Voyager Bulletin

MISSION STATUS REPORT NO. 40 APRIL 13 , 1979

Mission Highlights

When Voyager 1 swings through the Saturn system in late 1980, the volume of information returned from its Jupiter Encounter will still be under study. Voyager 1 unmasked whole new worlds – presenting new puzzles. Space exploration, as one journalist noted, is an endless adventure.

By March 15, Voyager 1 had returned over 15,000 photographs of Jupiter and its moons. Add to this the wealth of data accumulated by 10 other science experiments, and it becomes apparent that it will require months, perhaps years, to wade through it all. Preliminary results are in, however.

The pictures provide immediate visual information. In 1965, Mariner 4 returned 22 frames of Mars, 200 by 200 elements, and each requiring 8-1/2 hours to play back to Earth at a data rate of 8-1/3 bits per second. Fourteen years later, at a data rate of 115,200 bits per second, Voyager 1 returned many of its 800 x 800 element pictures in about 48 seconds.

This issue will concentrate on Jupiter and its environs; subsequent issues will deal with the satellites.

Sulfur Torus

Imagine a huge, glowing fluorescent tube, millions of miles in diameter. This is one model of the doughnut-shaped cloud (torus) of sulfur wobbling around Jupiter at the distance of Io's orbit.

Visible only in ultraviolet light, the torus of sulfur-three atoms (or doubly-ionized sulfur, which has lost two electrons per atom due to high temperatures), has a density of about 500 sulfur atoms per cubic centimeter (compared to less than 0.01 total particles per cubic centimeter in the interplanetary medium). Some sulfur was expected, but the density was a surprise.

In addition, a great deal of energy, perhaps as much as 500 billion watts of power, is required just to hold the particles in orbit. The sulfur was thought to be sputtered off the dry surface of Io, but that theory was laid to rest when Io's explosive volcanoes were discovered.

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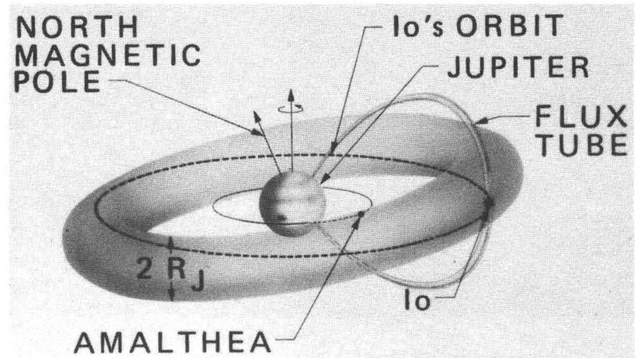


SULFUR TORUS – Ultraviolet observations discovered a hot, charged ring of sulfur encircling Jupiter.

Update

Five weeks after its sweep through the Jovian system, Voyager 1 continues taking parting shots and scanning the system on the far side of the planet.

On April 9, Voyager 1 fired its attitude control thrusters to adjust its course toward Saturn, nearly 800 million kilometers (500 million miles) away. Nineteen months from now, in mid-November, 1980, Voyager 1 will get its closest look at the ringed planet and six of its companions.

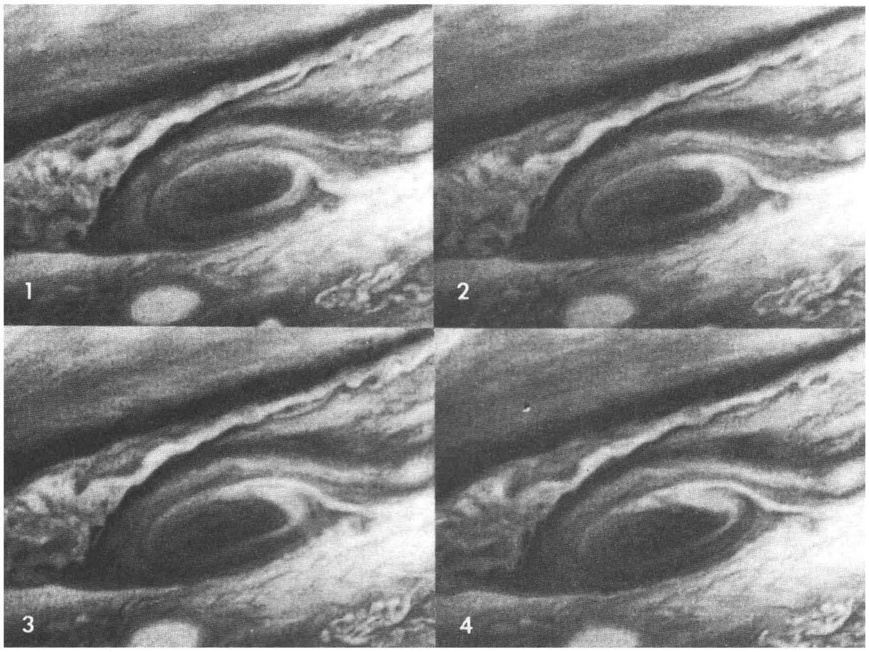
Jupiter's orbital energy has already been used to accelerate the spacecraft to about 84,500 kilometers per hour (52,500 miles per hour) and altered its flight path. Without Jupiter's aid, Voyager 1 would require nearly 1.5 million kilograms (1600 tons) of fuel as opposed to 5 kilograms (11 pounds) to achieve the same flight path. Three more trajectory correction maneuvers are planned before Saturn Encounter.

Voyager 1 will now settle into a relatively quiet cruise mode, continuing to look at the dark side of Jupiter and its spectacular satellites, to sample the interplanetary medium, and to make regular instrument calibrations and tests.

Voyager 2's Jupiter observations begin on April 24, 76 days before its closest approach to the system on July 9. Now travelling with less than half Voyager 1's velocity, Voyager 2 is 64.6 million kilometers (40 million miles) from Jupiter. On April 16 through 20, the spacecraft will execute the sequence of events for July's Encounter. Voyager 1 made a similar dry run in December.

NASA
National Aeronautics and
Space Administration
Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

Recorded Mission Status (213) 354-7237
Status Bulletin Editor (213) 354-4438
Public Information Office (213) 354-5011



RED SPOT CIRCULATION – Taken one Jupiter rotation apart, these photos depict four days in the life of the centuries-old atmospheric feature. Changes in circulation during the 40-hour period are clearly visible, especially the flow of light material at the spot's right edge. The photos were taken on February 2-3, 1979 from 31 million km (19.4 million mi).

Atmospheric Characteristics

Jupiter is far more complex in its atmospheric motions than ever imagined. Linear flows diverge and vortices reverse direction. Neighboring jet streams flow in opposite directions. Its bright orange and white bands are in constant turmoil, yet appear to retain their sharp-edged structure down to resolutions of 25 kilometers. It looks at times like a dance between two unmixable fluids (like oil and water). Yet Jupiter's atmosphere is all gas, and material exchange between flows has been observed.

First sited from Earth nearly three centuries ago, the Great Red Spot remains a mystery. Is it a hurricane? Is it anchored to a feature deep below the cloud tops? Is it tied to a "floating raft" of solidified water in the lower levels of the atmosphere? Why has it existed for so long? Why is it reddish?

Variable in size and color, the spot today is about 21,000 by 11,000 km (13,000 by 7,000 mi) and paler than when the Pioneer spacecraft photographed it in 1973-74. It has remained at about the same position, 22 degrees south latitude, for as long as it has been observed. It is cold and bright and oscillates slightly as it migrates east and west every 90 days. Whirling counterclockwise, one complete trip takes about six days. High-speed jet streams flowing in opposite directions above and below it may explain its whirling motion.

The task remains to reconstruct the atmospheric flow patterns on the planet. One technique for this is to assemble hundreds of still photos to produce, in effect, a movie in which the motions are readily visible and easily mapped.

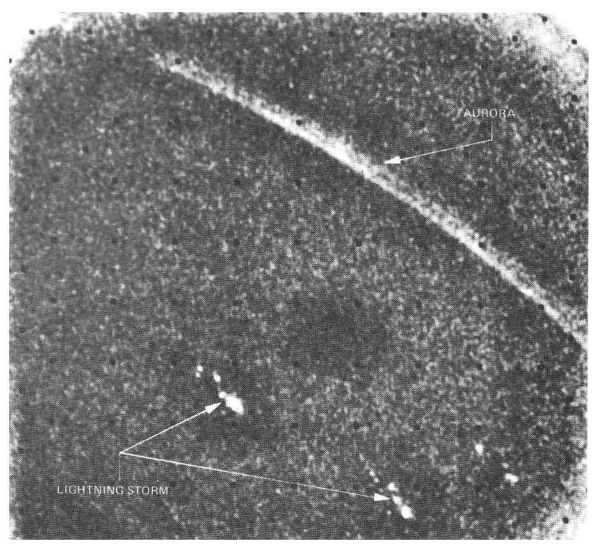
Northern Lights and Lightning

Earth and Jupiter have at least one thing in common – auroras. Voyager 1 spotted the largest aurora ever seen by mankind – nearly 29,000 kilometers (18,000 miles) long – at Jupiter's north pole. At Earth, auroras at the poles (northern and southern lights) are caused by the acceleration into the atmosphere of charged particles from the Van Allen radiation belts along the magnetic lines of force. Similar processes probably cause Jupiter's autoras.

First detected in the ultraviolet, Jupiter's auroras were much stronger than expected and detectable on both the night and day sides of the planet. Analysis of the auroras will aid in deciphering the planet's atmospheric composition, already known to consist primarily of hydrogen, with helium and some ammonia, methane, and water.

The long-exposure photograph of the aurora also appears to show a lightning storm – nineteen bright spots several thousand miles south of the aurora. Lightning had been suspected to exist on Jupiter, but at deeper levels of the atmosphere.

In a classic laboratory experiment, an electrical current (lightning) passed through a mixture of hydrogen, methane, ammonia, and water, has been shown to set off a reaction that forms more complex organic molecules. Whether such a process has occurred on Jupiter awaits further analysis.



"NORTHERN LIGHTS" – A long exposure (3 minutes, 12 seconds) captured this aurora and lightning storms on Jupiter's dark side six hours after closest approach on March 5, 1979.