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The Voyager Mission Through the Jupiter Encounters

E. C. STONE

Voyager Project Scientist, California Institute of Technology, Pasadena, California 91125

The Voyager mission is a major element in NASA's program of exploration of the outer solar system. Objectives of the Voyager mission include comparative studies of the Jovian and Saturnian planetary systems and exploratory studies of the interplanetary medium at increasing distances from the sun. With the successful Saturn encounter in November 1980, the objectives of the mission have been extended to include an exploration of Uranus and interplanetary studies to beyond 20 astronomical units.

The papers in this special issue represent the first comprehensive report of the detailed analysis of data from the initial phase of the mission, extending from launch through the Jupiter encounters. Voyager 1 was launched on September 5, 1977, and arrived at Jupiter on March 5, 1979, while Voyager 2 was launched on August 20, 1977, and arrived at Jupiter on July 9, 1979.

The two trajectories were chosen to provide complementary measurements at Jupiter within the constraints imposed by objectives at Saturn and the desire for maintaining the option for Voyager 2 to continue on to Uranus. The Voyager 1 trajectory provided reasonably close encounters with Ganymede and Callisto following closest approach to Jupiter and provided a close south polar passage at Io with an attempt to penetrate the Io flux tube, while the Voyager 2 trajectory provided a close approach to Europa and close approaches to Ganymede and Callisto prior to Jupiter closest approach. In addition, the outbound Voyager 2 trajectory allowed the deepest penetration to date of the Jovian magnetotail and both trajectories allowed earth and sun occultations for the radio and ultraviolet studies of the Jovian atmosphere. Closest approach distances to Jupiter and some of the satellites are indicated in Table 1.

Scientific studies during this initial phase included both interplanetary studies and studies of the Jovian system, which can be organized into the general areas of the atmosphere, the ring, the satellites, and the magnetosphere. The magnetosphere provides a significant coupling between these areas such that, for example, all of the scientific investigations have contributed to the study of the Io plasma torus and its effects. The scientific investigations on the two Voyager spacecraft are indicated in Table 2. A detailed description of the eleven scientific investigations, as well as of the spacecraft, the mission design, and the trajectory selection appeared in *Space Science Reviews* (*21*, 75–376, 1977).

The initial reports of the Voyager 1 encounter results were published in *Science* (*204*, 945–1006, 1979) and in *Nature* (*280*, 725–806, 1979), followed by the initial Voyager 2 reports in *Science* (*206*, 925–995, 1979). Further analyses appeared in *Geophysical Research Letters* (*7*, 1–68, 1980). The papers in this issue reflect the status of the detailed analysis as of November 1980, at which time the principal Voyager focus shifted to Saturn. These papers have, however, far from exhausted the rich veins of new information contained in the Voyager data.

The composition of the Voyager scientific teams for the first phase of the mission is as follows:

Cosmic rays. R. E. Vogt, J. R. Jokipii, F. M. McDonald, A. W. Schardt, E. C. Stone, J. H. Trainor, and W. R. Webber.

Imaging science. B. A. Smith, R. F. Beebe, J. M. Boyce, G. A. Briggs, M. H. Carr, S. A. Collins, A. F. Cook II, G E. Danielson, M. E. Davies, G. E. Hunt, A. P. Ingersoll, T. V. Johnson, H. Masursky, J. F. McCauley, J. L. Mitchell, D. Morrison, T. Owen, C. Sagan, E. M. Shoemaker, L. A. Soderblom, R. G. Strom, V. E. Suomi, and J. Veverka.

Infrared radiometry and spectroscopy. R. A. Hanel, B. J. Conrath, F. M. Flasar, D. Gautier, P. Gierasch, S. Kumar, V. G. Kunde, W. C. Maguire, J. C. Pearl, J. A. Pirraglia, C. Ponnamperuma, and R. E. Samuelson.

Low-energy charged particles. S. M. Krimigis, T, P. Armstrong, W. I. Axford, C. O Bostrom, C. Y. Fan, G. Gloeckler, E. P. Keath, and L. J. Lanzerotti.

Magnetic fields. N. F. Ness, M, H. Acuna, K. W. Behannon, L. F. Burlaga, R. P. Lepping, and F. M. Neubauer.

Photopolarimetry. C. F. Lillie, C. W. Hord, D. L. Coffeen, J. E. Hansen, K. Pang, M. Sato, and R. A. West.

Planetary radio astronomy. J. W. Warwick, J. K. Alexander, A. Boischot, W. E. Brown, Jr., T. D. Carr, S. Gulkis, F. T. Haddock, C. C. Harvey, M. L. Kaiser, Y. Leblanc, J. B. Pearce, R. G. Peltzer, R. Phillips, A. C. Riddle, and D. H. Staelin

Plasma ions and electrons. H. S. Bridge, J. W. Belcher, L. F. Burlaga, C. K. Goertz, R. E. Hartle, A. J. Hundhausen, A. J. Lazarus, K. W. Ogilvie, S. Olbert, J. C. Scudder, G. L. Siscoe, J. D. Sullivan, and V. M. Vasyliunas.

Plasma waves. F. L. Scarf, D. A. Gurnett, and W S. Kurth

Radio science. V. R. Eshleman, J. D. Anderson, T. A. Croft, G. S. Levy, G. F. Lindal, G. L. Tyler, and G. E. Wood.

Ultraviolet spectroscopy. A. L. Broadfoot, S. K. Atreya, M. J. S. Belton, J. L. Bertaux, J. E. Blamont, A. Dalgarno, T. M. Donahue, R. Goody, J. C. McConnell, M. B. McElroy, H. W Moos, B. R. Sandel, D. E. Shemansky, and D. F Strobel.

TABLE 1. Selected Voyager Encounter Parameters

Body	Mean Distance From Jupiter, 10^3 km	Closest Approach Distance, km	
		Voyager 1	Voyager 2
Jupiter		348,890	721,670
Amalthea (J5)	181.3	420,200	558,370
Io (J1)	421.6	20,570	1,129,900
Europa (J2)	670.9	733,760	205,720
Ganymede (J3)	1070.0	114,710	62,130
Callisto (J4)	1880.0	126,400	214,930

Distances are to the center of mass, not to the body surface.

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Voyager 1 took this photo of Jupiter and two of its satellites (Io, left, and Europa) on February 13, 1979. Io is about 350,000 km (220,000 miles) above Jupiter's Great Red Spot: Europa is about 600,000 km (375,000 miles) above Jupiter's clouds. Although both satellites have about the same brightness, Io's color is very different from Europa's. Io's equatorial region shows two types of material—dark orange, broken by several bright spots—producing a mottled appearance. The poles are darker and reddish. Preliminary evidence suggests color variations within and between the polar regions. Io's surface composition is unknown, but scientists believe it may be a mixture of salts and sulfur. Europa is less strongly colored, although still relatively dark at short wavelengths. Markings on Europa are less evident than on the other satellites, although this picture shows darker regions toward the trailing half of the visible disk. Jupiter is about 20 million km (12.4 million miles) from the spacecraft. At this resolution (about 400 km or 250 miles) there is evidence of circular motion in Jupiter's atmosphere. While the dominant large-scale motions are west-to-east, small-scale movement includes eddy-like circulation within and between the bands. This photo was assembled from three black and white negatives by the Image Processing Lab at Jet Propulsion Laboratory. JPL manages and controls the Voyager project for NASA's Office of Space Science.

TABLE 2. Voyager Scientific Investigations

Investigation	Abbreviation	Principal Investigator/Team Leader	Institution
Imaging science	ISS	B. A. Smith	University of Arizona
Infrared spectroscopy	IRIS	R. A. Hanel	Goddard Space Flight Center
Photopolarimetry	PPS	C. F. Lillie/C. W. Hord	University of Colorado
Radio science	RSS	V. R. Eshleman	Stanford University
Ultraviolet spectroscopy	UVS	A. L. Broadfoot	University of Southern California
Magnetic fields	MAG	N. F. Ness	Goddard Space Flight Center
Plasma ions and electrons	PLS	H. S. Bridge	Massachusetts Institute of Technology
Plasma waves	PWS	F. L. Scarf	TRW Defense and Space Systems
Planetary radio astronomy	PRA	J. W. Warwick	Radiophysics, Inc.
Low-energy charged particles	LECP	S. M. Krimigis	Johns Hopkins University/Applied Physics Laboratory
Cosmic rays	CRS	R. E. Vogt	California Institute of Technology

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