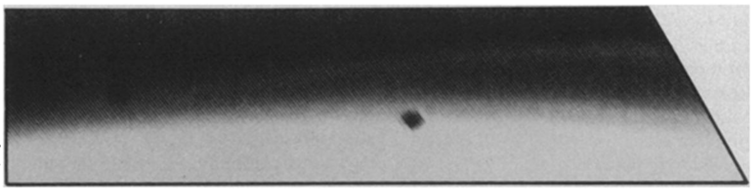
SCIENCE NEWS OF THE WEEK

Sorting Out the Saturn System

Some of the researchers trying to analyze the Voyager 1 spacecraft's voluminous and exciting data about Saturn, its rings and moons have had relatively little time for the task, what with presenting the early results at scientific meetings and rushing to prepare a preliminary report on them for a journal. New findings are emerging, however, and they range from the core of the planet out to its distant satellites.


Voyager 1/JPL

High haze layer tops parts of Saturn's atmosphere.

The planet: Like Jupiter, Saturn gives off more heat than it receives from the sun. In Jupiter's case, the excess can be explained by compression due to the massive world's gravity. Saturn, however, is far less massive. One pre-Voyager idea was that the excess could be caused by the helium in Saturn's gassy structure settling to the bottom of the lighter-weight hydrogen, leaving a helium depletion that might show to Voyager's instruments. In the frantic activity surrounding last November's Saturn flyby, scientists first thought Saturn to have about the same helium percentage in its outer layers as does Jupiter, about 19 percent, leaving the smaller world's warmth a mystery. Refined analysis, however, has now lowered the Saturn measurement to 11 percent — just about what the helium-hydrogen separation idea would predict, providing tentative confirmation of a totally different way of heating a planet's insides.

Another of Saturn's inner mysteries has been that the axis of its magnetic field, instead of being tilted about 10° like those of other planets known to have intrinsic fields, is virtually straight up. This one is still a puzzle (though the reason for the tilts in the other cases is equally elusive), but researchers have at least succeeded in measuring the tiny angle of the Saturnian field's tilt: a mere $0.7° \pm 0.3°$.

Newer discoveries, meanwhile, continue to be made, as scientists get time to reexamine photos and other data that could only receive a glance in the initial rush. Mere days ago, Allan F. Cook of the Harvard-Smithsonian Center for Astrophysics discovered a previously unsuspected layer of extremely high-altitude haze visible along portions of Saturn's limb or edge. Some 60 kilometers thick, the layer looms about 150 km above the much denser layer that is believed to contribute to Saturn's bland appearance by masking its colored bands. "It takes a gross increase in temperature to raise something that high," says Cook, yet the smooth layer shows no signs of the turbulence that would indicate it to be uplifted by convection from within the planet, and the sun's heat, he believes, is too weak for the job at Saturn's great distance. Perhaps, Cook suggests, the magnetosphere plays some role, possibly heating the top of the atmosphere by bombarding it with charged particles, but "there's no similar phenomenon at Jupiter, where the magnetosphere is much more active." The high layer seems to be localized, existing in isolated regions rather than surrounding the planet, and some Voyager photos show it to be absent from regions where it was formerly seen. Another Saturnian quandary.

The rings: Two of Voyager 1's greatest Saturn mysteries — the spoke-like features in the wide B-ring and the seemingly braided, multi-stranded-F-ring — have drawn scores of tentative hypotheses from scientists around the country and abroad, but there is yet no widely accepted explanation for either phenomenon. Detailed study of the spokes, in fact, has made them more perplexing still: Early looks at the photos led researchers to think that the spokes remained radial to Saturn as they traveled around the ring when they should have been progressively "slanted" by the differing orbital speeds of ring particles near and far from the planet. The idea then evolved that the spokes remained radial because they were in some way related to the planet's magnetic field, and this in turn suggested various possible ways in which the strange features might be formed. Now, however, Voyager scientists have found that the spokes do, in fact, slant — which sends the researchers back to square one in trying to understand what causes them. The F-ring's "braids," meanwhile, are even more baffling. The F-ring is extremely narrow, apparently kept that way by two tiny satellites that orbit just inside and outside it, and the University of Arizona's Bradford Smith suggests that the braiding may be related in part to some gravitational perturbation caused when the little moons exactly straddle the ring. Voyager 2, due to pass Saturn in late August, will photograph the F-ring exhaustively, but the answer may still be a long time coming.

The moons: Photos showing a lack of large impact craters on part of Saturn's moon Rhea prompted the suggestion last November that solar-system objects may have been subjected to more than one major episode of meteorite bombardment (separated by periods of resurfacing), rather than the one "great bombardment" often cited. Inferred from only one moon, the idea met with some skepticism, but scientists have since identified similar evidence on Mimas and Dione. □

White dwarf stars that make pulsars

Pulsars are supposed to be neutron stars. Those that pulse in X-rays have so far been neatly explained as neutron stars residing in binary systems in which the two stars are very close together. A neutron star is unbelievably condensed: As massive as the sun, it may be only 20 kilometers in diameter. Such density means a fantastically strong gravitational field and a formidable magnetic field. The gravitational field pulls material from the neutron star's companion. The magnetic field channels it to the magnetic poles of the neutron star. As the infalling matter crashes into the atmosphere or the surface of the neutron star, X-rays are generated. We see them in pulses as the poles of the rotating neutron star cross our line of sight.

It's a neat theory, except that now there are two X-ray pulsars that seem to have white dwarfs as the active members of the binary. Both were studied with the Einstein observatory satellite. A report on AE Aquarii was published a short time ago by Joseph Patterson, D. Branch, G. Chincarini and E. L. Robinson of the Harvard-Smithsonian Center for Astrophysics. Now comes H2252—035, discussed in the most recent Astrophysical Journal Letters (vol. 243, p. L83) by Patterson and Christopher M. Price of the University of Michigan.

White dwarf stars are hardly rare as members of binary systems, but they should not have the gravitational and magnetic fields necessary to channel infalling material with the precision of a pulsar. In fact, there is evidence that material from their companions comes to them erratically: Their optical or X-ray brightness fluctuates in a disorderly way, as though matter were now falling on them and now not. From this characteristic they are known as cataclysmic variables. Cataclysmic variables are not expected to act as pulsars, but here are two that seem to.

H2252 — 035, as Patterson and Price