Voyager Spacecraft Description

TO ACCOMANY YOUR VOYAGER SPACE CRAFT® SCIENCE KIT SCALE MODEL

The Voyagers are robotic observatories that carry out their measurements from carefully optimized vantage points in the distant reaches of our solar system. Their eleven science experiments make measurements over large portions of the observable spectrum, from magnetic fields and plasma waves through radio frequencies to infrared, visible, and ultraviolet light. They also sample plasmas, low- and high-energy charged particles (electrons and nuclei). Data from the spacecraft and its instruments are returned to Earth not only during planetary encounters, but also during the years in between, and the interstellar journey beyond. The science experiments are described in *italics* using the following abbreviations: eV (electron Volts), Hz (Hertz, or cycles per second), m (meters), nuc (nucleus), k (kilo- or thousand), M (mega, or million), G (giga, or billion), n (nano, or billionth), H (hydrogen), Fe (iron).
Note: one nm = .001 micron or micrometer = 10 Ångstroms.

Low-Field Magnetometers *sense magnetic fields in the spacecraft's immediate environment that originate in planets, the Sun, or interplanetary space. They are mounted on a fiberglass boom 13 m in length to keep them as far as possible from magnetic interference from the spacecraft.*

Thermal Blanketing which covers much of the spacecraft is not depicted.

Low-Gain Antenna was used for communications when the spacecraft was close to Earth.

Sun Sensor acts as a pitch and yaw reference for attitude control by watching the Sun's position. Since the High-Gain Antenna dish must face the Earth (and the nearby Sun) for communications, the Sun Sensor looks back through a hole in the antenna dish.

Subreflector: Part of the High-Gain Antenna that focuses the incoming and outgoing X-band radio signals.

The Link with Earth: The High-Gain Antenna consists of a reflector dish 3.7 m in diameter, and a subreflector supported above it. Around the Earth, NASA's Deep Space Network antennas are of similar shape, and are up to 70 m in diameter. Radio signals are modulated to carry commands from Earth, and telemetry from the spacecraft. In addition, radio signals to and from the spacecraft are used for precisely tracking the spacecraft's speed, distance, and angular position on the sky as seen from Earth.

Radio Science: *The spacecraft can transmit unmodulated, precise-frequency microwave radio signals for experiments which directly probe and yield information about rings and atmospheres, mass distribution, and more (8.4 GHz and 2.3 GHz).*

Cosmic Ray Instrument: *Measures, in the spacecraft's immediate environment: the energy spectrum of electrons (3-110 MeV) and the energy and composition of nuclei (1-500 MeV/nuc, H to Fe).*

Plasma Instrument: *Measures the density, pressure, and velocity of plasma in the spacecraft's immediate environment (10 eV to 6 keV).*

High-Field Magnetometers *are sensitive to stronger magnetic fields in the spacecraft's immediate environment than the low-field sensors are.*

Scan Platform can be commanded to point its five optical remote-sensing instruments in specified directions, with two degrees of freedom. At times, intricate maneuvers are also performed to help position the instruments, or to carefully track fast-moving targets.

Low-Energy Charged Particle Instrument *examines electrons and ions in the spacecraft's immediate environment. Starting around 10 keV, its ranges of sensitivity overlap into the Cosmic Ray Instrument's coverage.*

Imaging Science Instruments: *Wide-angle camera (above) and narrow-angle camera (below) on the scan platform provide high-resolution images in visible light. Color pictures are obtained by combining images taken through different filters. Image sensors are videcon tubes.*

Photopolarimeter *on the scan platform measures intensity and polarization of light in visible and ultraviolet wavelengths. Examines surfaces, rings, and atmospheric particles. Can observe stellar occultations. Note: the Brewster Plate atop Bay 2 (see model) was designed for calibrating the instrument.*

Plume Shield separated the RTGs from exhaust from the (now detached) propulsion module during launch.

Canopus Star Tracker acts as a roll reference by watching Canopus or another selected bright star.

Radioisotope Thermoelectric Generators produce a supply of electric current, about 400 Watts at launch, from banks of thermocouples heated by the decay of radioactive material, and the cooling effect of radiator fins. Note: struts still attached to the RTGs supported them in their launch position.

Spacecraft Bus structure houses electronics and computers for attitude control and scan platform pointing, command processing, flight and science data processing. Also houses components such as radios, data storage tape recorder, and propulsion equipment.

Propellant Tank contained 100 kg of hydrazine at launch. The hydrazine is used by small thrusters to continually stabilize the spacecraft's attitude, and make infrequent minor course corrections. Note: An additional propulsion module was jettisoned from the lower part of the spacecraft after launch.

Calibration Target Plate is a known shade of grey for image calibration. Also supports the shunt-type voltage regulator in the spacecraft's electrical power system. At known power levels, the regulator produces known heat levels which the target plate radiates, and can serve to calibrate the infrared instrument.

Planetary Radio Astronomy Instrument *uses a 10-m long dipole antenna to sense radio waves being generated by planetary systems (1.2 kHz to 40.5 MHz).*

Plasma Wave Instrument *shares the Planetary Radio Astronomy instrument's antenna. Measures the electric field components of plasma waves in the spacecraft's immediate environment (10 Hz to 56 kHz).*

Thermal Control Louvers: Mechanical devices which open and close automatically to control radiation of heat from within the spacecraft. Located at various places on spacecraft bus, science instruments, and sun sensor.

Ultraviolet Spectrometer *on the scan platform is sensitive to wavelengths of 50 to 170 nm. In addition to making observations during planetary encounters, it is used frequently to observe targets of astronomical interest outside the solar system.*

Infrared Interferometer Spectrometer / Radiometer *on the scan platform measures the thermal, compositional, and structural nature of its targets (Interferometer range: 4 to 55 microns; radiometer: 0.33 to 2 microns).*

The Record of Messages and Images from Earth contains pictures and sounds describing life on earth, and greetings in many languages. This record is carried for the remote possibility of an alien civilization in another star system finding the spacecraft. The Voyagers will never return to the Sun, but will drift in orbit about the galactic center for eons. They will pass the Sun's stellar neighbors after spans of time measured in hundreds of thousands of years, long after they have fallen silent.