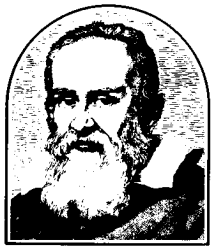
SECTION 6



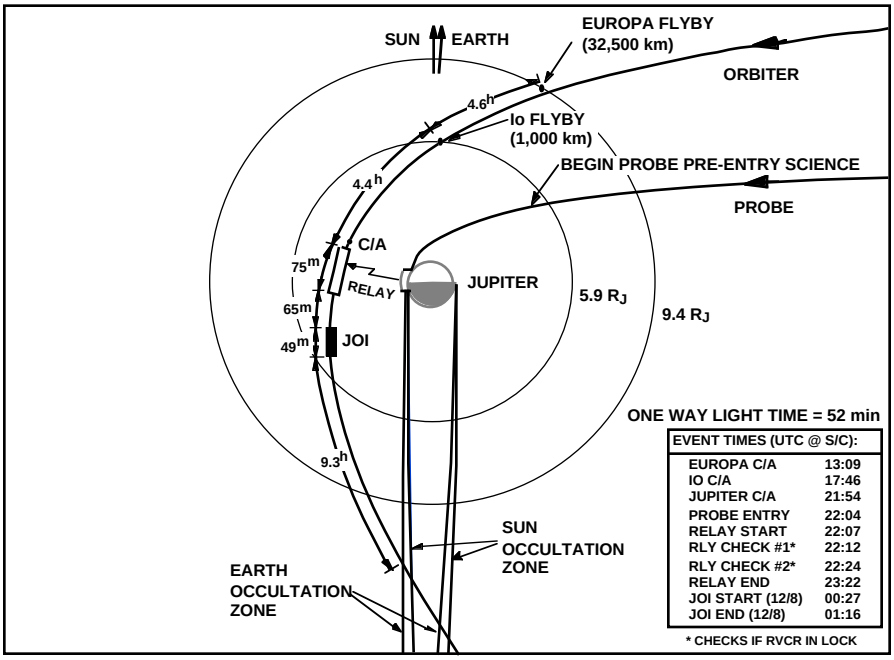
ARRIVAL AT JUPITER

It was a day of anticipation—tension too—as the men and women of Project Galileo watched and waited. The presence of NASA dignitaries; friends and families; and the press, supported by television crews, contributed to the excitement. Data telling the story of events happening over 900 million kilometers away took 52 minutes (the one-way light time for a radio signal to traverse the space between Jupiter and Earth) to be received by the Jet Propulsion Laboratory via the Deep Space Network stations. During the long day, experts analyzed the precious stream of data; then commentators vividly portrayed the news of spacecraft and probe activity for viewing on television monitors throughout the Laboratory. Word of the ongoing success of the mission circled the globe, headlined in newspapers and television. By evening, the celebration was on. All had gone well. There had been no problems!

So Much To Do

The 24 hours of Arrival Day—December 7, 1995—were the busiest of the whole mission. The orbiter flew close to two of the Galilean satellites, listened as the probe plunged into the atmosphere, and performed a large burn to slow itself down and get into orbit.

Arrival Day Events
December 7, 1995

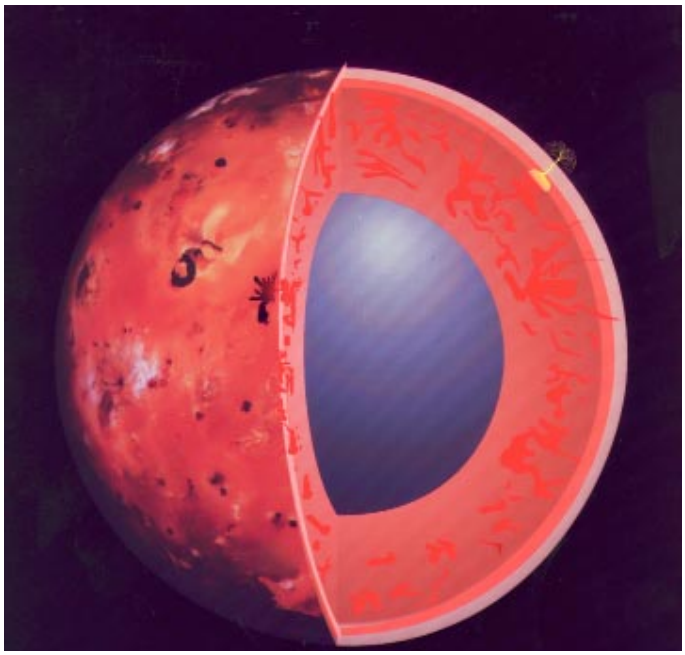


We Fly By Two Moons

The orbiter passed about 32,500 kilometers from Europa and will return for in-depth study three times during its 2-year operation in the Jovian system. Less than 5 hours after Europa, the orbiter flew by Io at about 900 kilometers (559 miles). Because of the tape recorder problem, no pictures (which require high tape recorder rates) were taken of either moon. For Io, especially, this is a great loss. (Currently, there is no plan for further close encounters because of the intense radiation, but Io will be monitored from intermediate ranges throughout the tour.) The tape recorder was able to record (at a low rate) fields and particles data on the Io plasma torus for three and one-half hours, ending one-half hour after closest approach. The tape recorder stopped one-half hour after the Io flyby and waited for the probe relay. Fields and particles recording resumed after the relay.

Io Has An Iron Core!

Yes, we now know the theory to be true. Io has an iron core. It is dense and gigantic, taking up half of the moon's diameter. Scientists took advantage of this closest approach by any spacecraft to conduct a celestial mechanics experiment (see Radio Science, The Galileo Orbiter section). The pull of Io's gravitational field altered the orbiter's speed slightly, causing changes in frequency of the signal radioed to Earth. Analysis of the data indicates that Io has a two-layer structure, a metallic core (probably made of iron and iron sulfide) about 900 kilometers (559 miles) in radius, surrounded by partially molten rock and crust. The core was probably formed from heating in the interior of the moon, either when it originally formed or as a result of the perpetual tidal heating driving its volcanoes.



The Core Revealed

And A Magnetosphere?

Surprise! Besides verifying the existence of Io's core of iron, the Galileo magnetometer detected a large cavity (a region where the strength of the magnetic field decreased greatly) in Jupiter's magnetic field as it passed near this moon. This phenomenon could indicate that two magnetospheres are in contact with one another, one being inside the other. Galileo fields and particles instruments will try to answer the question: does Io generate its own magnetosphere? If so, it would be the only moon known to do so. There is also mounting evidence that Io is the source of the amazing high-velocity dust streams apparently coming from the Jovian system.

A Close Approach

When the orbiter crossed Io's orbit, the probe had already been awakened from its 150-day cruise. An hour later, its first instrument (LRD/EPI) began measurements of the high energy particles encircling Jupiter. About 4 hours after leaving Io, the orbiter made its closest approach to Jupiter. The radiation was intense, perhaps 25 times more than is deadly for humans. In fact, a third of the total expected radiation dose for the whole 2-year tour at Jupiter might have been absorbed on this one day.

What really happened? Star scanner data suggested that the radiation flux had a different profile than prelaunch expectations. Further analysis can be made after we receive the Arrival Day fields and particles data (awaiting playback from the tape in mid-June). Meanwhile, there is no evidence of any radiation-induced anomalous effects; the spacecraft and its instruments have been and continue to perform normally.

Eight minutes after closest approach to Jupiter, the tape recorder started again in preparation for storing probe data and engineering data from the Jupiter orbit insertion (JOI) maneuver. The orbiter was 215,000 kilometers (134,000 miles) above the probe—ready for the radio relay.

The Probe Descent

Three minutes later, the sturdy probe withstood a structural load 230 times the acceleration of Earth-surface gravity, and temperatures twice as hot as the Sun's surface as it slammed into the top of Jupiter's atmosphere at the comet-like speed of 170,000 kilometers per hour (106,000 miles per hour). Two minutes into entry, the probe had slowed enough to deploy its parachutes and drop what was left of the heat shield. A minute later, the parachute deployment occurred (nearly a minute late).

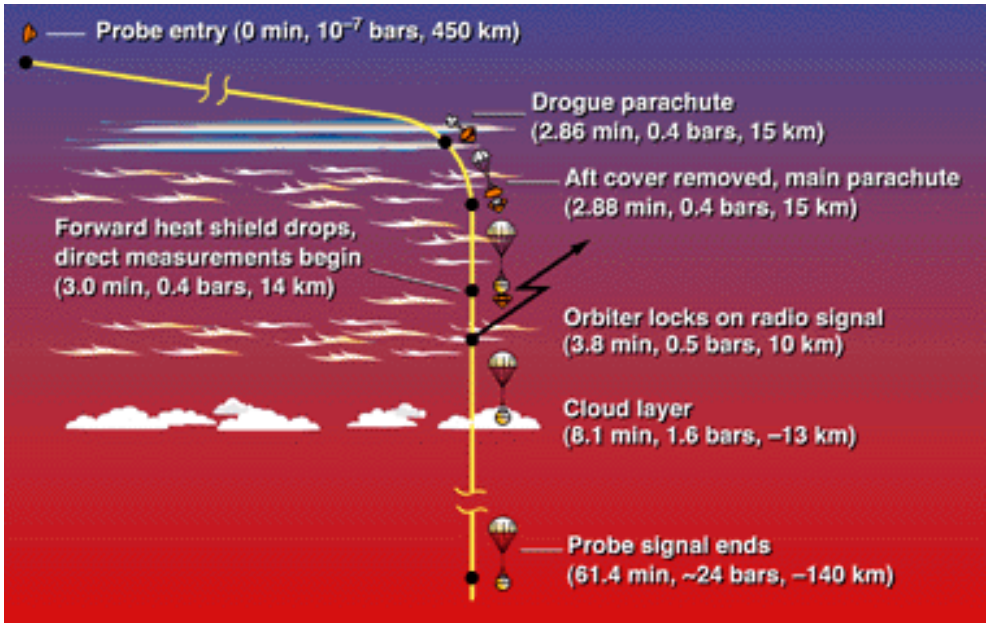
Thirty-five seconds later, the probe began to transmit its data (much of it redundant) to the orbiter at 128 bits per second per string (channel). The probe transmitted reports on the sunlight and heat flux, pressure, temperature, lightning activity, winds, and composition and structure of the atmosphere, as well as energetic particles measurements acquired during pre-entry. Only traces of the anticipated ammonia and ammonium hydrosulfide cloud layers were believed to have been detected.

Some 8 minutes after it entered the atmosphere, the probe was expected to approach the tops of water clouds, but none were encountered. The probe sensed stronger winds than expected and evidence of distant though very intense lightning.

The probe's internal temperature was more closely coupled to that of the atmosphere than had been expected. Consequently, the science instrument temperatures exceeded operational limits. Nevertheless, all the instruments worked. To confirm the accuracy of the data acquired by the instruments at lower altitudes and under these extreme conditions, scientists plan to recalibrate some of the flight spares, tested to the actual temperature profile experienced by the probe.

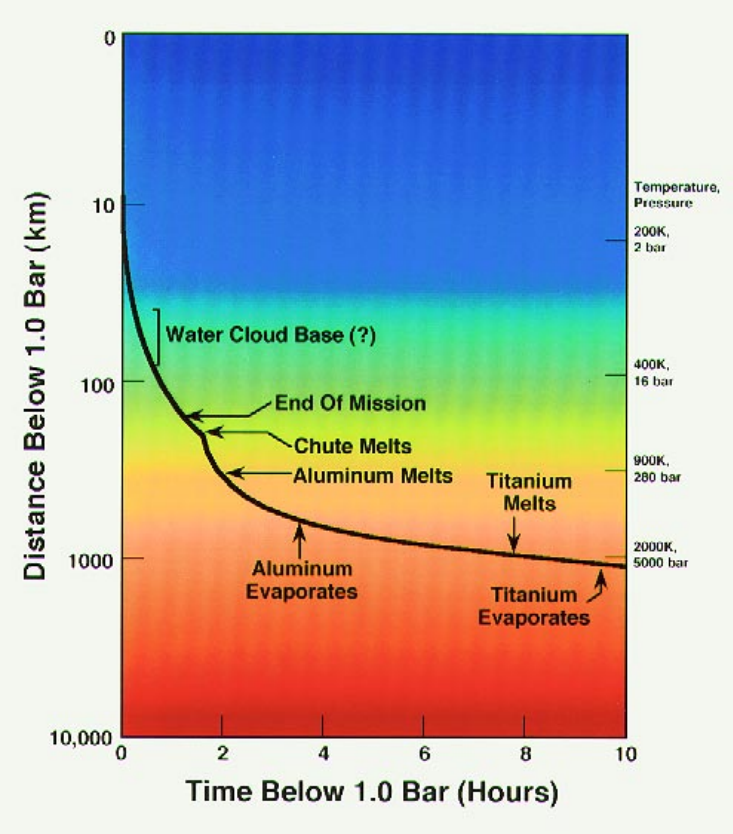
Thirty-two minutes past entry, the orbiter's articulated relay radio antenna slewed to compensate for the probe's changing position below it. The spacecraft slewed three more times at 10-minute intervals to maintain lock. The probe continued to transmit data for 57.6 minutes until the 24-bar level (152 degrees Celsius and 140 kilometers below the 1-bar pressure level).

The Probe Fulfills Its Mission



The Fate of the Galileo Probe

Scientists believe that as it continued to fall into the planet after completion of its mission, the probe melted, then evaporated in the intense heat (at the 5000-bar level, 1700 degrees Celsius). It was reduced to its atomic components and is now one with the atmosphere of Jupiter.



Into the Depths of Jupiter

JOI— A Critical Maneuver

Unlike other maneuvers the orbiter had done, there was only one chance to get JOI right. An error could have sent Galileo flying past Jupiter! The orbiter spun up to 10.5 rpm as soon after completion of the probe relay as possible to guarantee orientation and stability during the burn. The orbiter then fired the 400-newton engine to slow its speed by 643 meters per second. The burn, which began 82 minutes after the end of probe relay, lasted 49 minutes. The expert DSN tracking, on-target navigation (without the use of optics, since imaging had been eliminated during approach), and a perfect JOI placed Galileo in the desired orbit.

Earth Occultation

Nine hours after engine cutoff, Earth disappeared behind the disk of Jupiter. Fifty minutes later, the Sun passed behind Jupiter, too, and the orbiter was in darkness for the first time in years. Finally, after 3 and 1/2 hours of radio silence, the Earth reappeared to the orbiter, and contact was reestablished. The Sun reappeared 47 minutes later. The orbiter, alive and well, was on its 7-month first orbit in the Jovian system!