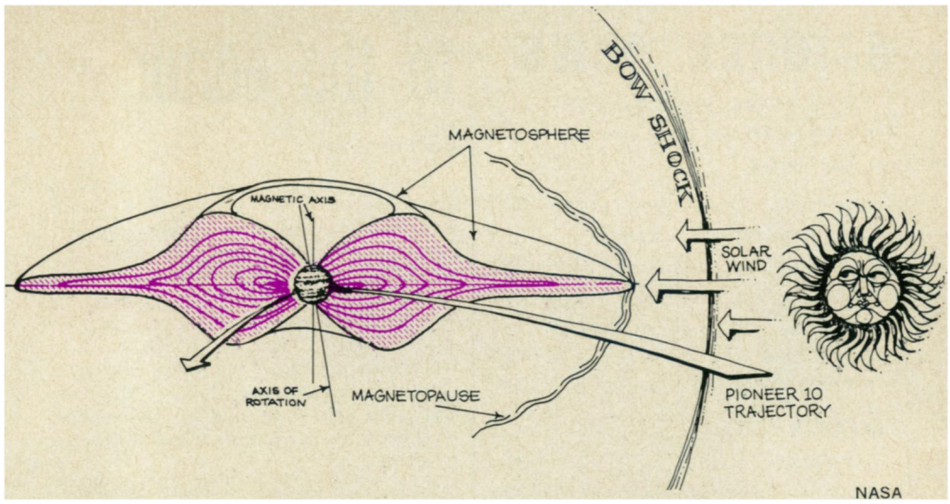
Digesting the data on Jupiter and its moons



A thick-centered disc of dense, energetic particles rings Van Allen's Jupiter

Permanently cloaked in impenetrable clouds, Venus has a popular reputation as the solar system's planet of mystery. But for the teams of scientists now poring over data from the Pioneer 10 spacecraft's flight past Jupiter last week, the giant planet might well assume the title.

Even a quick look at the incoming storehouse of information shows a truly alien world (SN: 12/8/73, p. 356). As the researchers begin their months of painstaking analysis, their early impressions are only confirmed.

A heat map of the planet, compiled by the spacecraft's infrared radiometer and impossible to make from earth, verified what is still one of Jupiter's most conspicuous curiosities: that it gives off about two and a half times as much heat as it gets from the sun. Despite the planet's frigid temperatures, says infrared experimenter Guido Munch of California Institute of Technology, if the sun were somehow cut off it would take a week to lose all the heat trapped in the dense atmosphere.

The controversial giant red spot, Jupiter's most prominently visible feature, is still an enigma, but Pioneer 10 has provided more food for thought, thanks largely to remarkable images provided by the photopolarimeter of Tom Gehrels of the University of Arizona as well as to the temperature mapping. The spot, says Munch, may well turn out to be a free-floating vortex born in some Hadean thermal disturbance below. Future investigators may discover that it looks like a giant tower of russet cloud, reaching, says Gehrels, perhaps five kilometers above the rest of the cloud tops. Laborious, computer-assisted efforts by Arizona's William Swindell to refine the pictures may, in fact, reveal that Pioneer managed to record a special prize: an image made at such a low sunlight angle that the red spot is casting a long shadow, which could reveal the height of its bulge. So great are Jupiter's atmospheric pressure and gravity, and so low its temperature, according to Munch, that such atmospheric "cells," if such they are, probably take hundreds of years to rise to the cloudy summit.

Ultraviolet measurements from Pioneer, again impossible through the blanket of earth's atmosphere, confirm that primeval hydrogen is still in Jupiter's atmosphere, glowing, as expected, about 100 times more brightly than the helium that is also present. The relative amounts of the two gases, however, must be determined from months of detailed computer study by Darrell Judge of the University of Southern California, who also hopes to compare his results with current estimates of the gases' relative abundances in the universe.

The vast magnetic and particle fields surrounding Jupiter are as confusing as the planet itself. An early consensus seems to be that the magnetic field bulges out into what Pioneer project scientist John H. Wolfe of NASA describes as a "soggy doughnut," almost 10 million miles in diameter. The greatest concentrations of the energetic protons and electrons trapped by the field are in a sort of disc that is thicker the nearer it is to the planet's surface, says James A. Van Allen of the University of Iowa, finally expanding to follow the strong inner part of the magnetic lines of force. In this inner section, adds John A. Simpson of the University of Chicago, the particles are strongly bound to the field lines; it is the weaker grip of the outer field that may be letting them break loose, perhaps accounting for some of the turbulence recorded by Pioneer's instruments on the edge of Jupiter's influence.

Jupiter was not the spacecraft's only target, however. Four of its dozen moons also received their first close scrutiny:

- Io, nearest to the planet, is also so dense, says John Anderson of Jet Propulsion Laboratory, that it is "far out of line" with the rest of Jupiter's satellites. It may have condensed in an anomalously heavy part of the gaseous cloud that formed the solar system or, suggests Anderson, it may even have been born elsewhere and captured by Jupiter's gravitational field (possibly from among the inner planets since its density resembles that of Mars). More important, however, was the discovery that Io has an atmosphere of sorts. It is so rarified, theorizes Arvydas Kliore of JPL, that it may be an on-again off-again feature composed of surface particles that only occasionally get warm enough to evaporate; another possibility is that it is the remainder of an ancient, thicker atmosphere which got so cold in eons past that most of it simply snowed out.
- Europa, second of the four moons discovered by Galileo, was the only one to show an appreciable "sweeping" effect in clearing the energetic protons and electrons from part of Pioneer's path, perhaps because the spacecraft passed closest behind Europa's wake. The effect seemed to occur at all energy levels, at least for the electrons, although its effectiveness in helping Pioneer survive is not yet known. Europa was also found to be slightly denser than earth-based predictions suggested —3.07 grams per cubic centimeter, compared to about 3.00.
- Ganymede was just the opposite—1.93 instead of an expected 2.03—a difference of about a tenth the mass of earth's moon, yet . . .
- Callisto, like Europa, turned out to be denser than anticipated—1.65 grams per cubic centimeter versus 1.3.

And still the decision awaits for Pioneer 11: will it go to Saturn? □