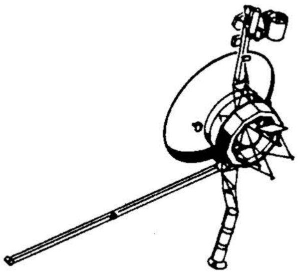

MISSION STATUS BULLETIN

VOYAGER

July 25, 1978

No.22

SUMMARY

Both spacecraft continue their interplanetary cruises, with periodic calibrations and tests. The gap between them is widening, as the data clearly show:

July 25, 1978	*Voyager 1*	*Voyager 2*
Distance from Earth, km	*~ 714 million*	*~ 683 million*
Distance from Earth, mi	*~ 444 million*	*~ 425 million*
Distance from Earth, AU (1 AU = 150 million km or 93 million mi)	*~ 4.7*	*~ 4.5*
Heliocentric velocity	*17 km/sec (10.5 mi/sec)*	*16 km/sec (10 mi/sec)*
One-way light time	*39 min 40 sec*	*37 min 59 sec*
Launch Date	*September 5, 1977*	*August 20, 1977*
Jupiter Encounter Date (closest approach)	*March 5, 1979*	*July 9, 1979*

UPDATE

Solar Conjunction

Voyagers 1 and 2 took a brief rest this month as the Earth and spacecraft moved into solar conjunction. For a period of about two weeks for each spacecraft, the Sun-Earth-Probe (SEP) angle was less than ± 5 degrees, and no commands which would change the state of the spacecraft were allowed.

Due to the position of the Sun between the Earth and the spacecraft, data reception was "ratty" during this period. Voyager 2 moved out of solar conjunction on July 24.

Voyager's solar conjunction happened to occur during the largest solar flare activity observed in recent years.

AACS Patch

In mid-August, several refinements will be made to the attitude and articulation control subsystem (AACS) of both spacecraft.

One change will compensate for rate changes induced by movement of the digital tape recorder (DTR). These rate changes, although slight, are still enough to cause smear in the imaging. The AACS will now automaticallly sense when the DTR starts, stops, or reverses direction, and will pulse the attitude control jets to offset this torque.

A second patch will allow fine-tuning of the rate to position gain in the attitude control functions.

A third correction will be for gyro drift compensation. A new command will allow intentional turning of the spacecraft at a slow rate of speed, independent of the drift compensation built into the software.

In inertial control, spinning gyros provide references which, by their nature drift slightly, causing spacecraft turning. The drift can be measured and corrected. At times, however, controlled slow turning is desirable, as when even the spacecraft turn rate is too high for the ultraviolet spectrometer to track the planet limb. The new capability will allow independent control of gyro drift.

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THE VOYAGER SPACECRAFT

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

Part 5 – Magnetic Fields Investigation

The magnetic field of a planet is an externally measurable indication of conditions deep within its interior. Four magnetometers aboard each Voyager will gather data on the planetary magnetic fields at Jupiter, Saturn, and possibly Uranus; the satellites of these planets; solar wind and satellite interactions with these planetary fields; and the interplanetary magnetic field.

If we are still communicating with the spacecraft when they pass beyond the orbit of Pluto and out of our solar system, the instruments may beam back news of the interstellar medium as well.

Voyager's fields and particles investigations, of which the magnetic fields experiment is one, are complementary, having overlapping areas of study but each with its own unique methods of observing and reporting on the same phenomena.

Solar Wind and Magnetospheres

The magnetometers will reveal a great deal about the interplanetary medium – the thinly scattered ionized and magnetized gas within the spaces of our solar system – which forms the solar wind.

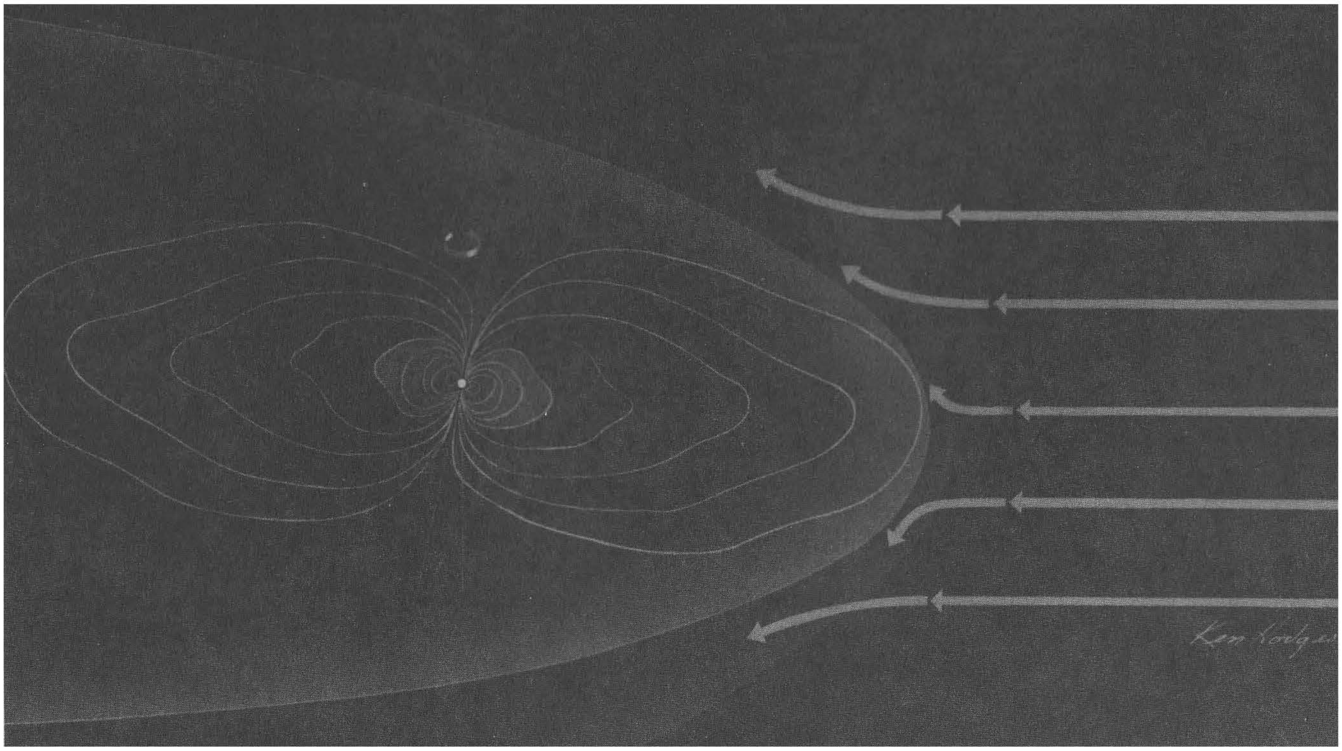
Our Sun is constantly emitting electrically-charged particles, mostly protons and electrons, from the ionization of hydrogen. This gas is in the fourth state of matter called a very high "plasma" (the other three states are solid, liquid and gas). It travels at speeds varying from 300 to 1100 kilometers (185 to 685 miles) per second. Although of extremely low density (less than 100 particles per cubic centimeter), the plasma permeates all of interplanetary space and forms the solar wind. Because of its ionized state, it is an electrically-conducting medium in interplanetary space.

The solar wind is deflected by planetary magnetic fields and streams around the obstacle, confining the planet's magnetic field to a limited region of space called the magnetosphere. At Earth, the magnetosphere is a long, narrow tail on the far side of the planet (away from the Sun). The ion tails of comets (but not the dust tails) also stream in the direction of the solar wind flow.

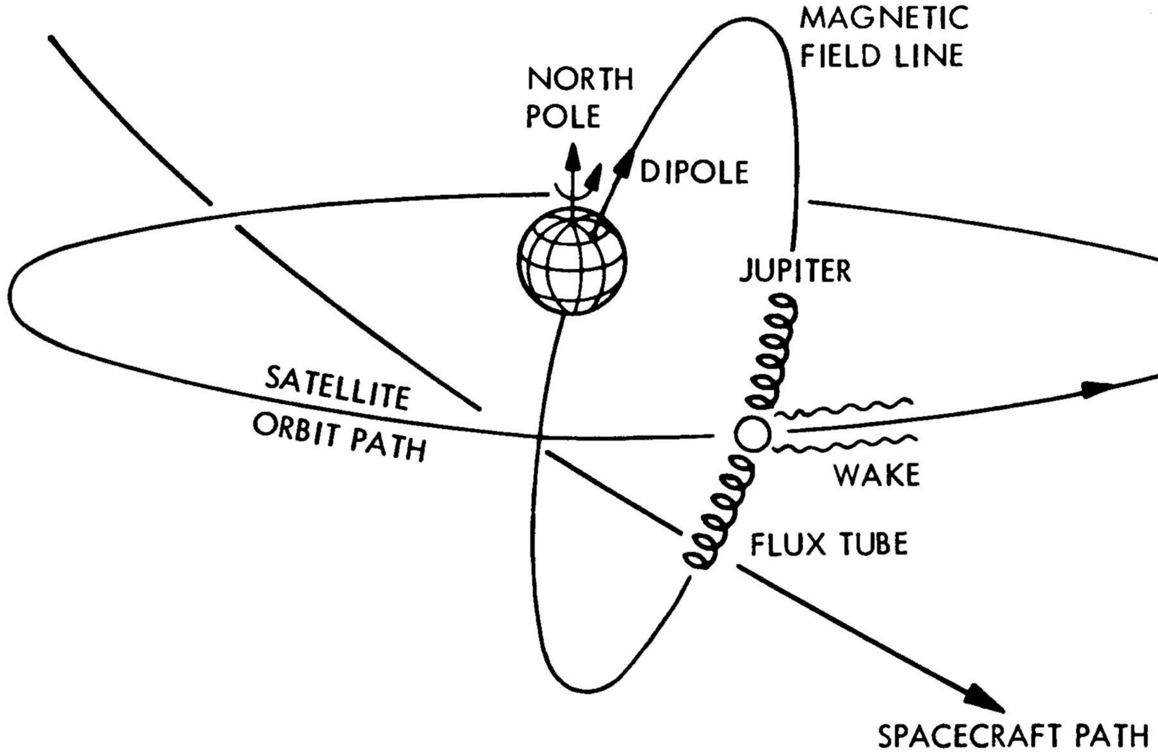
Well past the orbit of Uranus (at 20 AU), Voyager will be alert to detect the outer edge of the solar wind, although this may be as far distant as 50 AU (7-1/2 billion kilometers or 4-3/4 billion miles), well beyond the nominal limits of the mission.

The three-dimensional shape of Jupiter's magnetosphere is not well understood. The timing of the Voyager arrivals at Jupiter, four months apart, will allow concurrent measurements of the interplanetary medium near Jupiter and the Jovian magnetosphere itself. Thus, changes in characteristics of the magnetosphere can be identified as true spatial variations or as temporal ones induced by changes in the interplanetary medium.

Jupiter's rapid rotation rate (1 Jovian day is about 10 Earth hours) may be a cause of the strongly distorted



SOLAR WIND – The outer, least dense region of the Jovian magnetosphere (left) is highly variable in size, perhaps due to varying pressure of the impinging solar wind (right).



JUPITER FLUX TUBE AND IO WAKE – The motion of a Galilean satellite through the Jovian environment can produce such interesting geometrical regions as a "flux tube", where the satellite interrupts the flow of charged particles along the magnetic field lines, and a "wake" region, which arises from the satellite interference with the co-rotating planetary plasma.

outer magnetosphere. At large distances from the planet, the magnetic field lines appear to form a spiral structure, which might be explained by outward plasma flow.

The interaction between a satellite and the Jovian magnetosphere depends on the properties of the satellite and its ionosphere, on the characteristics of the field and particle environment, and on the properties of the Jovian ionosphere.

The Jovian magnetosphere rotates with the planet, extending as far as the orbit of Callisto, the fourth Galilean satellite of Jupiter.

Io Interaction

A strong factor in choosing the spacecraft flight paths was the desire to observe a special region of interaction between Jupiter and its satellite Io, known as the flux tube. The flux tube is defined by the magnetic lines of force of Jupiter which pass through Io, and is roughly a banana shape.

Voyager 1 is targeted to pass through the flux tube at a distance of 25,000 kilometers (15,500 miles) from Io, and should return a definitive observation of the interaction. The spacecraft will spend a maximum of 4-1/2 minutes in the flux tube.

Decametric radio wave noise bursts (4 to 40 kilo-Hertz) from Jupiter are a puzzling phenomena which are probably connected with plasma instabilities within the Jovian ionosphere. The satellite Io appears to exert some influence on these radio emissions through its magnetic flux tube, which intersects both the plasma around Io and the Jovian ionosphere.

Io is thought to have no internal magnetic field, although its rocky surface, and that of Europa, should have some magnetizable material. Io is known to have an atmosphere and to be a source of sodium.

Saturn and Titan

Saturn may also have a magnetic field and magnetosphere similar to Jupiter's, but its magnetic field is expected to be somewhat weaker. There is no large satellite like Io close to Saturn. The major Saturnian satellite to be studied by Voyager, Titan, is more than 1 million kilometers (620 thousand miles) from the planet and may or may not be inside the planet's magnetosphere.

Titan is larger and more massive than Earth's Moon and has a gravitationally-bound atmosphere. Study of Titan will be of special significance, and Voyager 2 may have an opportunity to measure Titan's "wake" as the satellite moves through the solar wind or the Saturnian magnetosphere.

If the Uranus flyby option is realized, a "pole-on" probe of the Uranian magnetosphere may be possible, since the axis of Uranus points almost toward the Sun. The magnetosphere appears to include the orbit of the satellite Oberon.

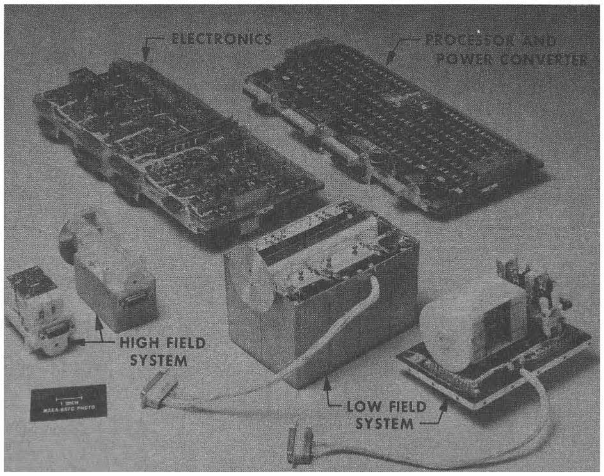
Instrument Package

Each spacecraft carries dual magnetometers to provide simultaneous data and eliminate from the measurements the small but increasingly important magnetic field of the spacecraft itself.

Since a wide, dynamic measurement range is required to meet the planetary and interplanetary objectives, the experiment uses both a low-field and a high-field system. Each system contains two identical triaxial fluxgate magnetometers. The low-field system will be operated alone during cruise, measuring the interplanetary medium in eight ranges from about 0.002 gamma to 1/2 Gauss (the Earth's field at the surface is about 1/2 Gauss). Both systems will operate during encounter periods.

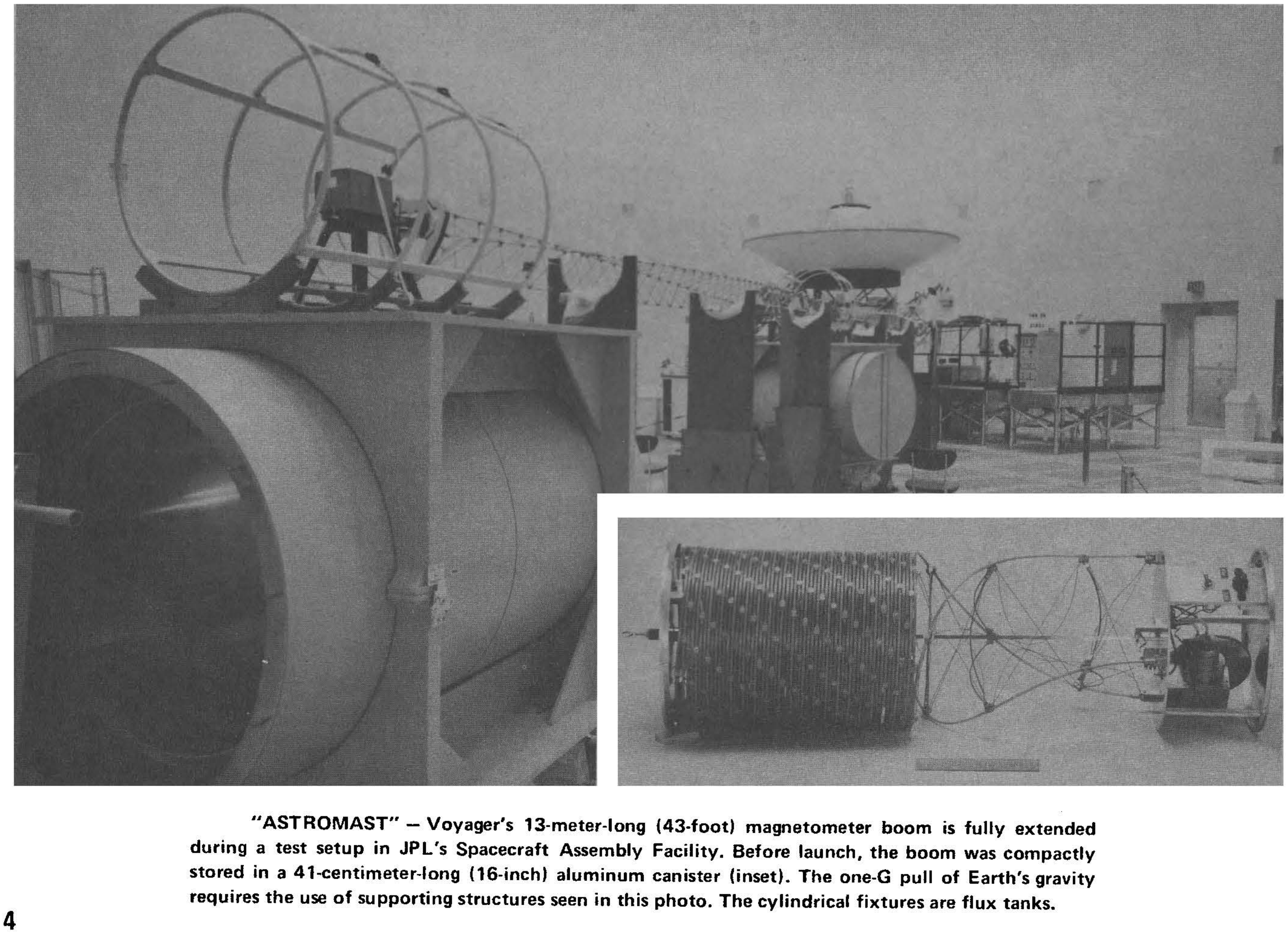
To isolate the low-field magnetometers from the spacecraft's own magnetic field as much as possible, the instruments are located on a 13-meter (43-foot) boom which was carefully packed into an aluminum canister during the launch phase and then extended out to its full length during the parking orbit. This "Astromast" type of boom is indeed an engineering achievement and the longest boom for such purposes ever flown.

One low-field sensor is perched at the tip of the boom, while the other is stationed at about the midpoint. The high-field sensors are located nearer the spacecraft bus, on the boom's support structure.



With the addition of the electronics, the total experiment weight is 5.6 kilograms (12 pounds) and the maximum power requirement is 2.2 watts.

Principal investigator for the experiment is Dr. Norman Ness of the Laboratory for Extraterrestrial Physics at NASA's Goddard Space Flight Center (GSFC), Greenbelt, Maryland. Co-investigators include Drs. M. H. Acuna, K. W. Behannon, L. F. Burlaga, and R. P. Lepping, all at GSFC, and F. M. Neubauer at the *Institut für Geophysik und Meterologie, Technische Universität*, Braunschweig, Federal Republic of Germany.



"ASTROMAST" – Voyager's 13-meter-long (43-foot) magnetometer boom is fully extended during a test setup in JPL's Spacecraft Assembly Facility. Before launch, the boom was compactly stored in a 41-centimeter-long (16-inch) aluminum canister (inset). The one-G pull of Earth's gravity requires the use of supporting structures seen in this photo. The cylindrical fixtures are flux tanks.