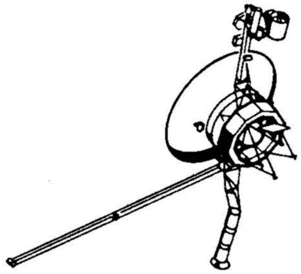

MISSION STATUS BULLETIN

VOYAGER

February 21, 1978 **No. 15**

SUMMARY

Now over 322 million kilometers (200 million miles) from Earth, Voyager 1 is operating normally, with a velocity of about 23 kilometers (14 miles) per second relative to the Sun. At the speed of light (and radio waves), one-way communication time is 17 minutes 48 seconds.

Voyager 2 is nearly 313 million kilometers (195 million miles) from Earth, travelling at a velocity of about 22 kilometers (13.7 miles) per second relative to the Sun. One-way communication time is 17 minutes 18 seconds, half a minute less than Voyager 1. Voyager 2 is operating normally.

UPDATE

VOYAGER 1

In early January, Voyager 1 completed its first test and calibration of the magnetometers' mechanical flippers. The magnetometer sensors, located on a 13-meter (43-foot) boom to minimize the effects of the spacecraft's own magnetic field, are flipped end-to-end and calibration measurements are taken. The commands for this sequence are sent during real time rather than incorporated into an automatic computer sequence, so that the event may be monitored as it happens.

The filter wheels on the cameras are stepping normally again after being turned off during the December sequence verification tests. Diagnostic tests have identified a bad memory location in the flight data subsystem computer, and a spare memory location is now being used and will be used in future programs.

Two changes have been made in Voyager 1's Earth-to-Jupiter mission phase schedule. The second trajectory correction maneuver, previously scheduled for June 1978, will now be executed in September 1978. In addition, the start of the Jupiter Observatory data acquisition has been moved to January 4, 1979 to allow personnel a quiet period over the winter holidays before the start of intensive activities which will span eight months as first one, then the other, spacecraft observes Jupiter.

On February 17, Voyager 1 entered a safing routine before completing a cruise science maneuver. A complete cruise maneuver involves 10 360° yaw turns and 24 roll turns, taking 18 hours to complete, and allows routine calibration of several instruments by looking at the entire sky.

VOYAGER 2

A test of the magnetometers' mechanical flippers was successfully completed on January 24.

A target maneuver is scheduled for March 7. The purpose of the maneuver is to calibrate the imaging cameras, photopolarimeter, and infrared interferometer spectrometer, all mounted on the scan platform at the tip of the science boom. A series of spacecraft turns positions the target plate, mounted below the bus at an angle to the scan platform, in the sunlight, so that each instrument can "look" at the reflective plate as the scan platform is maneuvered. The sequence requires about 5 hours to complete. Target maneuvers will be performed regularly on both spacecraft throughout cruise.

THE VOYAGER SPACECRAFT

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

Part 4 — Cosmic Ray Investigation

When cosmic rays, high-energy radiation from outer space, were discovered less than 70 years ago, they caught the attention of the public and fired the imaginations of science fiction writers, who quickly invented cosmic ray guns, those deadly weapons of invading aliens. Although much has been learned about these phenomena in the intervening years, and cosmic ray guns have given way to lasers, phasers, and light sabers, many questions remain unanswered, or, as is often the case in scientific inquiry, some answers have only raised more questions.

Cosmic rays are the most energetic particles found in nature and are atomic nuclei, primarily protons, and electrons. They are comprised of all elements known to man. Over certain energy ranges and at certain periods of time, the elemental content of cosmic rays is similar in proportion to that of the matter of the solar system. Generally, however, their composition varies significantly with energy, indicating that a variety of astrophysical sources and processes contribute to their numbers.

Cosmic rays could pose a hazard to future space travellers. They can also cause mutation by altering or destroying genes. Although it is unlikely that life on Earth could be

National Aeronautics and Space Administration

Recorded Mission Status (213) 354-7237

Recorded Mission Operations Status (213) 354-6665

Status Bulletin Editor (213) 354-4438

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affected much (our atmosphere shields us), cosmic rays may play a role in organic evolution in space. Cosmic rays may, as we search for their origins, tell us much about our solar system and its origins and processes. Cosmic rays, which are material samples from the galaxy, can tell us much about how stars synthesize (cook) the elements. In addition, cosmic ray studies have contributed greatly to the field of subnuclear physics, giving us mesons, hyperon, muons, positrons, and neutrinos, long before they were artificially created in atomic accelerators in Earth's laboratories.

Early cosmic ray studies sought to identify the origin of cosmic rays in specific atomic reactions, but today the emphasis has shifted to study of the acceleration (pull) of ions by electromagnetic fields which are thought to exist in the interstellar spaces or in the neighborhood of certain celestial bodies.

Experiment Objectives

The Voyagers carry identical cosmic ray experiments, one of several fields and particles studies on the mission. The investigations will provide data on the energy content, origin and acceleration process, life history, and dynamics of cosmic rays in the solar system and nearby interstellar space.

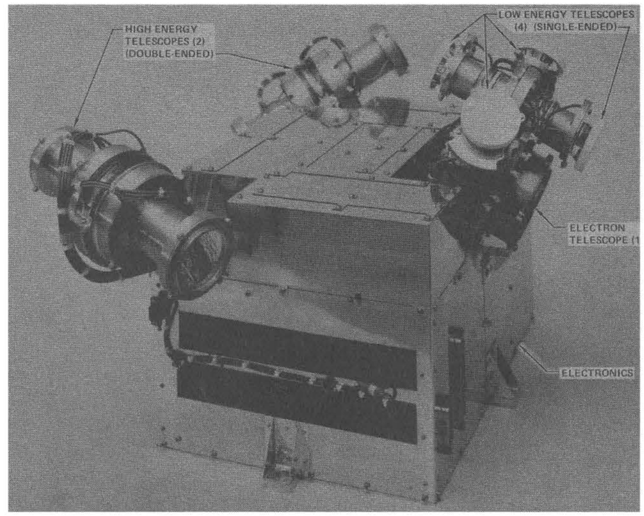
The investigations will analyze, at increasing distances from the Sun, the energy spectra and elemental composition of all cosmic-ray nuclei from hydrogen through iron, over an energy range from about 1 million to 500 million electron volts. (In comparison, medical x-rays pack about 10,000 electron volts of energy, while an atom in an exploding atomic bomb carries about 10 million electron volts.)

At ever increasing distances from the Sun, the experiments will gather data over a wide range of mass, charge, and energy, with high resulotion and at high data rates. Close in, the Sun's magnetic field and plasma tends to prevent entry of lower-energy cosmic rays from the galaxy. Farther from the Sun, presumably at distances of 20 to 30 AU (the Earth's distance from the Sun is 1 AU), one hopes to discover, for the first time, low-energy galactic particles and to learn about their sources and how these particles are accelerated to their immense energies. The energies and streaming patterns of particles can reveal much about their origin and where they have been since.

Instrument Package

There are two basic types of instruments used in cosmic ray studies. One type uses track visualization, in which the paths of cosmic ray particles are made visible and photographed. The second, electron counting, converts all or part of a particle's kinetic energy to electrical impulses which are recorded. The Voyager instruments are of the second type.

Each Voyager cosmic-ray experiment, mounted about half-way out on the science boom, consists of seven fixed-mounted telescopes: four single-ended low-energy telescopes, two double-ended high-energy telescopes, and one electron telescope. All use arrays of solid-state detectors, silicon wafers of varying thicknesses (35 microns to 6 millimeters) and area (2.8 to 9.6 square centimeters), each cut from carefully-grown pure crystals. Various electrically-conducting metals (aluminum, gold, or lithium) are laid on the semi-conductor wafer surfaces to give them their sensor properties. The energy, mass, and direction of each entering particle is measured by the number of detectors it penetrates, the electrical charge it deposits, and which telescope it enters. The telescopes are positioned at various angles to that the experiment does not need spacecraft maneuvers to gather samples from all directions.



The instrument package weighs 7.25 kilograms (16 pounds), measures about 20 x 30.5 x 25 centimeters (8 x 12 x 10 inches) and draws 5.2 watts of power.

Principal investigator for the experiment is Dr. R. E. Vogt of the California Institute of Technology and Chief Scientist at the Institute's Jet Propulsion Laboratory. Co-investigators are Dr. J. R. Jokipii (University of Arizona), Dr. F. B. McDonald (Goddard Space Flight Center and the University of Maryland), Voyager Project Scientist Dr. E. C. Stone (Caltech), Dr. B. J. Teegarden (Goddard), Dr. J. H. Trainor (Goddard), and Dr. W. R. Webber (University of New Hampshire).

Goddard Space Flight Center, Greenbelt, Maryland, built the high-energy telescopes, while Caltech built the low-energy and electron telescopes, as well as the bench checkout equipment for pre-flight testing.