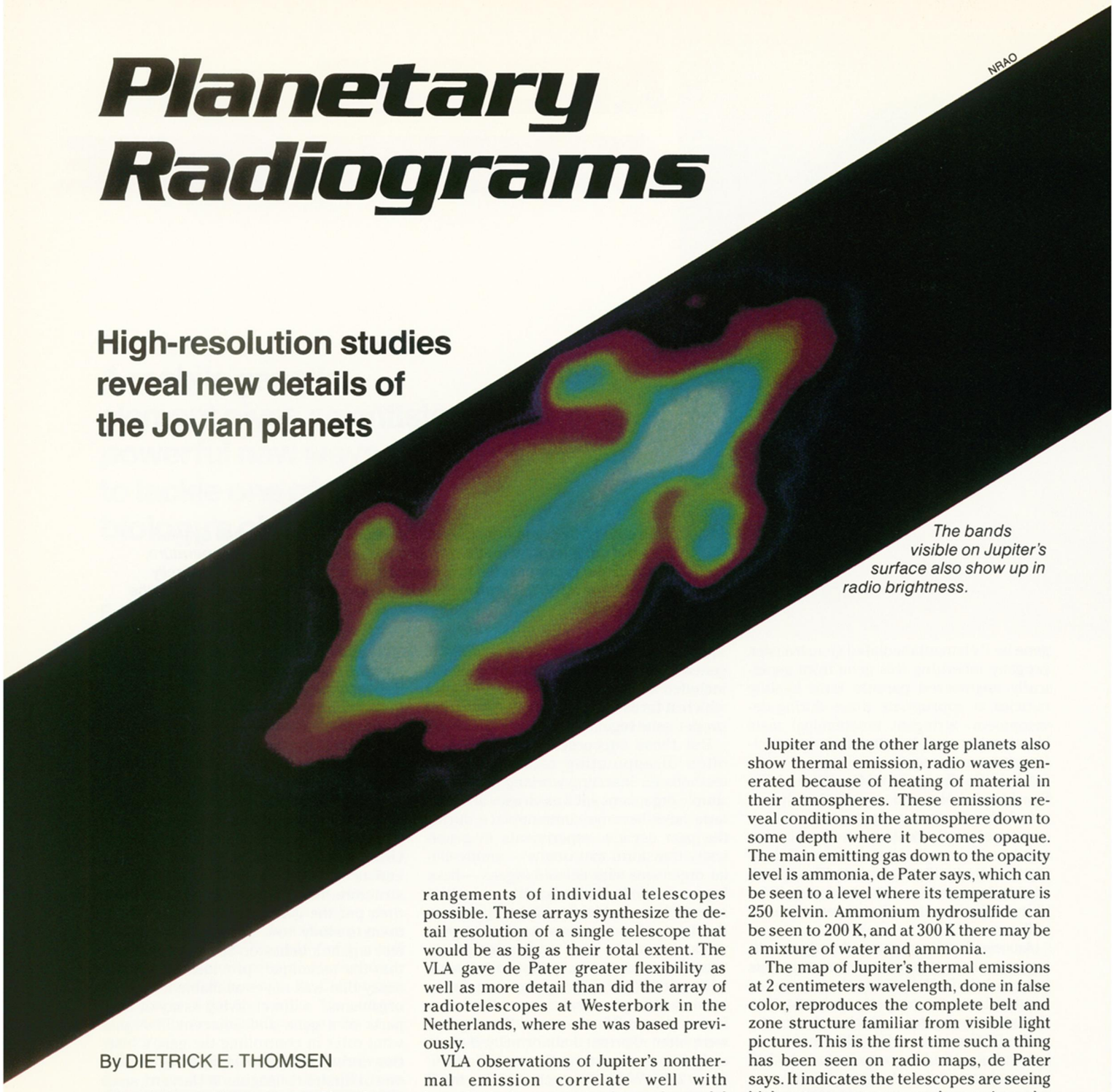
Planetary Radiograms

High-resolution studies reveal new details of the Jovian planets



The bands visible on Jupiter's surface also show up in radio brightness.

By DIETRICK E. THOMSEN

Astronomers think of the Very Large Array of radiotelescopes that stands on the Plains of San Augustin in New Mexico as an instrument for getting highly detailed maps of complex but distant radio sources, such as quasars and galaxies. And it has mostly been used for such studies. Recently, however, the VLA mapped some of the nearest radio sources there are, the Jovian planets. Imke de Pater of the University of California at Berkeley, the astronomer in charge of this work, discussed some of the data found in the maps at the recent meeting in San Antonio of the American Physical Society.

The VLA has a Y shape with several arrangements of individual telescopes possible. These arrays synthesize the detail resolution of a single telescope that would be as big as their total extent. The VLA gave de Pater greater flexibility as well as more detail than did the array of radiotelescopes at Westerbork in the Netherlands, where she was based previously.

VLA observations of Jupiter's nonthermal emission correlate well with hypothetical maps derived from the model of what should be there (based on previous observation) except that there are bright lobes of emission not in the model, and the emission extends out from the planet a distance equal to three times Jupiter's radius instead of two-and-a-half. Why the lobes are there is a subject for further investigation. Jupiter's innermost moon, Io, seems to be both a source of the nonthermally radiating electrons and a modulator of their behavior. This greater extension of the emitting material than had previously been supposed may mean that another moon is also involved, de Pater says.

Jupiter and the other large planets also show thermal emission, radio waves generated because of heating of material in their atmospheres. These emissions reveal conditions in the atmosphere down to some depth where it becomes opaque. The main emitting gas down to the opacity level is ammonia, de Pater says, which can be seen to a level where its temperature is 250 kelvin. Ammonium hydrosulfide can be seen to 200 K, and at 300 K there may be a mixture of water and ammonia.

The map of Jupiter's thermal emissions at 2 centimeters wavelength, done in false color, reproduces the complete belt and zone structure familiar from visible light pictures. This is the first time such a thing has been seen on radio maps, de Pater says. It indicates the telescopes are seeing higher temperatures or deeper into the atmosphere at the darker belts. There may be less ammonia there. This observation also seems to give the first direct evidence that Jupiter's cloud layer may be made of ammonia crystals, as there is a depletion of emission above the dark bands where white clouds are seen.

De Pater went on to the first VLA maps showing Saturn's disk and rings. The disk is 16 seconds of arc across. The maps—at 6 and 2 cm—show thermal emission from the disk, darkness representing absorption by the rings, and emission from the rings, which is really emission from the planet scattered by the particles in the

rings. Scattering does not depend on wavelength, which seems to mean larger rather than smaller particles in the rings.

From the 2-cm map, changes in the darkening of the edges (limbs) of the planet can be followed, and they show that poles are "too hot as expected. The temperature really is hotter, and there is less ammonia at the poles," she says. A high-resolution map containing data from both 6-cm and 2-cm surveys is particularly good for studying absorption by the rings to determine such things as their optical depth (that is, the density of material) in different locations.

One of the interesting features here is the Cassini Division, a rift in the middle of the rings. One of the longstanding questions is whether the Cassini Division is really empty or whether it just looks that way. On this map the division shows up as a thin bright line, indicating that at radio waves as at visible wavelengths, it is optically thin, that is, there is little or nothing in it.

The VLA can resolve the even more distant planet Uranus, showing it as a disk rather than just a bright point. The disk is only four seconds of arc across, so not a great deal of detail can be picked out. However, the map does shed some light (perhaps it would be better to say "radio") on another longstanding question. Over the last 20 years Uranus appears to have gotten warmer, and astronomers want an explanation.

The answer could involve the motion of the planet. The rotation axis of Uranus lies almost in the plane of the ecliptic (the general plane of the sun and planets). Uranus is unique in this respect, as the axes of the other planets are all nearly perpendicular to the ecliptic. The axis of Uranus precesses, and this precession has been bringing the pole of Uranus closer and closer to our line of sight over those same twenty years.

On the 6-cm radio map the pole can be distinguished from the subsolar point, which, naively, one would expect to be warmest. However, the point of brightest emission (and so presumably of highest temperature) is not the subsolar point, but one lying close to the pole. If the precession has been bringing that point closer to our line of sight along with the pole, that could explain the apparent warming. However, on the 2-cm map the brightest point is not the same spot, but one somewhere between the pole and the subsolar point. "This complicates things," de Pater says.

She closed with a defense of such groundbased observations against those who would ask why we need them after the Voyager probes. These observations are complementary to the Voyager ones, she says. "We probe the region inward of three Jupiter radii; they stayed outside it. We probe below the clouds. We see scatter by the ensemble of the rings; they saw scatter by individual particles." □

Letters

Food function

Re Richard Wurtman's statement ("Food for Mind and Mood," SN: 4/7/84, p. 216), "It remains peculiar to me that the brain should have evolved in such a way that it is subject to having its function and chemistry depend on whether you had lunch and what you ate. I would not have designed the brain that way myself."

It remains peculiar to me that the Rolls Royce should have been designed in such a way that it is subject to having its function and operation depend on whether you filled the gas tank and what you filled it with. I would not have designed the car that way myself.

It remains peculiar to me that the modern research scientist should have evolved in such a way that it is subject to having its function depend on how much money it is given to spend by how prestigious an institution. I would not have designed the research scientist that way myself.

Ursula K. Le Guin
Portland, Ore.

Seal hypocrisy

The letter from John P. Wren of the killing of harp seals (SN: 4/7/84, p. 211) complains of the hypocrisy of the opponents of the hunt, who oppose the seal harvest, yet wear and eat products from other animals — calves, cows, lambs, and fowl. But this isn't necessarily hypocrisy. Wren says that as long as the killing isn't brutal and "proper quotas" are enforced, there is no problem.

I beg to differ. While I don't oppose killing animals for human use, quotas are precisely the problem. With livestock, fowl, and other domesticated animals there is never any need for harvest quotas, because people own herds outright. There is no attempt to regulate the destruction of the species, because ownership creates strong incentives to maintain the size and productivity of a herd and the species. With seals, whales, and other animals, though, there is no legal framework of property rights. Instead, herds are left as a "common pool" resource, and quotas are set up for a maximum kill and apportioned among the various harvesting interests.

The quota system establishes incentives to kill as many animals as possible, and kill the best first, because if one harvester doesn't do it the next may. Upper limit quotas are set, but they are honored mainly in the breach, because the whole system also creates strong incentives to overharvest and to poach. The supply-side restraint of quotas also creates a demand-side incentive to violate quotas by driving up the prices for the limited number of legal seal products and creating a black market.

This whole systemic phenomenon takes place in every domain in which private property rights to resources are not developed or protected: wildlife and animals, land use, streams and lakes, etc. It accounts for the overgrazing of grasslands in the western United States in the 19th century (and by reservation-bound Navajo Indians in the late 19th and nearly 20th centuries). There, 160-acre homestead lots — viable farming units in the eastern U.S. — were too small for herds to graze on. But rather than allow ownership of larger amounts of land, the U.S. government made the open range a "common pool" resource, and tried to regulate access. But the incentives were to use the best foraging lands before someone else got to them, and to use the resources quickly rather than wisely — or lose their use totally. The result was overgrazing. The same thing happens in fisheries, polluted rivers, and throughout the environment and environmental policy; the classical formulation of the problem is Garrett Hardin's "tragedy of the commons."

So the concerns of the opponents of the seal harvest are real: the strongest incentives are those that threaten the existence of the harp seals. Unfortunately, many of these opponents themselves don't understand the systemic logic of the quota system, and favor strengthening it and creating more regulation and enforcement. But unless the killing of any animal is wrong, period, we should not act as though the only alternatives are total cessation of the harvest or quotas with destructive incentives. Rather, a legal framework of property rights in seal herds should be established, so that investments can be made and the seal herds developed as an economic resource.

No one worries that privately-owned varieties of cows or chickens will become extinct, and for good reason. The same would be true of harp seals, whales, king crabs, salmon, and countless other economically valuable animals if people had enforceable property rights in the animals, rather than easily-violated quota allotments with the incentives for their own violation built in. Whether such a rational system can be made emotionally clear and appealing enough for a political solution is, unfortunately, doubtful. But it is the only real long-term solution and hope. John Wren's faith in a regulatory solution is certainly short-sighted and misplaced.

David M. Stewart
Madison Heights, Mich.

In your article on harp seals (SN: 3/17/84, p. 164) you have hit a topic that makes my blood boil. The harp seal is a species that is in no danger of extinction, yet it is the basis of an issue that is causing economic hardship to many Canadians, including native peoples. The fish boycott hurts mostly west coast fisherman, about 3,000 miles from the seal herds in question.

The IFAW and Greenpeace seem bent on damaging the Canadian economy for no logical purpose — their attitude is irrational unless they also intend to stop slaughtering animals for food, also. While the damage to the IFAW aircraft cannot be condoned, it's a natural reaction to the outrage felt by poor fishermen towards rich layabouts who are putting them deeper into poverty.

It is to be hoped that Canadians will organize a boycott of McDonald's and Burger King, who have extensive chains of outlets here, if these companies join the IFAW boycott.

I note that whales and many other species are being driven to extinction while Greenpeace etc. focus their attention on a most unendangered species.

Michael James
Kanata, Ontario

John P. Wren's outburst against "bleeding heart liberals" who protest the killing of baby harp seals misses the point; calves, lambs, ducklings, etc. are used for *food,* not just to provide fur coats. There is a difference between food and vanity. (And actually, many of us bleeding heart liberals are vegetarians. In sneakers. Who can afford calf-skin shoes?)

Otis Kidwell Burger
New York, N.Y.