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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
Washington, D. C. 20546



(NASA-News-Release-72-25)
MISSION TO JUPITER
(NASA) 20 Feb. 1972 H.G. Allaway, et al
6 p

FOR RELEASE:

FEBRUARY 20, 1972

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RELEASE NO: 72-25

PIONEER F MISSION TO JUPITER

FACILITY FORM 602

(ACCESSION)

(PAGES) 63/30

(NASA CR OR TMX OR AD NUMBER)

Unclas
17367

N72-18831

Man will reach out beyond Mars to take the first close look at the planet Jupiter on the mission of the unmanned Pioneer F spacecraft, to be launched by the National Aeronautics and Space Administration from Cape Kennedy, Fla., between Feb. 27 and March 13, 1972.

The trip to Jupiter will last less than two years, for most launch dates, with most arrival times before Dec. 31, 1973.

Jupiter is a spectacular planet. It appears to have its own internal energy source and is so massive that it is almost a small star. It may have the necessary ingredients to produce life. Its volume is 1,000 times that of Earth, and it has more than twice the mass of all the other planets combined. Striped in glowing yellow-orange and blue-gray, it floats in space like a bright-colored rubber ball. It has a huge red "eye" in its southern hemisphere and spins more than twice as fast as Earth.

The mission includes a number of other firsts. Pioneer F is expected to make the first reconnaissance of the Asteroid Belt between the orbits of Mars and Jupiter. It is planned to be the first man-made object to escape the solar system, and the first to use the orbital velocity and powerful gravity of Jupiter for this escape. It is also the first NASA spacecraft to draw its electrical power entirely from nuclear generators, four radioisotope thermoelectric generators (RTGs) developed by the Atomic Energy Commission.

The Atlas-Centaur-TE-M-364-4 launch vehicle will drive the spacecraft away from the Earth initially at 51,800 kilometers per hour (32,000 miles per hour) -- faster than any man-made object has flown before. At this time the spacecraft will be named Pioneer 10. For the first week, it will travel an average of 800,000 kilometers (a half-million miles) a day. It will pass the Moon's orbit in about 11 hours.

Pioneer's 13 scientific experiments are expected to provide new knowledge about Jupiter and many aspects of the outer solar system and our galaxy. It will return the first close-up images of Jupiter, and will make the first measurements of Jupiter's twilight side, never seen from the Earth.

The mission opens the era of exploration of the outer planets, since it is intended in part to develop technology for other outer planet missions.

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FACILITY FORM 602	(ACCESSION NUMBER)	(THRU)
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The spacecraft will test out the hazards of cosmic debris in the Asteroid Belt. It will probe Jupiter's radiation belts, which could cripple or destroy a spacecraft approaching too closely. The belts are estimated to be as much as one million times more intense than Earth's Van Allen radiation belts.

Jupiter is so far away that radio messages moving at the speed of light will take 45 minutes to reach the spacecraft there, with a round trip time of 90 minutes. This will demand precisely planned command operations. Although Pioneer can store five commands, it will be controlled mostly by frequent instructions from Earth.

To carry out the mission, the advanced communications technology of NASA's Deep Space Network (DSN) will be strained to the limit. The DSN's 64-meter (210-foot) "big dish" antennas, one of which now hears the Mariner 9 spacecraft in Mars orbit will have to hear seven times as far as Pioneer approaches Jupiter.

Pioneer's eight-watt signal, transmitted from Jupiter, will reach DSN antennas with a power of 1/100,000,000,000,000,000 watts. Collected for 19 million years, this energy would light a 7.5-watt Christmas tree bulb for one-thousandth of a second.

Pioneer F is a new design for the outer solar system, but it retains many tested subsystems of its predecessors, the Pioneer 6 to 9 spacecraft. All four are still operating in interplanetary space. Pioneer 6 is in its seventh year.

The 260-kilogram (570-pound) Pioneer F is spin-stabilized, giving its instruments a full-circle scan. It uses nuclear sources for electric power because solar radiation is too weak at Jupiter for an efficient solar-powered system.

Its 2.75-meter (nine-foot) dish antenna will be locked on the Earth like a big eye throughout the mission -- changing its view direction as the home planet moves to and fro in its orbit around the Sun. The entire flight path is in, or very close to, the plane of Earth's orbit, the ecliptic.

Jupiter itself is little understood.

It broadcasts predictably modulated radio signals of enormous power. Though it has only 1/1000th the mass of the Sun, it may have Sun-like internal processes, apparently radiating about four times as much energy as it receives from solar radiation.

In addition to helium, the planet's atmosphere contains ammonia, methane, hydrogen, and probably water, the same ingredients believed to have produced life on Earth about four billion years ago. Because of the planet's internal heat source, many scientists believe that large regions below the frigid cloud layer are around room temperature. These conditions could allow the planet to produce living organisms despite the fact that it receives only 1/27th of the solar energy received by the Earth.

Jupiter is probably more than 75 percent hydrogen, the main constituent of the universe. The planet may have no solid surface. Due to its high gravity, it may go from a thick gaseous atmosphere down to oceans of liquid hydrogen, to a slushy layer, and then to a solid hydrogen core. Ideas of how deep beneath its striped cloud layers any solid hydrogen "icebergs" or "continents" might lie vary by thousands of kilometers.

Astronomers have long seen violent circulation of the planet's large-scale cloud features. A point on Jupiter's equator moves at 35,400 km/hr (22,000 mph), compared with 1,600 km/hr (1,000 mph) for a similar point on Earth's equator.

The most bizarre feature of the planet is the Great Red Spot, known as the "Eye of Jupiter." This huge oval is 48,000 kilometers (30,000 miles) long and 13,000 kilometers (8,000 miles) wide, large enough to swallow up several Earths with ease. The Red Spot may be an enormous standing column of gas, or, says one scientist, a "raft" of hydrogen ice floating on a bubble of warm hydrogen in the cooler hydrogen atmosphere, and bobbing up and down at 30-year intervals, so that the Spot disappears and reappears. The Spot appears to rotate at a different speed from the planet. Its red color may be due to the presence of organic compounds found in a gigantic lightning charge in the Jovian atmosphere, according to one theory.

Potential benefits of the Pioneer Jupiter mission and others like it include increased knowledge of "collisionless plasmas" of the solar wind. This bears directly on the "ultimate" clean system for electric power production, controlled hydrogen fusion. The findings may also lead to better understanding of Earth's weather cycles, and to insights into Earth's atmosphere circulation through study of Jupiter's rapidly rotating atmosphere. There may also be indications of Jovian resources, such as perhaps a quantity of petrochemicals equivalent to Earth's consumption for a million years.

Pioneer F spacecraft will carry a 30-kilogram (65-pound) experiment payload. It will make 20 types of measurements of Jupiter's atmosphere, radiation belts, heat balance, magnetic field, moons, and other phenomena. It also will characterize the heliosphere (solar atmosphere); perhaps the interstellar gas; cosmic rays; asteroids; and meteoroids between the Earth and 2.4 billion kilometers (1.5 billion miles) from the Sun.

A second, almost identical spacecraft, Pioneer G, will be launched to Jupiter in early April of 1973.

NASA's Office of Space Science assigned project management for the two Pioneer Jupiter spacecraft to NASA's Ames Research Center, Mountain View, Calif., near San Francisco. The spacecraft are built by TRW Systems, Redondo Beach, Calif. The scientific instruments are supplied by NASA Centers, universities and private industry.

Tracking is by NASA's Deep Space Network, operated by the Jet Propulsion Laboratory, Pasadena, Calif. NASA's Lewis Research Center, Cleveland, manages the launch vehicle, which is built by General Dynamics, San Diego, Calif.

Cost of two Pioneer Jupiter spacecraft, scientific instruments, and data processing and analysis is about \$100 million. This does not include costs of launch vehicles and data acquisition.

The 30-minute evening launch window opens progressively earlier each day -- approximately 9:00 pm EST, on Feb. 27, and at 7:00 pm by March 13, 1972.

Depending on launch date, the trip to Jupiter will take from 630 to 795 days with arrival dates between Nov. 21, 1973, and July 27, 1974.