

Voyager Bulletin



MISSION STATUS REPORT NO. 29 JANUARY 4, 1979

Mission Highlights

Voyager 1 Jupiter Observatory Phase Begins

Sixty days and sixty million kilometers from Jupiter, Voyager 1 begins its Jupiter observatory phase on January 4. The events of the next twenty-six days are designed to provide a time history of scientifically important phenomena on Jupiter.

Most of the observations in this phase are repetitive, to provide a data base for all ensuing data. Significant calibration sequences occur between January 4 and 6 to prepare for the Jovian encounter.

On January 6, the imaging cameras will begin to record a series of four, single narrow-angle images, each in a different color. Taken every two hours (every 72 degrees of Jupiter rotation), the series is part of a long duration study of large-scale atmospheric processes. These images will be examined to determine the most dynamic features on Jupiter and to allow retargeting to them during the near encounter period.

Daily "system scans" by the other optical instruments will provide a large-scale look at the entire Jovian system. The ultraviolet spectrometer (UVS) will raster the system eight times each day for two hours, looking for the distribution of ultraviolet emissions. The infrared interferometer spectrometer (IRIS) will collect about 100 infrared spectra of Jupiter in a 1½-hour period once a day, sampling different longitudes.

The photopolarimeter (PPS) scans will search for the edge of Io's sodium cloud, expected to extend as far as 60 Jupiter radii (R_J) (4.3 million kilometers or 2.7 million miles) from Jupiter, nearly 10 times farther than Io's orbital radius.

In addition, the system scans include a search for the bow shock, the intersection of the solar wind plasma and the planetary magnetosphere.

The planetary radio astronomy/plasma wave duo will search for Jupiter radio bursts and perturbations of the plasma once a day. All of the fields and particles instruments will begin an accelerated level of daily measurements to characterize the beginning of Jupiter's influence in the sea of solar wind particles that dominates most of the space in the solar system.

The daily accumulations of data will fill nearly eight tracks a day on the on-board digital tape recorder that consists of one 8-track magnetic tape about 328 meters

(1076 feet) long. The tape will be played back to Earth daily, taking approximately three hours each time.

Only the 64-meter (210-foot) antennas of the Deep Space Network have the capability to receive the daily playbacks. Seven and one-half hours of daily coverage will be provided by the 64-meter antenna at Madrid, Spain, since this station will be in view of the spacecraft during prime shift working hours (at JPL) throughout the observatory phase. The DSN's 26- and 34-meter antennas will monitor the ship during the remaining 16.5 hours each day.

Astronomy Notes

On January 4, Earth reaches perihelion, its closest approach to the Sun during the year. On this day, Earth will be 147 million kilometers (91 million miles) from the Sun.

Jupiter reaches opposition on January 24, when it will be directly opposite the Sun from the Earth. Throughout January, Jupiter will be exceptionally bright and visible all night. Currently in the constellation Cancer, Jupiter will be north and east of the bright star Sirius this month.

The Voyager Spacecraft

(This is the eleventh in a planned series of brief explanatory notes on the spacecraft and its subsystems.)

Part 11 – Photopolarimeter Experiment (PPS)

By studying sunlight scattered by the atmospheres and surfaces of the planets and satellites, Voyager's photopolarimeter experiment will unveil many secrets of the outer planets.

Eight wavelengths in the ultraviolet and visible regions of the spectrum (from 2350 to 7500 Angstroms) will be measured in intensity (brightness) to determine the physical properties of the atmospheres of Jupiter and Saturn (perhaps seeing evidence of lightning and auroral activity), the rings of Saturn, the satellite surfaces, and the sodium cloud around Io.

Scientific Objectives

The photopolarimeter will examine both the large- and micro-scale structure and properties of the clouds of Jupiter, Saturn, and the Saturnian satellite Titan. It will

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Recorded Mission Status (213) 354-7237
Status Bulletin Editor (213) 354-4438

probe the vertical distribution of cloud particles, as well as the particle size and shape, and provide inferences on atmospheric composition.

Similar studies will define the structures of major planetary features such as Jupiter's Great Red Spot, zones, and belts. The photopolarimeter will search for evidence of crystalline particles in these features, and will gather data on the effects of scattering and absorption of sunlight by these particles, and the resulting effect on thermal balance. From these data, additional model calculations will be made, providing insight into domains impenetrable by Voyager's complement of remote sensing instruments.

The atmospheres will be compared to two already well-known samples — the thick, hazy, warm atmosphere of Venus, and the more familiar atmosphere of Earth.

At the satellites of the outer planets, the photopolarimeter will probe the density of the atmospheres (where they exist), the texture and possible compositional variations (on a large scale) of the surfaces, the bulk reflectivity, and the sodium vapor cloud around Jupiter's Io.

The spectral reflectivity of a body can aid in determining its surface composition, be it bare rock, dust, frost deposits, ice, or meteor remains.

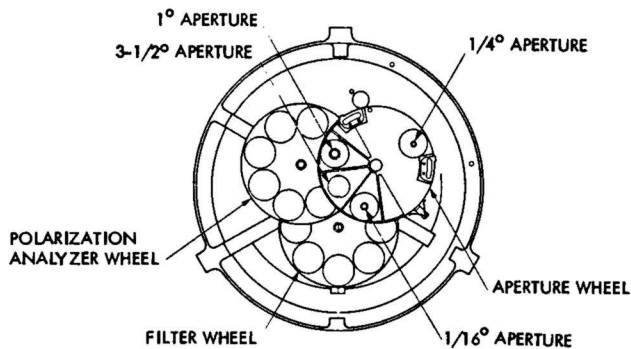
Io's Encircling Cloud

The first suggestion that gases escaping from the satellite atmospheres might be unable to escape from the planetary gravity fields and would thus form doughnut-shaped rings (toruses) around the planet, was made in 1973. Since then, it has been confirmed that such a toroid does indeed exist in the vicinity of Jupiter's satellite Io, and that it is composed primarily of sodium and atomic hydrogen. It extends from about three times the radius of Jupiter ($3 R_J$) to beyond 10 times the radius ($10 R_J$). Io, and perhaps Amalthea and Europa, orbit within this cloud, and Voyager will search for it during the far encounter phase as it sails closer to the giant planet.

Io seems to be covered by evaporite salts, including atomic hydrogen, sodium, potassium, and sulfur, and possibly atomic magnesium, calcium, and silicon. These are sputtered off from Io's salt-covered surface into its atmosphere by charged atomic particles (ions) which are trapped in Jupiter's strong magnetic field.

Ring Puzzles

Finally, the photopolarimeter will probe the rings of Saturn, including the size and shape, and allow inferences on the probable composition of the ring particles, their density, and radial distribution. The dynamics of the rings



will also be probed: Why are there several distinct rings, which do not appear to merge? Is there an atmosphere between the rings? What are the lifetimes of particles in the rings? How does the gravitational field of Saturn hold these rings in orbit?

Instrumentation

Mounted on the scan platform, Voyager's photopolarimeter is a combination photometer/polarimeter with filters. Light is gathered through a 6-inch-diameter Cassegrain telescope and passed through an aperture, a polarization analyzer, a filter, and a depolarizer before being converted into electrical pulses which indicate the number of photons (a measurable unit of light) in a particular energy band (color or wavelength), and polarization.

The apertures, analyzers, and filters are all mounted on separate wheels which turn independently of each other and so provide a great number of combinations. Normal operation during Encounter would consist of stepping through a programmed sequence of 40 filter/analyzer wheel combinations every 24 seconds.

There are four apertures providing 1/16, 1/4, 1, and 3-1/2-degree diameter circular fields of view. Eight positions on the analyzer wheel provide open, dark, a calibration source, and five Polacoat analyzers with their transmitting axes located at 0, 60, 120, 45, and 135 degrees rotation. Eight filters measure wavelengths from 2350 through 7500 Angstroms, each corresponding to the spectral features of specific elements or compounds (for example, sodium D, hydrogen, helium, calcium, magnesium, silicon, and potassium atoms, ozone, and hydroxyl radicals). Some filters measure scattering and methane absorption.

Instrument Status

Voyager 1's analyzer wheel has been sticking periodically throughout cruise, and efforts to regain completely normal operation have been stymied. Laboratory tests on the flight spare instrument indicate that a similar problem may occur with the filter wheel. During Jupiter Encounter, therefore, the analyzer wheel will be in the clear position only and the filter wheel will be allowed to step for only 50 hours during the near encounter period. The polarization data will be lost.

Investigators

Sharing the role of principal investigator are C. F. Lillie (cruise) and C. W. Hord (Encounter), both of the University of Colorado. Co-investigators are D. L. Coffeen and J. E. Hanson (Goddard Institute for Space Studies, New York), and K. Pang (Science Applications, Inc.).

