Voyager Bulletin

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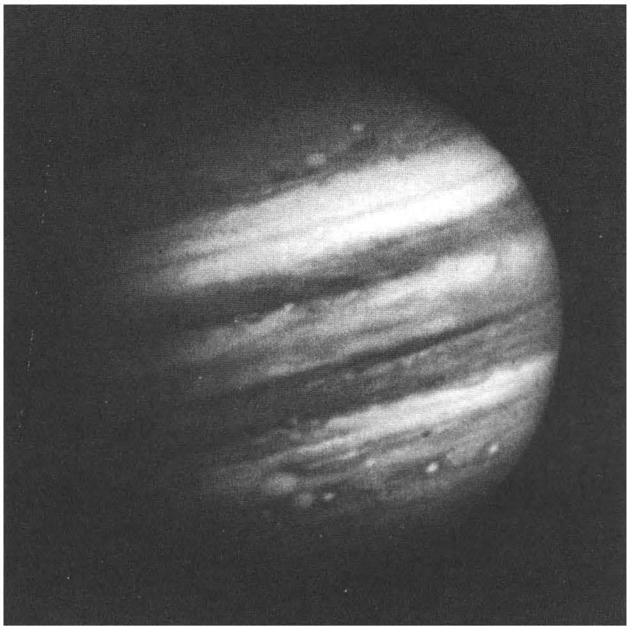

IO CASTS ITS SHADOW – As Jupiter's satellite Io (lower center) passes before the giant planet, its shadow (left) can be seen falling on the planet's face. Io is traveling from left to right in its one-and-three-quarter-day orbit around the planet. Even from this great distance the image of Io shows dark poles and a bright equatorial region. Voyager 1 was 47 million kilometers (29 million miles) from the planet when this image was taken through a blue filter on January 17, 1979.

The Voyager Spacecraft

Part 14 – Imaging

Until about 1960, photography of Jupiter was hit or miss – if some time was available at the telescope on a clear night, and if someone was inclined, they might take a picture of Jupiter. The next opportunity might not come for weeks.

But the visible disk of Jupiter is all "weather" – random photos of the planet amount to little more than taking an occasional picture of clouds somewhere on Earth and then trying to forecast the weather.

In the early 1960's, astronomers began a new routine – an observation program in which they took pictures of Jupiter every hour all night long, on every night that was good for viewing. In ten years, astronomers learned more about Jupiter than they had learned in all the preceding time.

Now, in the next eight months, NASA's two Voyagers will take tens of thousands of high-resolution photographs of the Jovian system, free of interference from the distortion caused by Earth's bubbling, boiling atmosphere.

More Than Pretty Pictures

The photos returned by Voyager thus far show a pretty tangerine-and-white-striped ball. But there's more than meets the eye, and the list of objectives is long. The Voyager imaging investigators will study:

Planetary Atmosphere

- Global circulation, including convection, vorticity and divergence
- Horizontal and vertical structure of the visible clouds and their relationship to the belted appearance and dynamical properties
- Vertical structure of high, optically thin scattering layers
- Anomalous features such as the Great Red Spot, south equatorial belt disturbances, plumes, hot spots, and white ovals
- Cloud coloration

Satellites

- Comparative geology of the Galilean satellites at less than 15-kilometer resolution
- Geologic structure of several satellites at high resolution (about 1 kilometer)
- Chromophores on Io
- Atmospheres
- Size and shape of the satellites by direct measurement
- Direction of the spin axes and period of rotation of the satellites; establish coordinate systems for the larger satellites

System

- Optical scattering properties of the planets and satellites at several wavelengths and phase angles
- Novel physical phenomena such as the "flux tube," meteors ("fireballs"), lightning, auroras, or satellite shadows.

(contd)

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Encounter Minus 31 Days

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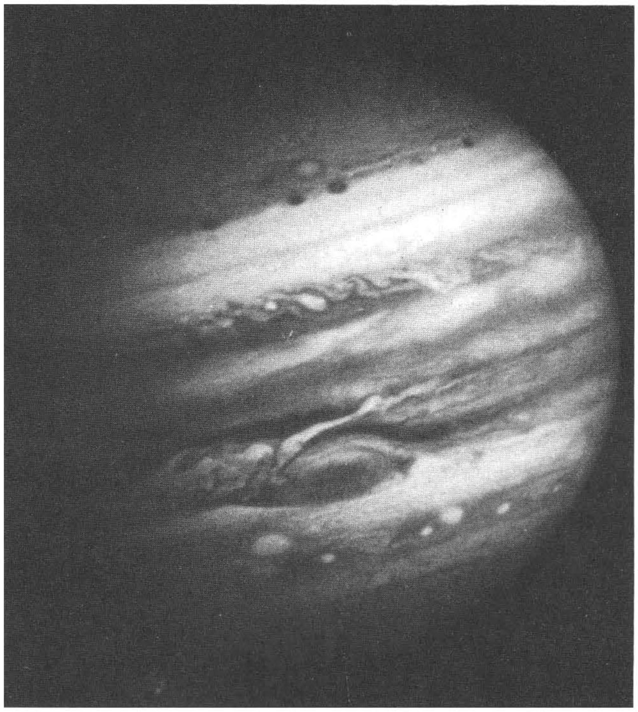

RED SPOT VORTICITY — The Great Red Spot shows prominently (below center), surrounded by a remarkable complex region of the giant planet's atmosphere. An elongated yellow cloud within the Great Red Spot is swirling around the spot's interior boundary in a counterclockwise direction with a period of a little less than six days, confirming the whirlpool-like circulation that astronomers have suspected from ground-based photographs. Ganymede, Jupiter's largest satellite, can be seen to the lower left of the planet. Ganymede is larger than Mercury. This black and white image was taken through a blue filter on January 24, 1979 while Voyager was 40 million kilometers (25 million miles) from Jupiter.

How Do They Do That?

Each spacecraft carries a 200-mm, f/3.5 wide-angle camera and a 1500-mm, f/8.5 narrow-angle (telephoto) camera that can be shuttered singly, alternately, or simultaneously at exposure times from 0.005 to 15.36 seconds, or even longer in special modes.

Each camera assembly includes an eight-position filter wheel, including clear (2), violet, blue, orange, green (2), and ultraviolet for the narrow-angle, and blue, clear, violet, sodium D, green, orange, and two wavelengths of methane for the wide-angle. The sensitivity of the filters ranges from 3450 (ultraviolet) to 6200 Angstroms (visible orange). Visible light encompasses the range from about 3800 to 6800 Angstroms.

Color reconstruction is done by combining images taken through different filters; for example, blue, green and orange. Certain features, such as the Great Red Spot, are more prominent and show more contrast in some filters (blue, for example), than in others (orange) due to the reflectivity.

The cameras are slow-scan vidicon designs that use a one-inch selenium-sulfur vidicon to convert the optical image into electrical signals. The subject is scanned one line at a time, and each fragment of light registered (called a picture element or "pixel") is converted into electrical signals for transmission to Earth. After acquisition by the Deep Space Network, the signals are processed, manipulated by a computer system to adjust for the planet's rotation between shuttering, and reconstructed with a laser system on standard photographic film.

The frame area is 800 scan lines by 800 pixels, or 640,000 pixels. Depending on the spacecraft data rate, the readout time for each frame is 48 seconds (at 115.2 kilobits) to 480 seconds (at 21.6 kilobits). The frames may be edited to a slower data rate if necessary (for example, if high winds or rain precluded use of a 64-meter antenna to receive the 115.2 kbps data). The pictures are read out and appear on the monitors one line at a time.

Twenty days before closest approach, about mid-February, the disk of Jupiter will exceed the 0.4-degree field of view of the narrow-angle camera, and the 3.2-degree field of view of the wide-angle camera will be required to continue full-disk imaging.

Mosaics of the Jovian system will be sequenced, mapping the planet, the satellites, and features of interest such as the Great Red Spot, white ovals, and hot spots.

The surface resolution criterion for maps of the satellites is the same as for the Earth-orbiting satellite Landsat (1:5,000,000 is the largest acceptable scale). Reference maps at a scale of at least 1:25,000,000 will be produced for Io, Europa, Ganymede, and Callisto, with high resolution maps of Io and Ganymede at 1:1,000,000 scale. (In comparison, U.S. Geological Survey 15-minute topographical maps are at a scale of 1:62,500 and one inch equals nearly one mile.) The highest resolution near each encounter will be 1 kilometer or less.

Mounted on the scan platform, the imaging system weighs about 38.2 kilograms (84 pounds). The vidicons were produced by General Electrodynamics Corporation, Dallas, Texas, while Xerox Corporation, Electro-Optical Systems, Pasadena, California, assembled the imaging electronics.

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