Mr. French

Voyager 2

P81-10098

Encounter with Saturn

Press Kit

NASA

National Aeronautics and
Space Administration

Page intentionally left blank

RELEASE NO: 81-97

CONTENTS

For Release:

Charles Redmond
Headquarters, Washington, D.C.   10:30 a.m. EDT
(Phone: 202/755-3680)   August 13, 1981

Don Bane
NASA Jet Propulsion Laboratory, Pasadena, Calif.
(Phone: 213/354-5011)

RELEASE NO: 81-97

VOYAGER 2 TO MAKE CLOSEST ENCOUNTER WITH SATURN IN AUGUST

NASA's Voyager 2 will reach Saturn Aug. 25, 1981, with closest approach occurring at 8:25 p.m. PDT, as it passes 101,000 kilometers (63,000 miles) above the planet's cloud tops.

Voyager 1 flew past Saturn Nov. 12, 1980, and is moving out of the ecliptic plane of the solar system, searching for the heliopause, the limit of the solar wind. Barring any serious spacecraft subsystem failure, Voyager 1 could continue to return scientific data into the next century.

Voyager 2, launched Aug. 20, 1977 from Cape Canaveral, Fla., will travel another 2.84 billion km (1.76 billion mi.) to a Uranus encounter in January 1986, then on to a rendezvous with Neptune in August 1989.

July 29, 1981

NEPTUNE
24 AUG 89

URANUS
24 JAN 86

VOYAGER 2

VOYAGER 1

PLUTO
8/89

SATURN
25 AUG 81

20 AUG 77

5 SEPT 77

SATURN
12 NOV 80

JUPITER
9 JUL 79

JUPITER
5 MAR 79
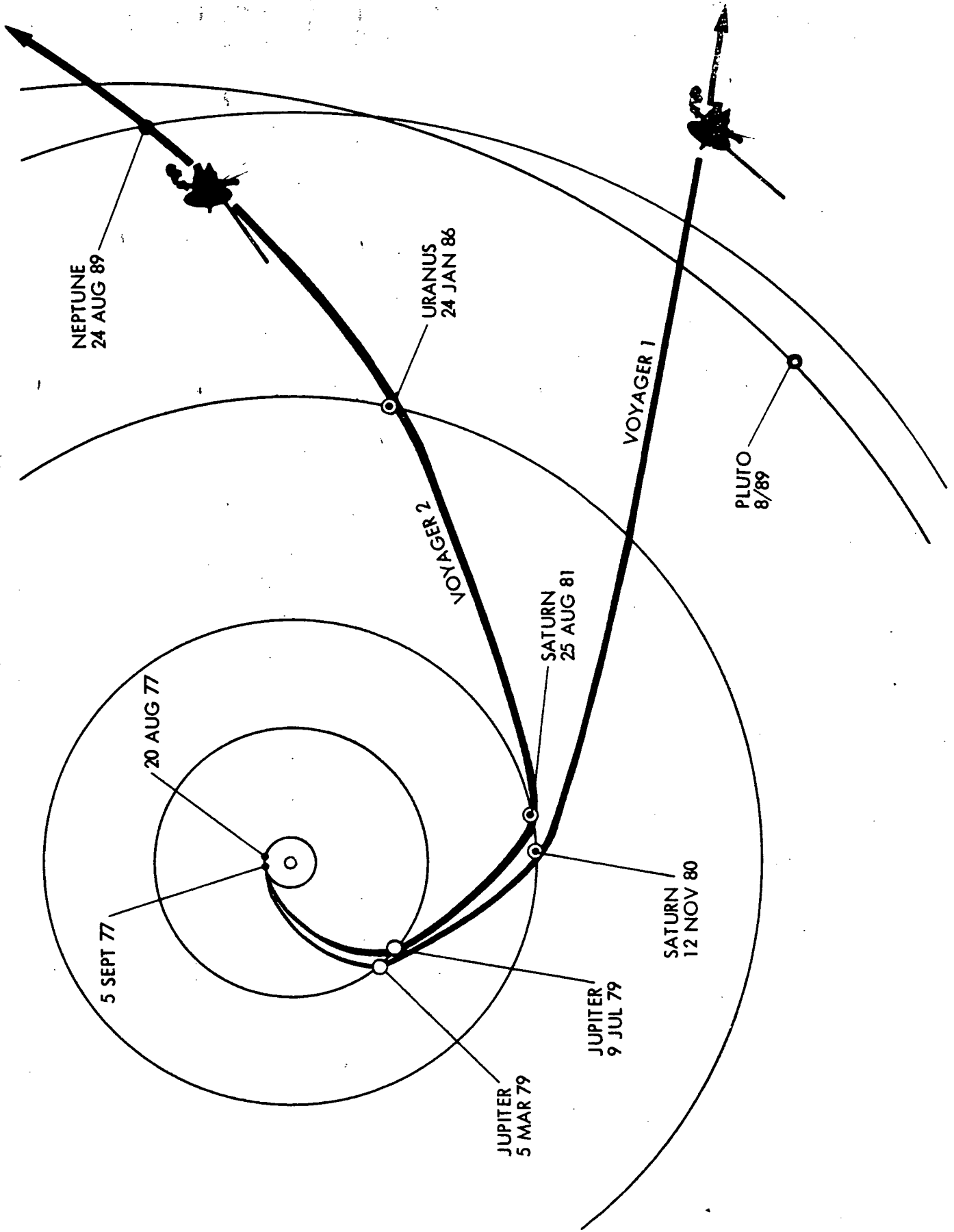
Before Voyager 1's Saturn encounter, project officials planned that Voyager 2's studies of Saturn, developed over two years, would be revised based on scientific data returned by the first spacecraft. So many unexpected and unexplained phenomena were observed by Voyager 1 in the Saturnian system that Voyager 2 was extensively reprogrammed in flight to tailor its encounter to further explore the results from the first Voyager.

Saturn's rings, for example, unparalleled in the solar system, were found by Voyager 1 to be even more complex in their structure and dynamics than previously believed. Voyager 2 will pinpoint areas of the ring system to be extensively studied. Conversely, science objectives for Voyager 1's study of the large satellite Titan were achieved, so time that might have been devoted to further photographic coverage of Titan by Voyager 2 will instead be used on new images of the rings, planet and other satellites. Additional remote sensing of Titan, however, is planned.

More than 18,500 photos of Saturn, its rings and satellites will be taken by Voyager 2. When the post-encounter period ends Sept. 28, 1981, both Voyagers will have returned more than 70,000 photographs of Jupiter, Saturn, their rings and satellites.

During Voyager 2's flight over Saturn's ring plane on Aug. 25, the spacecraft's photopolarimeter (located on the movable scan platform) will be aimed at the star Delta Scorpii, on the opposite side of the rings and more than 989 light years away.

Measuring the star's light as it flashes through the ring material could provide the best data so far on the number of ringlets, their densities and widths, and the widths of the gaps between them. The experiment will occur from 4:42 p.m. to 7 p.m. PDT and cover 70,000 km (43,000 mi.) of the rings from the limb of the planet to the F-ring.

The second occultation of the star by the rings will occur about nine hours after Voyager 2 has passed Saturn. As the spacecraft looks back at the planet, the star Beta Taurii, 180 light years away will be tracked by the photopolarimeter for about 40 minutes, as the star flashes through the F- and outer A-rings. The photopolarimeter will resolve ring material as small as 100 m (328 ft.).

A different radio occultation of Saturn is expected from Voyager 2 than Voyager 1. Voyager 2's radio signals will not penetrate to deeper cloud layers, but the spacecraft will fly across a more constant latitude (from about 20 degrees north to 20 degrees south), providing a more even sampling of the planet's atmosphere.

Voyager 2 will closely study the spokelike features of the B-ring discovered by Voyager 1. The spokes emerge from the planet's shadow and seem to dissipate after a few hours. They may be the product of fine ring material suspended above the ring plane, possibly a result of electrostatic charges. The spacecraft's cameras will photograph the spokes as they move about the planet.
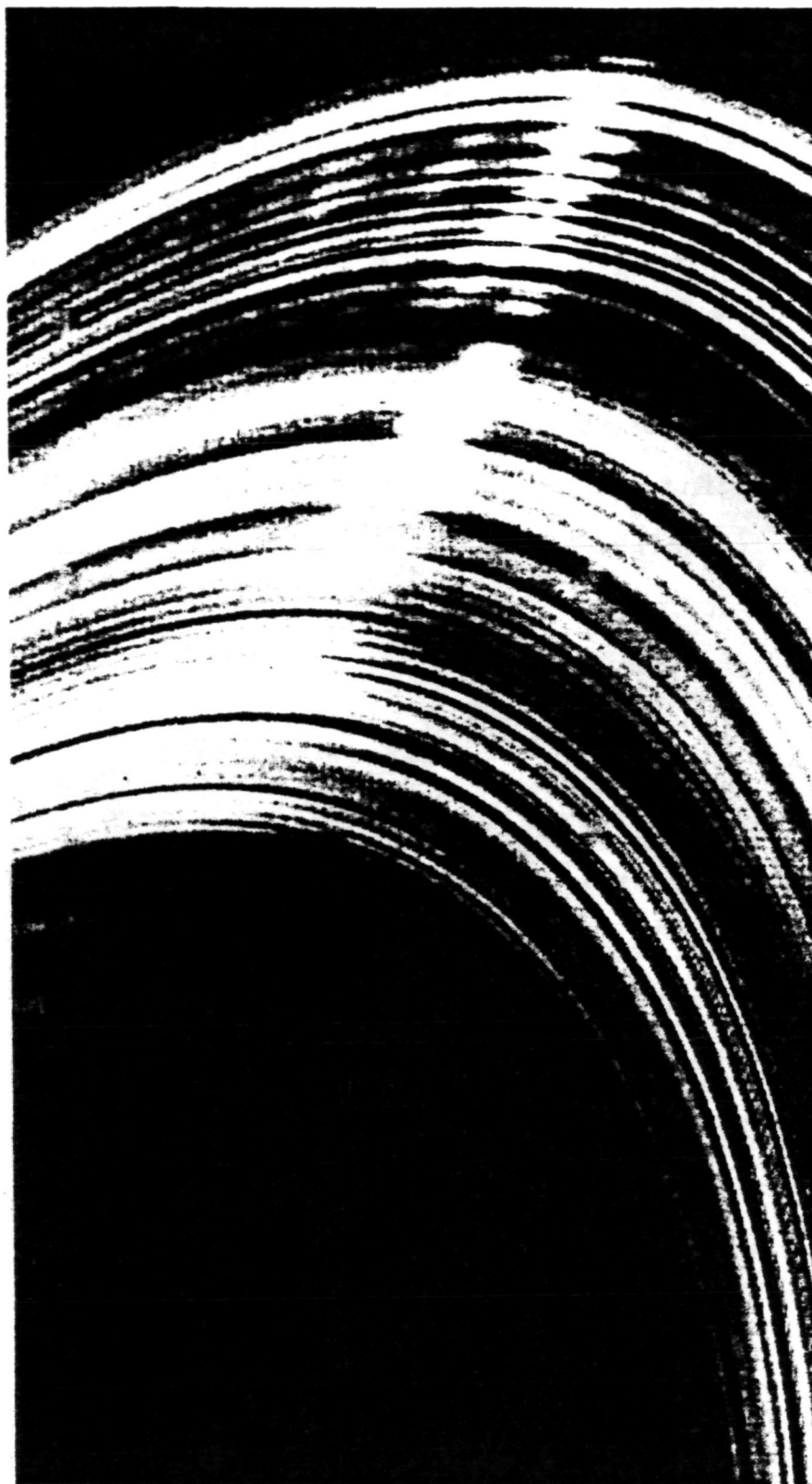
Spokelike features in Saturn's rings are bright areas in this image
taken by Voyager 1 on Nov. 13, 1980. In this view, concentric structure
in the B-ring increases contrast and accentuates hundreds of ringlets.

-more-

As the spacecraft moves through the ring plane, the cameras will photograph the rings edge-on, searching for signs of possible clouds of small particles elevated above the rings. The planetary radio astronomy experiment will search for electrical emissions originating near the spokes.

The apparent twisted and clumped appearance of two of the three visible strands of the F-ring will be the subject for pseudo-stereo imaging, in which photographs taken from different angles will be combined for a three-dimensional view of the ring. Sequences of images should reveal whether the structure of the F-ring changes with time.

As Saturn was the final planetary encounter for Voyager 1, its trajectory was designed to maximize the science return from the encounters with little regard to where the spacecraft would travel after Saturn. For Voyager 2, the aim point at Saturn was defined solely by the requirement to continue the trajectory to Uranus. The arrival time at Saturn, however, was selected to allow closer approaches to several moons viewed more remotely from Voyager 1.

Voyager 2 crosses the potentially hazardous ring plane only on its outbound leg (Voyager 1 crossed the ring plane at different distances both inbound and outbound) at about 111,800 km (69,500 mi.) from the cloud tops, just 1,200 km (745 mi) outside the orbit of the G-ring which is only approximately located by a single Voyager 1 photograph. (Voyager engineers expect the spacecraft to clear the G-ring by 1,200 km or 745 mi.)
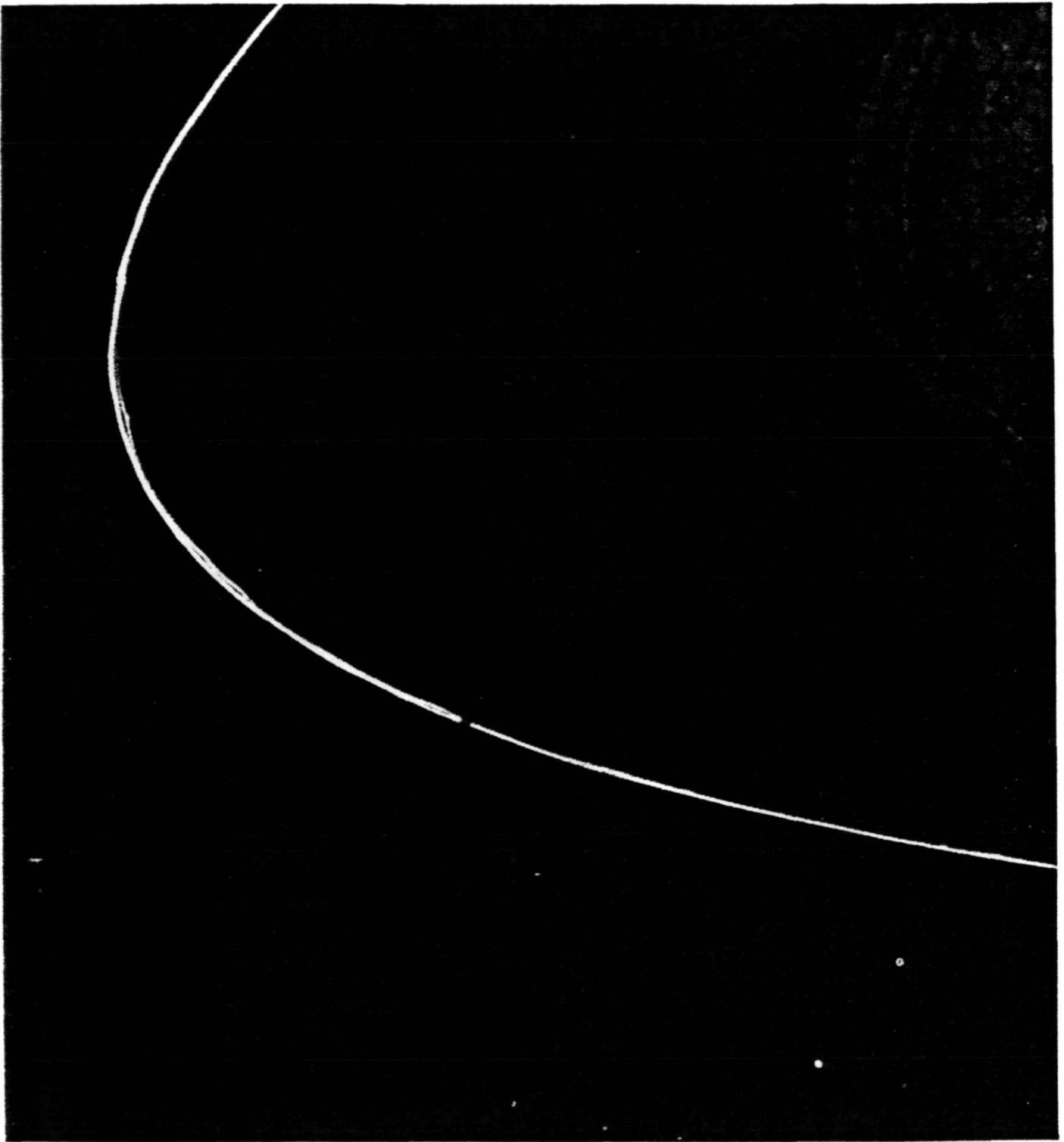
Visible in this image, taken by Voyager 1 on Nov. 12, 1980, is the braided and clumpy appearance of Saturn's F-ring, due possibly to the gravitational effects of the two nearby satellites.

The ring plane crossing occurs while the spacecraft is blocked from Earth view, so reacquisition of communications after occultation will signal the safe crossing through the plane.

Voyager 2 will pass 23,000 km (14,300 mi.) closer to Saturn than did Voyager 1. In addition, the spacecraft will make closer approaches to the satellites Enceladus, Tethys, Hyperion, Iapetus and Phoebe.

Both Voyagers used Jupiter's gravity to change their flight paths in order to fly on to Saturn. More significantly, spacecraft velocity was increased by approximately 56,300 km per hour (35,000 miles per hour). A similar gravity-assist swingby of Saturn is required for Voyager 2 to fly to Uranus. In turn, the Uranus gravity boost will direct the spacecraft toward Neptune.

The velocity increases shorten flight times, making it possible to send spacecraft beyond Jupiter within reasonable time frames. For example, a direct flight to Saturn could take eight years. Gravity assist makes the trip possible in half that time.

Saturn is the sixth planet from the Sun and the second largest in the solar system. Like Jupiter, it is a giant sphere of gas -- mostly hydrogen and helium with a small core of molten rocky material. But unlike Jupiter, Saturn's dark belts and light zones are muted by a thick haze layer above the planet's visible cloud tops.

Saturn generates almost two-and-a-half times the amount of heat it receives from the Sun, a phenomenon which is probably due to gravitational separation of helium (which accounts for about 11 percent of the upper atmosphere) and hydrogen.

Winds as high as 1,800 km (1,100 mi.) an hour blow eastward at Saturn's equator. The velocity decreases to near zero at about 35 degrees latitude north and south.

The planet takes 29.46 years to complete one orbit around the Sun, which is approximately 1.42 billion km (886 million mi.) away. A day on Saturn lasts 10 hours, 39 minutes, 26 seconds (as determined by Voyager 1 last year).

Until four years ago, Saturn was believed to be the only planet encircled by rings. But both Jupiter and Uranus were discovered to have thin, barely visible rings. (The Jovian ring was discovered by Voyager 1.) Saturn's rings, however, are much richer in material, mostly chunks of ice and rock ranging in size from dust grains to huge boulders many tens of meters in diameter.

Before Voyager 1's arrival at Saturn last year and the discovery of several hundred "ringlets," the rings were thought to consist of perhaps six individual rings; from the planet outward, they are the D-, C-, B-, A-, F- and E-rings. The dusty G-ring, which was first photographed by Voyager 1, is the innermost ring orbiting about 109,000 km (68,000 mi.) above Saturn's cloud tops.

The Cassini and Encke Divisions visible in Earth-based telescopes were thought to be empty of material, but Pioneer 11 detected material within the gaps, which Voyager 1 discovered to be ringlets. Voyager 2 will study the detailed ringlets within the Cassini Division to see if their structure has changed in the nine months since Voyager 1's visit.

Saturn is now known to have at least 17 satellites. Three were discovered by Voyager 1, and two were discovered in ground-based observations since Voyager 1's encounter.

The innermost satellite, discovered by Voyager 1, is temporarily designated 1980S28, (i.e., the 28th observation of a Saturnian satellite in 1980), and is about 40 by 20 km (25 by 12 mi.) in diameter. It orbits within 76,970 km (47,800 mi.) of the cloud tops just outside the A-ring.

The next two satellites, also discovered by Voyager 1, are 1980S27 and 1980S26. These serve as shepherding moons, maintaining the edges of the braided F-ring. They are both approximately 200 km (124 mi.) in diameter and orbit 79,070 km (49,130 mi.) and 81,370 km (50,560 mi.), respectively, from Saturn's cloud tops.

Two small moons, 1980S3 and 1980S1 share an orbit about 91,120 km (56,600 mi.) from the cloud tops. 1980S3 is 90 by 40 km (55 by 25 mi.) in diameter; 1980S1 is 100 by 90 km (60 by 55 mi.).

A satellite sharing the orbit of Dione is 1980S6, about 160 km (100 mi.) in diameter. It orbits about 60 degrees ahead of Dione at a distance of 318,270 km (197,760 mi.) above the cloud tops.

The two satellites discovered in ground-based observations occupy Tethys' orbit; 1980S25 orbits about 60 degrees behind Tethys, while 1980S13 orbits about 60 degrees ahead. They appear to be about 30 to 40 km (20 to 25 mi.) in diameter.

Nine satellites whose existences have been known for some time are (from the planet outward) Mimas, Enceladus, Tethys, Dione, Rhea, Titan, Hyperion, Iapetus and Phoebe.

Each Voyager uses 10 instruments and the spacecraft's radio system to study the planets, their satellites, rings, the magnetic and radiation regions surrounding the planets, and the interplanetary medium.

Each Voyager carries telescope-equipped television cameras, a cosmic ray detector, an infrared interferometer spectrometer, a low-energy charged-particle detector, magnetometers, a photopolarimeter, a planetary radio astronomy receiver, a plasma detector, plasma-wave instrument and ultraviolet spectrometer. Each spacecraft is comprised of 65,000 individual parts.

Voyager 2 was launched Aug. 20, 1977, from Cape Canaveral, Fla., aboard a Titan-Centaur rocket combination. Two weeks later, on Sept. 5, Voyager 1 was launched on a faster, shorter trajectory and sped past its twin before the end of the year.

By the time Voyager 2 reaches Saturn, it will have traveled more than 2 billion km (1.24 billion mi.) and will have consumed about 15,000 kilowatt hours of power supplied by an array of three radioisotope thermoelectric generators.

The Voyager 2 Uranus and Neptune encounters are dependent upon the condition of the spacecraft subsystems.

Voyager 2's primary radio receiver, with which the space-craft receives commands and data to update its on-board computers from Earth, failed April 5, 1978; continuation of the Voyager mission depends upon the health of the remaining backup radio receiver on the spacecraft.

Should the backup receiver fail, a sequence of commands (backup mission load or BML) sufficient to operate the spacecraft for four years on the Uranus leg and through a minimal encounter science sequence will be stored in the spacecraft's computer command subsytem after completion of the Saturn encounter.

Both Voyagers will escape the solar system at velocities of nearly 59,550 km/hr (37,000 mph). The two spacecraft may reach the heliopause within 10 years. Even at these speeds, however, more than 40,000 years will pass before Voyager 1 flies within 1.6 light years of the star AC+793888 near the constellation Ursa Minor; in 358,000 years, Voyager 2 will pass within 0.8 light years of Sirius, now the brightest star in the heavens.

Both spacecraft were designed and built by the Jet Propulsion Laboratory, Pasadena, Calif., a NASA-owned facility operated for the space agency by the California Institute of Technology. The Jet Propulsion Laboratory manages the Voyager project for NASA.

NASA program manager is Frank A. Carr, and Dr. Milton A. Mitz is NASA program scientist. The Voyager project manager is Esker K. Davis, JPL, and Dr. Edward C. Stone, California Institute of Technology, Pasadena, is project scientist.

(END OF GENERAL RELEASE; BACKGROUND INFORMATION FOLLOWS.)

VOYAGER 2 SATURN MISSION PROFILE

Voyager 2 will make its closest approach to Saturn -- 101,000 kilometers (63,000 miles) above the planet's cloud tops -- at 8:25 p.m. PDT, Aug. 25, 1981.

More than 18,500 photos of Saturn, the rings and the satellites will be taken during the encounter period.

The spacecraft will take higher-resolution photographs of five satellites and the planet's rings than its predecessor, Voyager 1.

All event times listed in this summary are Pacific Daylight Time, at the time they occur at the spacecraft; one-way light time from the spacecraft to Earth at closest approach to Saturn will be 1 hour, 26 minutes, 35 seconds.

Voyager 2 began its Saturn encounter June 5, 1981. The Near-Encounter phase begins at 4:43 a.m. Aug. 25, and ends at 12:02 a.m., Aug. 27. The Saturn encounter will end Sept. 28.

One of Voyager 2's most important observations will be the occultation of the star Delta Scorpii by Saturn's rings. For 2 hours, 18 minutes on Aug. 25 -- from 4:42 p.m. to 7 p.m. -- the photopolarimeter will be aimed so that the star's light passes through Saturn's rings enroute to the instrument.

As the ring material makes the star appear to alternately blink on and off, the instrument is expected to count with high precision the number of ringlets, their widths, and the widths of the gaps between them. The star traverses the portion of the rings that is in Saturn's shadow, so scientists expect little interference from scattered sunlight.

The sequence is expected to give high radial resolution (about 300 meters or 1,000 feet) of the ring structure across the entire 70,000-km (43,500-mi.) radial extent of the rings. Mission controllers will use a special 7,200-bit-per-second data mode from the spacecraft that permits time resolution down to 1/100th second, compared with 6/10ths of a second in standard data modes. Photopolarimeter observations of the rings are also expected to define the light-scattering characteristics of the ring particles.
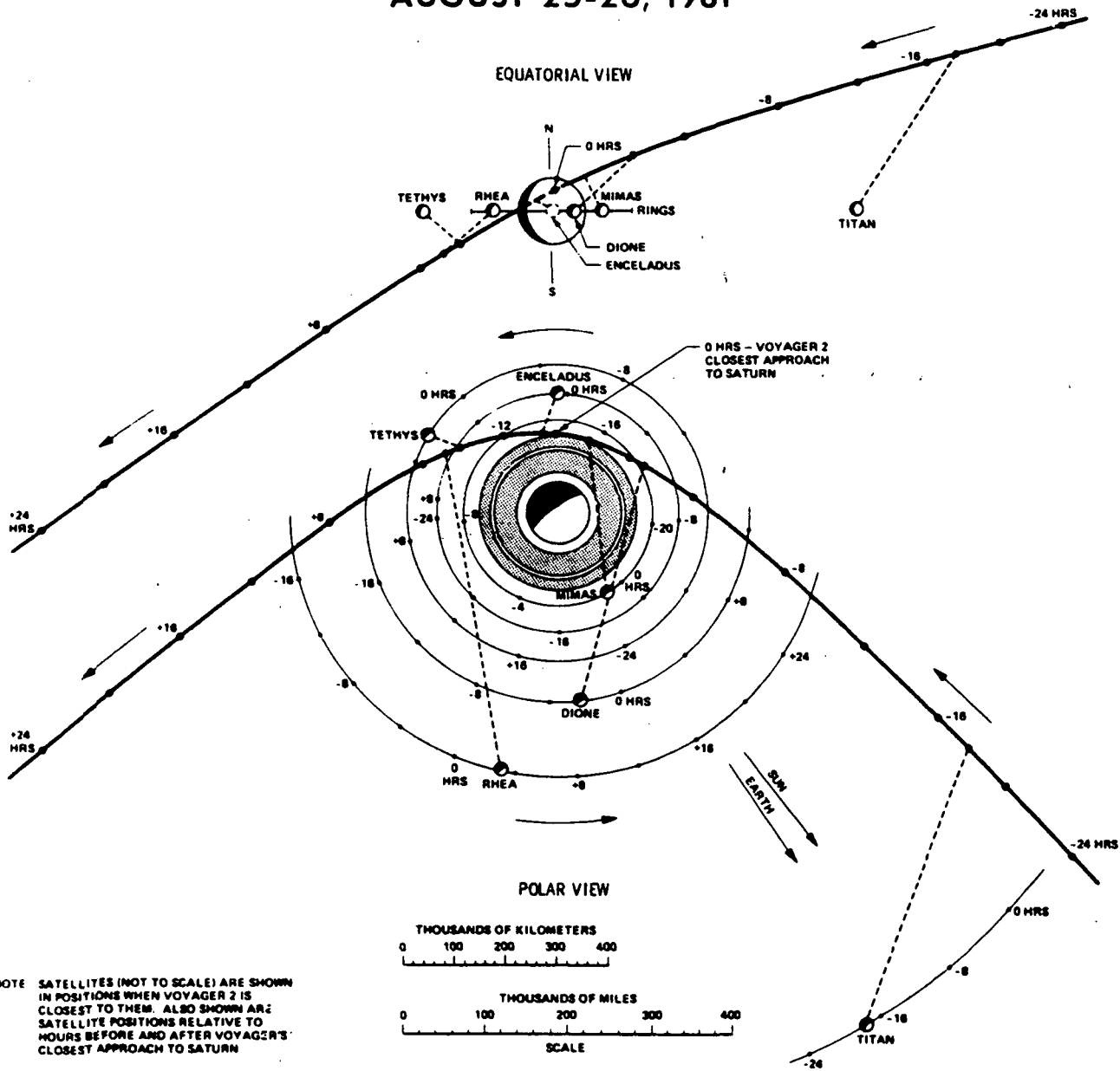
The spacecraft will make the following close approaches to these Saturnian satellites:

o Iapetus: 6:30 p.m., Aug. 22; 900,000 km (560,000 mi.);

o Hyperion: 6:27 p.m., Aug. 24; 480,000 km (300,000 mi.);

o Titan: 2:38 a.m., Aug. 25; 665,000 km (413,000 mi.);

o Dione: 6:05 p.m., Aug. 25; 502,000 km (312,000 mi.);

o Mimas: 7:34 p.m., Aug. 25; 310,000 km (193,000 mi.);

o Enceladus: 8:45 p.m., Aug. 25; 87,000 km (54,000 mi.);

o Tethys: 11:12 p.m., Aug. 25; 93,000 km (58,000 mi.);

o Rhea: 11:29 p.m., Aug. 25; 645,000 km (401,000 mi.); and

o Phoebe: 6:30 p.m., Sept. 4; 2,080,000 km (1,290,000 mi.). (Voyager 1 did not attempt to take pictures of Phoebe because of its great distance from the moon at closest approach.)

Voyager 2 will also take high-resolution photos of seven of Saturn's newly discovered satellites: 1980S26 and 1980S27, the pair that shepherds Saturn's F-ring; 1980S6, the satellite that occupies Dione's orbit; 1980S1 and 1980S3, the two moons that share an orbit occupies Dione's orbit; and 1980S25 and 1980S13, the two satellites discovered recently in Earth observations; they orbit Saturn about 60 degrees behind and ahead of Tethys.

Voyager 2 will approach Saturn from above the ring plane, with the Sun behind the spacecraft. Observations of the rings during approach will be entirely of their sunlit side, while outbound observations will be of the unlit side. The spacecraft crosses the ring plane only once -- in a downward direction -- before departing for Uranus.

TWO VIEWS OF VOYAGER 2
FLIGHT PATH PAST SATURN
AUGUST 25-26, 1981

EQUATORIAL VIEW

POLAR VIEW

NOTE SATELLITES (NOT TO SCALE) ARE SHOWN IN POSITIONS WHEN VOYAGER 2 IS CLOSEST TO THEM. ALSO SHOWN ARE SATELLITE POSITIONS RELATIVE TO HOURS BEFORE AND AFTER VOYAGER'S CLOSEST APPROACH TO SATURN

Crossing will occur about 54 minutes after closest approach, while the spacecraft is out of sight of Earth. Voyager 2's crossing will be 112,000 km (69,500 mi.) above the clouds. (The G-ring orbits about 109,000 km (68,000 mi.) above the clouds.) Pioneer 11 flew safely through the same general region in 1979, as a pathfinder for Voyager 2. The region is Voyager 2's "Uranus aim point," required to bend its flight path and place it on a trajectory to Uranus.

Voyager 2 will disappear behind Saturn (Earth occultation) at 9 p.m., Aug. 25, and will reappear at 10:35 p.m. (Note: This is spacecraft event time; for the time of signal arrival at Earth, add one hour, 27 minutes to all times.)

During Voyager 2's encounter, scientists will concentrate on selected targets rather than on a repeat of Voyager 1's sweeping look at the entire Saturnian system. Selections are based on knowledge gained from Voyager 1's encounter last fall and the flight path necessary to continue on to Uranus.

Photography of Titan, for example, has been largely replaced with additional high-resolution photography of the rings.

Voyager 2 is expected to get better-resolution IRIS (infrared interferometer spectrometer) maps of Saturn.

There should be additional information on Saturn's auroras (they are similar to Earth's northern lights).

Spatial and temporal studies of the braided F-ring, including pseudo-stereo photographs, are planned.

The photopolarimeter is expected to measure microstructure of the satellite surfaces and to observe aerosols and dust in Titan's and Saturn's atmosphere. (The photopolarimeter on Voyager 1 failed shortly after the spacecraft's Jupiter encounter and the instrument was not used at Saturn.)

There will be studies of Saturn's eccentric (non-circular) ringlets -- one in the C-ring and one in the Cassini Division -- to define their shapes and details of their motions. The questions scientists want to answer are these: Are they truly elliptical? If so, why? Measurements of the eccentric rings' ellipticity and their precession rate (how quickly the major axis of the ellipse rotates about the planet) should tell whether the satellite Mimas interacts with the ring material to produce the eccentricity, or if some other cause is responsible.

The planetary radio astronomy and plasma-wave instruments will obtain more high-resolution data within Saturn's magnetic field than Voyager 1 collected to characterize the rapidly varying emissions noted by Voyager 1.

There will be high-resolution photography of Enceladus, (about five times better than Voyager 1) in an attempt to determine why its surface looks so smooth and uncratered in Voyager 1 pictures. Some process may have warmed the satellite's surface -- in effect, erasing it clean of craters and other features within geologically recent times.

High-resolution photos (about 3 km or 2 mi.) will also be taken of Tethys. The satellite appears to be almost entirely water ice, according to Voyager 1 data, with only 10 to 20 percent denser material. Improved mass determination measurements of Tethys should be possible with Voyager 2 because it will approach the satellite so much more closely than Voyager 1 did.

Voyager 2 will photograph the opposite hemispheres of Hyperion and Iapetus from those photographed by Voyager 1, with resolution about four times better.

The infrared interferometer spectrometer (IRIS) will obtain higher spatial resolution data of Saturn's temperature structure at different latitudes than Voyager 1, by making its north-south map at closer range than sequences in Voyager 1's encounter.

Fields-and-particles experiments will measure deeper inside Saturn's magnetosphere than Voyager 1's instruments, because Voyager 2 will fly inside the orbits of Enceladus and Mimas, allowing observations in regions not penetrated by Voyager 1.

As Voyager 2 approaches Saturn, and perhaps after it leaves the planet, it may see signs of the presence of Jupiter. The plasma wave instrument saw evidence as early as January 1981 that Jupiter's magnetotail reaches almost to Saturn, and scientists have predicted that the tail, in fact, reaches even beyond Saturn. If that is true, Voyager 2 may be able to measure the effects on Saturn's magnetic field of the most distant portion of Jupiter's magnetic field.

The planetary radio astronomy instrument will obtain high-resolution data near the rings in an attempt to determine the origin of the electrical discharge signals recorded by Voyager 1.

About three and one-half days before closest approach to Saturn, Voyager 2's cameras will take a series of narrow-angle pictures of the B-ring. The cameras will concentrate on Saturn's B-ring and the radial, spoke-like features recorded by Voyager 1. One picture will be taken every 3.2 minutes for 13.5 hours covering about one and one-fourth full rotations of the B-ring.

At ring-plane crossing, the wide-angle camera will take a series of pictures of the B-ring in an attempt to observe material that may be elevated above the main ring structure, as current theories predict that the spoke material may be elevated above the rings.

During the encounter period, between Aug. 21 and Sept. 28, observers on Earth will be able to watch the two planets in the evening sky looking southward just after dusk as Jupiter overtakes and passes Saturn (as seen from Earth). Jupiter should cross in front of Saturn in mid-July.

VOYAGER 1 SATURN SCIENCE SUMMARY

Voyager 1's encounter with Saturn began Aug. 22, 1980, when the spacecraft was 109 million km (68 million mi.) from Saturn. Closest approach to Saturn took place at 3:46 p.m. PST, Nov. 12, when the spacecraft passed 126,000 km (78,000 mi.) from the cloud tops. The encounter ended Dec. 15, 1980. The spacecraft took more than 17,500 photographs of Saturn and its satellites.

Scientific results of the encounter are as follows:

Saturn

From the spacecraft, as from Earth, Saturn's atmosphere appears grossly similar to Jupiter's, with alternating dark belts and light zones, circulating storm regions and other discrete dark and light cloud markings. Unlike Jupiter, however, Saturn's markings are strongly muted by a thick haze layer above the visible cloud tops. (Jupiter has a similar haze layer, but it is not as optically thick as Saturn's.) Because Saturn is colder, the cloud layers are deeper in the atmosphere than at Jupiter and apperar blander.

Wind speeds in the atmosphere of Saturn are substantially higher than on Jupiter, and do not appear closely tied to the belt-zone boundaries. Highest winds (about 1,800 km/hr or 1,100 mph) blow eastward at the equator and are five times stronger than on Jupiter. The velocity decreases smoothly to near zero around 40 degrees latitude north and south.

The bulk of Saturn's atmosphere is composed of hydrogen. Helium accounts for only about 11 percent of the mass of the atmosphere above the clouds, compared to an abundance of about 19 percent at Jupiter. The difference is consistent with gravitational separation of helium and hydrogen in Saturn's interior and could generate the excess energy radiated by Saturn over that received from the Sun.

Voyager 1 found aurora-like emissions near the illuminated limbs of the planet, and auroras in ultraviolet light were found in a band near 80 degrees south latitude. Scientists faced a difficult problem in attempts to detect lightning on the dark side of Saturn, since the rings reflected too much light onto the night side. Lightning has not been detected in images of Saturn's dark face, but radio emissions typical of electric discharges have been observed, most likely originating in the rings.

Radio emissions, primarily from the north polar region and near 90 degrees longitude, indicated that the body of Saturn and its magnetosphere rotate with a period of 10 hours, 39 minutes and 26 seconds.

The Rings

Voyager 1 found that the classically observed A-, B- and C-rings consist of hundreds of small ringlets, two of which are elliptical in shape. Even the classical gaps were seen to contain ringlets; the Cassini Division appears to contain at least five, each of which shows finer detail. The F-ring, discovered by Pioneer 11 in 1979, is composed of three separate ringlets that appear to be intertwined. The inner and outer limits of the F-ring are controlled by two shepherd satellites, 1980S26 on the outside and 1980S27 on the inside. The intertwining or "braiding" phenomenon is unexplained -- although it may be related to electrostatic charging of the dust-size particles comprising the ring.

Near the outer edge of the A-ring orbits the newly discovered satellite 1980S28. All three of those satellites (1980S26, 1980S27 and 1980S28) were discovered by Voyager 1.

Voyager 1 also photographed the D- and E-rings, during passage through Saturn's shadow, and confirmed a new ring near 2.8 Saturn radii from the center of the planet. It was designated the G-ring. The existence of a satellite or a ring at that radius had been postulated on the basis of Pioneer 11 fields and particles data.

Measurements show that the E- and F-rings have large populations of particles smaller than about 2/10,000th of an inch in diameter. Radio measurements of the C-ring indicate that it has particles as large as about 2 m (6 ft.), although most of the particles are much smaller. Similarly, particle sizes for the A-ring and the Cassini Division are as large as 10 and 8 m (33 and 26 ft.), respectively.

On its inbound leg, Voyager 1 discovered a series of transient, spoke-like features that radiate outward across the B-ring; they first appear as the ring emerges from darkness and seem to dissipate within a few hours. In photos taken during the inbound portion of the flight, the spoke-like features appeared darker than the surrounding ring material.

After Voyager 1 passed Saturn, photographs of the spoke-like features showed they were brighter than surrounding material, revealing that the spokes forward-scatter sunlight, implying extremely small particles (large particles backscatter light). It is possible that the fine material is levitated above the rings.

New Satellites

Photographs of the new satellites were used to measure their sizes. The innermost satellite, temporarily designated 1980S28, is about 30 km (19 mi.) in diameter. The next satellite, 1980S27, which shepherds the inner edge of the F-ring, is about 220 km (136 mi.) in diameter. Next is 1980S26, outer shepherd of the F-ring, about 200 km (120 mi.) in diameter. 1980S3 and 1980S1, which share an orbit 91,120 km (56,600 mi.) from the clouds, are 90 by 40 km (55 by 25 mi.) and 100 by 90 km (60 by 55 mi.), respectively. (1980S6, the new satellite that occupies the same orbit as Dione (about 60 degrees ahead) is estimated from Earth-based observations to be about 160 km (100 mi.) in diameter.) Other satellites may be discovered as Voyager scientists sift through the mountains of data returned from the spacecraft's encounter -- or from photos to be returned by Voyager 2.

Other Satellites

Voyager 1 observed all Saturn's known satellites except Phoebe. Mimas, Enceladus, Tethys, Dione and Rhea are approximately spherical in shape and appear to be composed mostly of water ice. Tethys in particlar seems to be largely ice, while Dione has a density that indicates it is 40 percent rock. Their measured diameters, accurate to about 20 km (12 mi.), are: Mimas, 390 km (240 mi.); Enceladus, 500 km (310 mi.); Tethys, 1,050 km (650 mi.); Dione, 1,120 km (700 mi.); and Rhea, 1,530 km (950 mi.).

Mimas, Tethys, Dione and Rhea are all cratered; Enceladus appears smooth.

One very prominent crater on Mimas covers about one-third the diameter of the satellite.

Stretching for 750 km (465 mi.) across the surface of Tethys is a valley that is 60 km (40 mi.) wide. The valley appears to be a great fracture in the crust of the satellite.

Several sinuous valleys, some of which appear to branch, are visible on Dione's surface, as are smooth plains, suggestive of internal processes that renew portions of the surface.

Both Dione and Rhea have bright, wispy streaks that stand out against an already-bright surface. The streaks are probably the result of ice that has migrated from the interior.

Enceladus shows no evidence, at 12 km (7 mi.) resolution, of any impact craters. Because the maximum density of the E-ring occurs at the orbit of Enceladus, it has been speculated that the satellite is the source of particles for that ring. Enceladus was not a prime target for Voyager 1; Voyager 2 will fly closer and return higher-resolution pictures of the satellite.

Hyperion's and Iapetus' masses are poorly known, so their densities are uncertain. Iapetus is peculiar because it has one bright and one dark hemisphere. The dark side, which faces forward as Iapetus orbits Saturn, reflects only one-fifth as much light as the bright, trailing side. Hyperion, which also has a somewhat darker surface, has a diameter of about 290 km (180 mi.), and Iapetus has a diameter of about 1,440 km (890 mi.).

Titan

Because of its unique atmosphere, Titan may turn out to be the most important and interesting body, from a terrestrial perspective, in the solar system.

For almost two decades, space scientists have searched for clues to the primeval Earth. At Titan, they found an atmosphere whose chemistry may be related to that of the early Earth.

Titan appeared from Earth-based and Pioneer 11 observations to be the largest satellite in the solar system. Voyager's close approach and diametric occultation show it to have a diameter of 5,140 km (3,194 mi.) -- slightly smaller than Ganymede, Jupiter's largest satellite. Both are larger than the planet Mercury. Titan's density thus appears to be about twice that of water ice, requiring Titan to be composed of nearly equal amounts of rock and ice, as is Ganymede.

Titan's surface cannot be seen in photos from Voyager 1; it is hidden by a dense, optically thick haze. Several distinct, detached haze layers can be seen above the visibly opaque haze layer. The layers merge into a darkened hood over the north pole of Titan.

The southern hemisphere is slightly brighter than the northern, possibly the result of seasonal effects. When Voyager 1 flew past, the season on Titan was the equivalent of early April on Earth, or early spring in the northern hemisphere and early fall in the south.

The atmospheric pressure near Titan's surface is about 1.6 bars, 60 percent greater than Earth's. The atmosphere is composed mainly of nitrogen, the major constituent of Earth's atmosphere, with about 6 percent methane and a trace of molecular hydrogen. There is also indirect evidence that the atmosphere may contain about 12 percent argon.

The surface temperature appears to be about 95 Kelvin (-288 Fahrenheit) at the equator, and about 3 K (5 F) colder at the poles. These temperatures are near the freezing point of methane (91 K or -296 F), so that it is possible there are polar methane ice caps and liquid methane at lower latitudes. Clouds of methane ice may form 5 to 10 km above the surface.

Titan's methane, through continuing organic chemistry, is converted to ethane, acetylene, ethylene and (when combined with nitrogen) hydrogen cyanide. The last is an especially important molecule, since it is a building block of amino acids. However, Titan's low temperature undoubtedly inhibits more complex organic chemistry.

Titan has no measurable intrinsic magnetic field; it therefore has no electrically conducting convective liquid core. Its interaction with Saturn's magnetosphere distorts the planet's field in Titan's wake. The big satellite also serves as a source for neutral and electrically charged particles in Saturn's magnetosphere.

The Magnetosphere

While Saturn's magnetosphere is only about one-third the size of Jupiter's, it is still a huge structure, extending nearly 1,200,000 km (750,000 mi.) from the planet toward the Sun before the flow of charged particles in the solar wind overcomes the effects of Saturn's magnetic field. As at Jupiter, charged particles in Saturn's magnetic field are dragged along by the magnetic field and circle the planet once in 10 hours, 39 minutes, 26 seconds. At Titan's orbit, those particles pass the satellite at a relative speed of 200 km (126 mi.) per second. The size of Saturn's magnetic field fluctuates as the solar wind pressure increases and decreases. As a result, Saturn's magnetic field is occasionally compressed inside Titan's orbit.

Titan was inside Saturn's magnetosphere as Voyager 1 flew past and observed the wake resulting from the flow past Titan of the electrically charged ions carried around by Saturn's rotating magnetic field.

Surrounding Titan and its orbit, and extending inward to Rhea's orbit, is a cloud of uncharged hydrogen atoms forming an enormous hydrogen torus. A disk of plasma, composed of hydrogen and possibly oxygen or nitrogen ions, extends outward to the orbit of Titan. The plasma is in nearly full corotation with Saturn's magnetic field.

Voyager 1 is now headed out of the solar system. Its scan-platform instruments were turned off Dec. 19, 1980. Most fields and particles instruments continue to operate, monitoring the solar wind and its changes with distance and time. Although the exact location of the heliopause (the outer edge of the solar wind) is unknown, it is possible Voyager 1 will reach it some time in the next 10 years. Even before that time, however, Voyager may detect, for the first time, undeflected low-energy cosmic rays penetrating into the outer reaches of the solar system from nearby supernova remnants.

SATURN'S SATELLITES

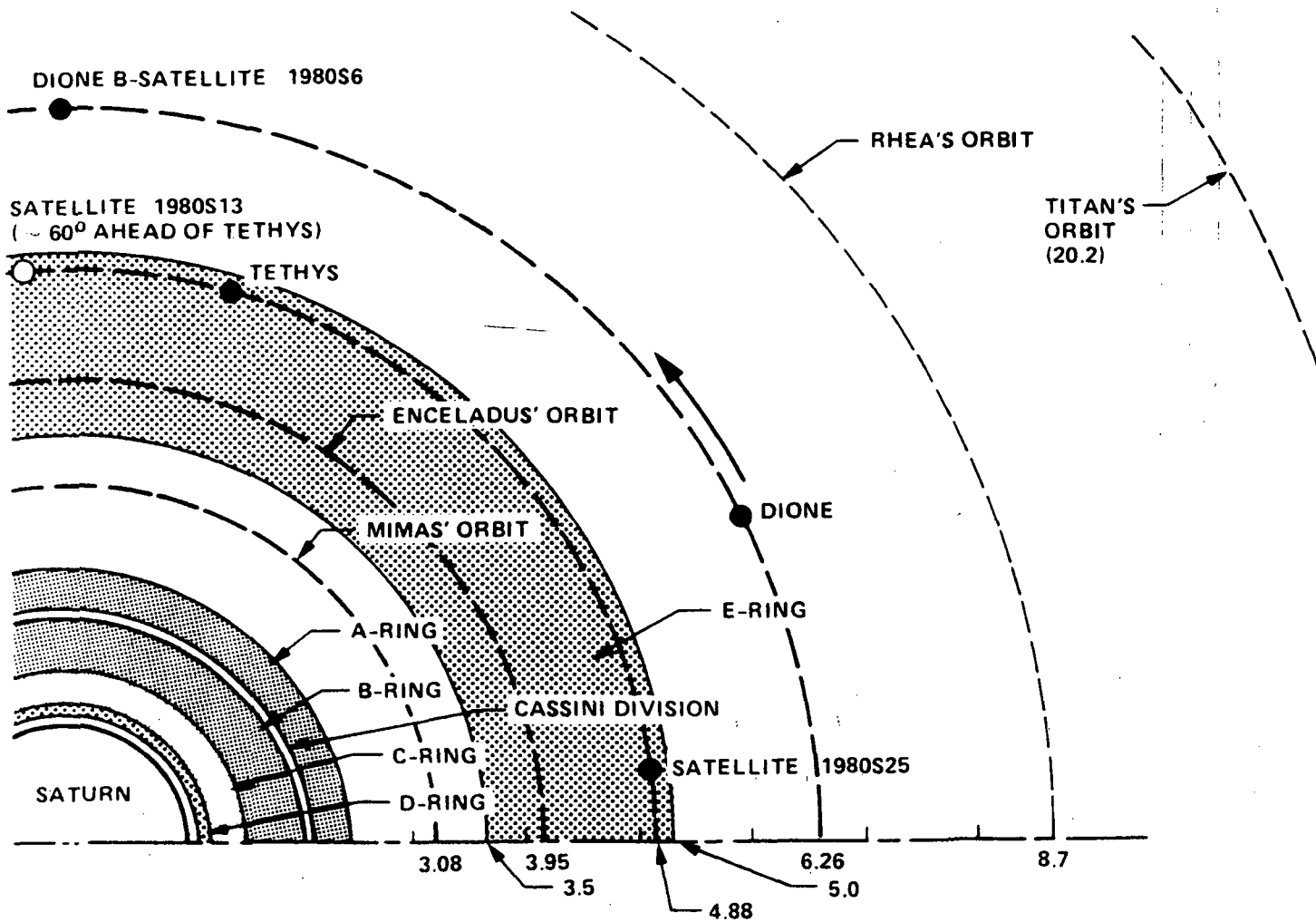| Name	Diameter	Distance	Closest Approach	
			Voyager 1	Voyager 2
1. 1980S28	40x20 km (25x12 mi)	137,670 km (85,540 mi)	219,000 km (136,000 mi)	287,170 km (178,300 mi)
2. 1980S27	220 km (140 mi)	139,353 km (86,590 mi)	300,000 km (186,000 mi)	246,590 km (153,220 mi)
3. 1980S26	200 km (120 mi)	141,700 km (88,050 mi)	270,000 km (168,000 mi)	107,000 km (66,490 mi)
4. 1980S3	90x40 km (55x25 mi)	151,422 km (94,089 mi)	121,000 km (75,000 mi)	147,010 km (91,350 mi)
5. 1980S1	100x90 km (60x55 mi)	151,472 km (94,120 mi)	297,000 km (185,000 mi)	222,760 km (138,420 mi)
6. Mimas	390 km (242 mi)	185,600 km (115,300 mi)	88,440 km (55,000 mi)	309,990 km (192,600 mi)
7. Enceladus	500 km (310 mi)	238,100 km (147,900 mi)	202,040 km (125,500 mi)	87,140 km (54,100 mi)
8. Tethys	1,050 km (652 mi)	294,700 km (183,100 mi)	415,670 km (258,300 mi)	93,000 km (57,800 mi)
9. 1980S25	30-40 km (19-25 mi)	294,700 km (183,100 mi)	237,332 km (147,471 mi)	284,396 km 176,715 mi)
10. 1980S13	30-40 km (19-25 mi)	294,700 km (183,100 mi)	432,295 km (268,616 mi)	153,518 km (95,392 mi)
11. 1980S6	160 km (100 mi)	378,060 km (234,920 mi)	230,000 km (143,000 mi)	318,200 km (197,720 mi)
12. Dione	1,120 km (696 mi)	377,500 km (234,600 mi)	161,520 km (100,400 mi)	502,250 km (312,000 mi)
13. Rhea	1,530 km (951 mi)	527,200 km (327,600 mi)	73,980 km (46,000 mi)	645,280 km (401,000 mi)
14. Titan	5,140 km (3,194 mi)	1,221,600 km (759,100 mi)	6,490 km (4,033 mi)	665,960 km (413,800 mi)
15. Hyperion	290 km (180 mi)	1,483,000 km (921,000 mi)	880,440 km (547,100 mi)	470,840 km (292,600 mi)
16. Iapetus	1,440 km (895 mi)	3,560,100 km (2,212,100 mi)	2,470,000 km (1,534,900 mi)	909,070 km (564,900 mi)
17. Phoebe	160 km (99 mi)	12,950,000 km (8,047,000 mi)	13,537,000 km (8,411,500 mi)	1,473,000 km (915,300 mi)

ORBIT LOCATIONS OF SATELLITES
NEAR SATURN'S A RING AND F RING

CO-ORBITAL
SATELLITES
1980S1 AND 1980S3

100 x 90
50 km (31 mi)

2.51

90 km x 40 km

(56 mi x 25 mi)

SATELLITE 1980S26

F-RING

SATELLITE 1980S27

SATELLITE 1980S28

A-RING

2.35
2.33
2.31
2.28
2.26

A-RING

B-RING

C-RING

D-RING

CASSINI
DIVISION

G-RING

F-RING

ENCKE
DIVISION

SATURN

1.53

1.95

2.01

2.21

2.26

2.33

2.8

1.11

1.21
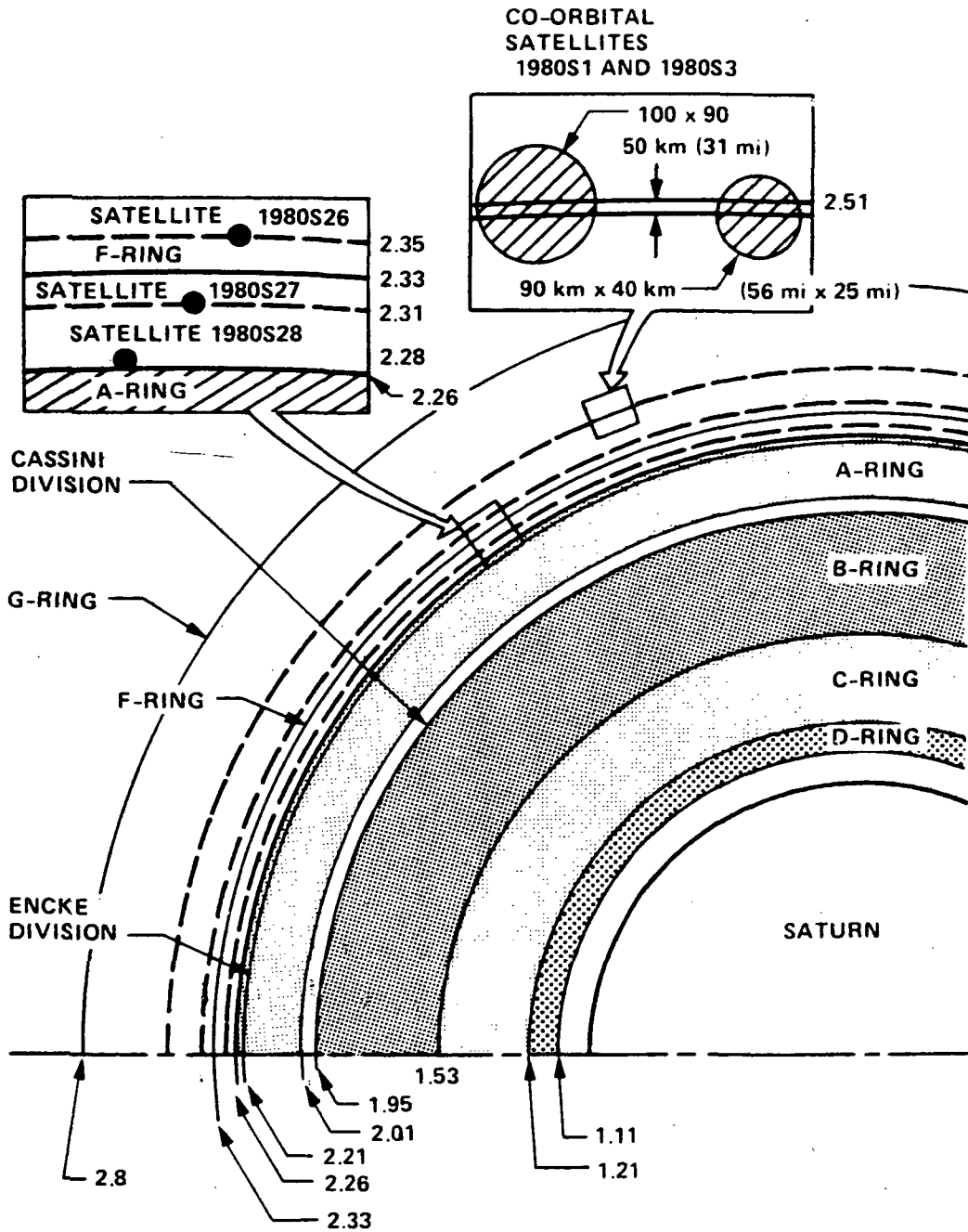
NOTE: SATURN RADIUS IS
60,330 km (37,489 mi)
SATELLITE ORBIT AND
RING DISTANCES ARE
GIVEN IN SATURN
RADII

ORBIT LOCATIONS OF 9 SATELLITES OF SATURN

DIONE B-SATELLITE 1980S6

RHEA'S ORBIT

SATELLITE 1980S13
(~ 60° AHEAD OF TETHYS)

TITAN'S
ORBIT
(20.2)

TETHYS

ENCELADUS' ORBIT

MIMAS' ORBIT

DIONE

A-RING

E-RING

B-RING

CASSINI DIVISION

C-RING

SATELLITE 1980S25

SATURN

D-RING

3.08   3.95   6.26   8.7
      3.5   5.0
            4.88

NOTE: SATURN RADIUS IS
      60,330 km (37,489 mi)
      SATELLITE ORBIT DISTANCES
      ARE GIVEN IN SATURN RADII

-more-

SATURN RING DATA

Feature	Distance From Center	Comments
1. Equatorial radius	60,330 km (37,500 mi)	Near 100 millibar level
2. D-ring inner edge	67,000 km (41,600 mi)	Seen only in forward-scattering light
3. C-ring inner edge	73,200 km (45,486 mi)	
4. B-ring inner edge	92,200 km (57,300 mi)	
5. B-ring outer edge	117,500 km (73,000 mi)	Inner edge of Cassini Division
6. A-ring inner edge	121,000 km (75,200 mi)	Outer edge of Cassini Division
7. Encke Division	133,500 km (83,000 mi)	About 200 km (124 mi) wide
8. A-ring outer edge	136,200 km (84,600 mi)	
9. F-ring	140,600 km (87,400 mi)	About 100 km (62 mi) wide; three components; eccentric
10. G-ring	170,000 km (105,600 mi)	Seen only in forward-scattering light
11. E-ring inner edge	210,000 km (130,500 mi)	
12. E-ring outer edge	300,000 km (286,400 mi)	

(The exact level of Saturn's cloud tops is not known, but is believed to be deeper than the 100 millibar level, the planet's equatorial radius. For purposes of this press kit, the top layer of Saturn's clouds are assumed to be 63,330 km (39,350 mi.) from the center of the planet.)

VOYAGER 2 SATURN ENCOUNTER VIDEO PROGRAMMING

In order to make special coverage of the activities associated with the encounter available to the public, we have leased, through the courtesy of the Christian Media Network, Transponder 16 on RCA's Satcom 1 for the following schedule:

```
August 24 - 8:00 to 9:00 p.m. EDT
August 25 - 8:00 to 9:30 p.m. EDT
August 26 - 8:00 to 9:00 p.m. EDT
August 27 - 8:00 to 9:00 p.m. EDT
August 28 - 8:00 to 9:00 p.m. EDT
```

The programming will also be available commercially (at no cost to the grovernment) at TVOC Los Angeles, New York and Washington, D.C.

Each segment of the five and one-half hours of programming will be complete with opening and closing titles. Program content will consist of Dr. Albert R. Hibbs, Scientist/Moderator, providing commentary and interpretations and conducting interviews with science team members. The programs will also include live and recorded views of science teams in action and live and computer enhanced views of Saturn, its rings and satellites.

All of the material will be in the public domain and will be available to all users without charge or copyright.

A limited amount of promotional material is available from NASA. For additional information or assistance please call or write:

Les Gaver or Tom Jaqua
Audio-Visual/Code LFD-10
NASA Headquarters
Washington, D.C. 20546   Telephone: 202/755-8366

VOYAGER SCIENCE TEAMS

Cosmic Ray

Rochus E. Vogt, California Institute of Technology,
  Principal Investigator

J. Randy Jokipii, University of Arizona

Frank B. McDonald, Goddard Space Flight Center

Edward C. Stone, California Institute of Technology

James H. Trainor, Goddard Space Flight Center

William R. Webber, University of New Hampshire

Al W. Schardt, Goddard Space Flight Center

Infrared Interferometry and Spectrometry

Rudolf A. Hanel, Goddard Space Flight Center,
  Principal Investigator

Barney Conrath, Goddard Space Flight Center

Dale Cruikshank, University of Hawaii

F. Michael Flasar, Goddard Space Flight Center

Daniel Gautier, Observatoire de Paris, France

Peter Gierasch, Cornell University

Shailendra Kumar, University of Southern California

Virgil Kunde, Goddard Space Flight Center

William Maguire, Goddard Space Flight Center

John Pearl, Goddard Space Flight Center

Joseph Pirraglia, Goddard Space Flight Center

Cyril Ponnamperuma, University of Maryland

Robert Samuelson, Goddard Space Flight Center

Imaging Science

Bradford A. Smith, University of Arizona, Team Leader

Geoffrey Briggs, NASA Headquarters

Imaging Science (cont'd.)

Allan F. Cook II, Center for Astrophysics

G. Edward Danielson, California Institute of Technology

Merton E. Davies, Rand Corp.

Garry E. Hunt, University College, London

Torrence V. Johnson, Jet Propulsion Laboratory

Harold Masursky, U.S. Geological Survey

Tobias Owen, State University of New York, Stony Brook

Carl Sagan, Cornell University

Laurence Soderblom, U.S. Geological Survey
    Deputy Team Leader

Verner E. Suomi, University of Wisconsin

Reta Beebe, New Mexico State University

Joseph Boyce, NASA Headquarters

Anne Bunker, Jet Propulsion Laboratory

Michael Carr, U.S. Geological Survey

Steward A. Collins, Jet Propulsion Laboratory

Jeffrey Cuzzi, Ames Research Center

Candice J. Hansen, Jet Propulsion Laboratory

Andrew Ingersoll, California Institute of Technology

John McCauley, U.S. Geological Survey

Jimmy L. Mitchell, Jet Propulsion Laboratory

David Morrison, University of Hawaii

James B. Pollack, Ames Research Center

Eugene Shoemaker, California Institute of Technology,
    U.S. Geological Survey

Robert Strom, University of Arizona

Richard Terrile, Jet Propulsion Laboratory

Imaging Science (cont'd.)

Joseph Veverka, Cornell University

Low-Energy Charged Particles

S. M. (Tom) Krimigis, Johns Hopkins University,
  Principal Investigator

Thomas P. Armstrong, University of Kansas

W. Ian Axford, Max-Planck-Institut fur Aeronomie

Carl O. Bostrom, Johns Hopkins University

Chang-yun Fan, University of Arizona

George Gloeckler, University of Maryland

Ed Keath, Johns Hopkins University

Louis J. Lanzerotti, Bell Laboratories

Plasma Science

Herbert S. Bridge, Massachusetts Institute of Technology,
  Principal Investigator

John W. Belcher, Massachusetts Institute of Technology

Len F. Burlaga, Goddard Space Flight Center

Christoph K. Goertz, Max-Planck-Institut fur Aeronomie

Richard E. Hartle, Goddard Space Flight Center

Art J. Hundhausen, High Altitude Observatory

Alan J. Lazarus, Massachusetts Institute of Technology

Keith Ogilvie, Goddard Space Flight Center

Stanislaw Olbert, Massachusetts Institute of Technology

Jack D. Scudder, Goddard Space Flight Center

George L. Siscoe, University of California, Los Angeles

James D. Sullivan, Massachusetts Institute of Technology

Vytenis M. Vasyliunas, Max-Planck-Institut fur Aeronomie

Magnetic Fields

Norman F. Ness, Goddard Space Flight Center,
   Principal Investigator

Mario F. Acuna, Goddard Space Flight Center

Ken W. Behannon, Goddard Space Flight Center

Len F. Burlaga, Goddard Space Flight Center

Ron P. Lepping, Goddard Space Flight Center

Fritz M. Neubauer, Der Technischen Universitat Braunschweig

Photopolarimetry

Arthur L. Lane, Jet Propulsion Laboratory,
   Principal Investigator

David Coffeen, Goddard Institute for Space Studies

Larry Esposito, University of Colorado

James E. Hansen, Goddard Institute for Space Studies

Charles W. Hord, University of Colorado

Makiko Sato, Goddard Institute for Space Studies

Robert West, University of Colorado

Richard B. Pomphrey, Jet Propulsion Laboratory

Robert M. Nelson, Jet Propulsion Laboratory

Planetary Radio Astronomy

James W. Warwick, Radiophysics, Inc.,
   Principal Investigator

Joseph K. Alexander, Goddard Space Flight Center

Andre Boischot, Observatoire de Paris

Walter E. Brown Jr., Jet Propulsion Laboratory

Thomas D. Carr, University of Florida

Samuel Gulkis, Jet Propulsion Laboratory

Fred T. Haddock, University of Michigan

Christopher C. Harvey, Observatoire de Paris

Planetary Radio Astronomy (cont'd).

Michael L. Kaiser, Goddard Space Flight Center

Yolande Leblanc, Observatoire de Paris

Jeffrey B. Pearce, Radiophysics, Inc.

Robert G. Peltzer, Martin Marietta Corp.

Roger Phillips, Jet Propulsion Laboratory

Anthony C. Riddle, University of Colorado

David H. Staelin, Massachusetts Institute of Technology

Plasma Wave

Frederick L. Scarf, TRW Defense and Space Systems Group,
  Principal Investigator

Donald A. Gurnett, University of Iowa

William Kurth, University of Iowa

Radio Science

G. Len Tyler, Stanford University, Principal Investigator

John D. Anderson, Jet Propulsion Laboratory

Thomas A. Croft, SRI International

Von R. Eshleman, Stanford University

Gerald S. Levy, Jet Propulsion Laboratory

Gunnar F. Lindal, Jet Propulsion Laboratory

Gordon E. Wood, Jet Propulsion Laboratory

Ultraviolet Spectroscopy

A. Lyle Broadfoot, University of Southern California,
  Principal Investigator

Sushil K. Atreya, University of Michigan

Michael J. S. Belton, Kitt Peak National Observatory

Jean L. Bertaux, Service d'Aeronomie du CNRS

Jacques E. Blamont, Jet Propulsion Laboratory,
  Centre National d'Etudes Spatiales

Ultraviolet Spectroscopy (cont'd.)

Alexander Dalgarno, Harvard College Observatory

Thomas M. Donahue, University of Michigan

Richard Goody, Harvard University

John C. McConnell, York University
Michael B. McElroy, Harvard University

H. Warren Moos, Johns Hopkins University

Bill R. Sandel, University of Southern California

Donald E. Shemansky, University of Southern California

Darrell F. Strobel, Naval Research Laboratory

VOYAGER TEAM

NASA Office of Space Science

Andrew J. Stofan	Associate Administrator for Space Science (Acting)
Dr. Jeffrey D. Rosendahl	Assistant Associate Administrator Space Science (Acting)
Daniel H. Herman	Director, Solar System Exploration Division (Acting)
Dr. Geoffrey A. Briggs	Deputy Director, Solar System Exploration Division
Dr. C. Howard Robins	Manager, Solar System Mission Operations
Frank A. Carr	Program Manager (Acting)
Dr. Milton A. Mitz	Program Scientist

NASA Office of Space Tracking and Data Systems

Robert E. Smylie	Associate Administrator for Space Tracking and Data Systems
Charles A. Taylor	Director, Network Systems Division
Norman Pozinsky	Deputy Director, Network Systems Division

Dr. Richard Green	Program Manager, Deep Space Network
Harold G. Kimball	Director, Communications and Data Systems Division

Jet Propulsion Laboratory

Dr. Bruce C. Murray	Director
Gen. Charles A. Terhune Jr.	Deputy Director
Robert J. Parks	Assistant Director for Flight Projects
Esker K. Davis	Project Manager
Richard P. Laeser	Deputy Project Manager, Mission Director
George P. Textor	Deputy Mission Director
Richard P. Rudd	Deputy Mission Director
Charles E. Kohlhase	Manager, Mission Planning Office
Robert G. Polansky	Manager, Ground Data Systems
Marvin R. Traxler	Manager, Tracking and Data System
Dr. Charles H. Stembridge	Manager, Flight Science Office
Dr. Ellis D. Miner	Assistant Project Scientist for Saturn
Edward L. McKinley	Manager, Flight Engineering Office
Douglas G. Griffith	Manager, Flight Operations Office

California Institute of Technology

Dr. Edward C. Stone	Project Scientist

-end-