

<https://science.nasa.gov/mission/voyager/where-are-voyager-1-and-voyager-2-now/>

Mission status data for Voyager 1 and Voyager 2 as of October 14, 2025

10/14/25, 1:25 PM

Where Are Voyager 1 and 2 Now? - NASA Science

	Voyager 1	Voyager 2
Launch Date	Mon, 05 Sept 1977 12:56:00 UTC	Sat, 20 Aug 1977 14:29:00 UTC
Mission Elapsed Time	48: 01: 09: 04: 29: 53 <small>YRS MOS DAYS HRS MINS SECS</small>	48: 01: 24: 02: 56: 53 <small>YRS MOS DAYS HRS MINS SECS</small>
Distance from Earth	15,709,189,949 mi 168.99637871 AU	13,089,348,936 mi 140.81264388 AU
Distance from the Sun	15,668,819,265 mi 168.56207883 AU	13,109,993,390 mi 141.03473285 AU
Velocity with Respect to the Sun (est.)	38,026.77 mph	34,390.98 mph
One-Way Light Time	23:25:30 (hh:mm:ss)	19:31:06 (hh:mm:ss)

<https://ntrs.nasa.gov/citations/19770029162>)

The Pioneer 11 radio occultation measurements of the Jovian ionosphere. Radio occultation data obtained with the Pioneer 11 spacecraft are utilized to study Jupiter's ionosphere. The ingress measurements, which were conducted by using a stable earth-based frequency reference for the tracking link, yielded ionospheric data near the morning terminator at about 79 deg south latitude. Data were also taken during egress on the evening side near 20 deg north latitude. The latter measurements were conducted in the one-way mode; i.e., an on-board crystal oscillator was employed as a frequency reference for the downlink (spacecraft-to-earth) signal. These data confirm previous results obtained with Pioneer 10 and show that Jupiter has a multilayered ionosphere extending over an altitude range of more than 3000 km. The topside scale height near 79 deg south latitude was 540 + or - 60 km. Assuming a topside electron, H(+) distribution controlled by diffusion yields a plasma temperature of 850 + or - 100 K in this region. The radio data indicate that the upper atmosphere is either warmer or more dissociated into atomic hydrogen than previously anticipated.

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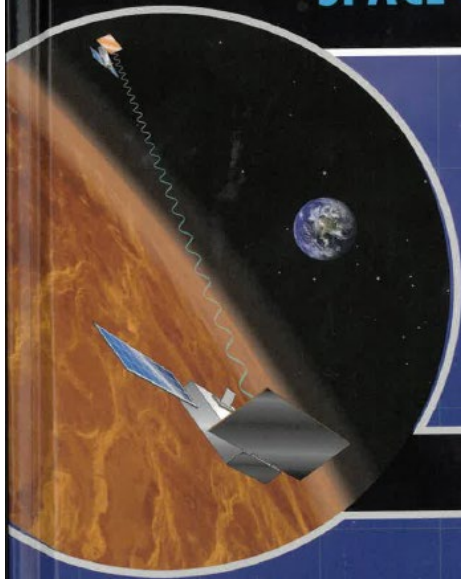
Location: Tucson, AZ

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JON HAMKINS, SERIES EDITOR

JPL DEEP-SPACE COMMUNICATIONS AND NAVIGATION SERIES

RADIO SCIENCE TECHNIQUES FOR DEEP SPACE EXPLORATION



SAMI W. ASMAR

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GRAIL and the Lunar Reconnaissance Orbiter (LRO) missions. On MGS, the Mars Orbiter Laser Altimeter (MOLA) described in Zuber et al. (1992), produced a high-resolution topography field that was correlated with the gravity field measured by the same mission (sometimes, also combined with historical data) leading to important discoveries (Zuber et al. 2000; McGovern et al. 2002). GRAIL did not carry an altimeter, but LRO was in operation in the same time period and carried the Lunar Orbiter Laser Altimeter (LOLA). Science teams used the GRAIL gravity data and LRO altimetry data to produce high-resolution correlations between the two data sets (Zuber et al. 2013b).

5.3.1 Spacecraft Ultrastable Oscillator

5.3.1.1 Purpose and Historical Development

The USO was developed for the purpose of carrying out planetary RO experiments in the one-way mode where there is a stable reference on each end of the link, spacecraft and ground station, or between two spacecraft. Reasons for carrying out the experiment in the one-way mode with a USO include:

- It eliminates the double propagation of the uplink and downlink signals in the same planetary medium under study. The double propagation requires more complex processing (Schinder et al. 2012; Hinson et al. 2008; Hinson et al. 2014; Tellmann et al. 2013), which is further complicated in cases of multi-path signal conditions in the planetary atmosphere (Fjeldbo et al. 1975; Lipa and Tyler 1979). The preferred one-way signal travels from the spacecraft through the medium once. This is typically a downlink configuration but, for the Pluto one-way uplink experiment, the direction was reversed and data were stored on the spacecraft then played back as telemetry files (Tyler et al. 2009).
- It eliminates the time needed by the transponder to lock-up on the uplink signal when the spacecraft is emerging from behind the occulting planetary body. Although the lock-up time can be short (a few seconds to a few minutes, depending on the atmospheric density, uplink SNR, sweep rate, etc.), this delay can be comparable to the length of the observation and cause the loss of the egress experiment in the lower atmospheric region. With a USO, the spacecraft can already be transmitting prior to the beginning of the occultation egress without loss of data.

Without a USO, the transponder's built-in auxiliary oscillator is not sufficiently stable to extract scientifically meaningful data (unless the aux osc stability improves significantly in the future). However, without a USO, an occultation experiment can be carried out in the two-way mode for ingress only (immersion). To clarify these issues, in a highly instructive 1975 paper on the Pioneer 10 RO of Jupiter's ionosphere at S-band (~2.1 GHz), Gunnar Fjeldbo (also known as Gunnar Lindal) and his team of RS pioneers discuss the use of an onboard auxiliary oscillator (referred to as the crystal oscillator, not thermally controlled) and summarize the state of the art at that time as well as the evolving thinking on the instrumentation due to the dilemma they faced prior to the invention of the USO for the Voyager program. The comment "considering to conduct the Pioneer 11 immersion measurements at Jupiter in the two-way mode" was addressed in Section 5.2.2.1. Fjeldbo et al. (1975) stated:

In view of the unexpectedly large topside scale height and temperature revealed by the Pioneer 10 data, we are now considering to conduct the Pioneer 11 immersion measurements at Jupiter in the two-way mode. In this tracking mode, a stable Earth-based oscillator (either a hydrogen maser or a rubidium vapor oscillator) is used to generate a 2.1-GHz uplink carrier. The spacecraft's radio transponder coherently translates the frequency of the uplink signal to approximately 2.3 GHz and retransmits the new RF carrier back to the tracking station where the difference between the uplink and downlink frequencies can be measured. Since the stability of any one of the available ground-based frequency standards is at least an order of magnitude higher than the stability of the spacecraft crystal oscillator, the two-way measurements can be expected to help substantially reduce the current uncertainty in the topside plasma scale height and temperature. Of course, two-way tracking will not yield reliable data in the lower ionosphere where multipath on the uplink may cause the spacecraft's phase-locked loop receiver to change lock from one signal mode to another in an unpredictable manner. However, this disadvantage is not a serious problem since one-way emission measurements can provide more data on the lower ionosphere.

Due to these challenges on Solar System missions, the first flight instrument developed specifically for RS enhancement was the USO, called the "single most dramatic improvement in radiometric performance" by G. L. Tyler (1987). The USO was developed for the Voyager atmospheric and ring RO experiments to provide a stable reference for the transponder as it transmits a one-way downlink signal to Earth.

The Voyager RS team leader at Stanford University charged a JPL team member, the late Gordon Wood, to partner with industry to develop a very stable clock small enough to fly on the Voyager spacecraft. **Frequency Electronics Inc. (FEI) of Long Island, NY, was selected (its founder Martin Bloch and Gordon Wood coined the "ultra-stable" classification).** Specifications were derived from the objectives of the Voyager investigations at the outer planets as well as the available technology.

After a prototype unit met the requirements, NASA procured five flight-qualified USOs. Voyager 1 and Voyager 2 carried one each, and the Galileo orbiter later carried USO serial 4 from that batch, later called the 10^{-12} class of stability. The Voyager USOs have since left our Solar System, although the Voyager 1 USO stopped functioning circa 1992 after successfully completing all its required scientific functions at planetary flybys. The Voyager 2 USO is still used for one-way communications at record distances and record longevity. USOs have been single-string science instruments while the transponders they are connected to (cross-strapped) are redundant.

After Voyager and Galileo, Cassini as well as orbiters at Mars, Venus, the Moon, and other planetary and Earth missions (listed in Asmar 2012b and updated in Table 5.1) have carried USOs from various manufacturers including FEI and the Johns Hopkins University Applied Physics Laboratory (APL); see example in Asmar et al. (2019). The post-Voyager USO models were as much as an order of magnitude better in their stability, the 10^{-13} class of stability. This was needed for Mars RO experiments where the atmosphere is significantly less dense than the outer planets. The first of these was flown on MGS, which, for a decade, carried thousands of atmospheric occultations with extremely valuable scientific results.

- 1) . Asmar, Sami (2022). *Radio Science Techniques for Deep Space Exploration* Page 204 para 5.3.1.1
- 2) . Asmar, Sami (2022). *Radio Science Techniques for Deep Space Exploration* Page 204 para 5.3.1.1

<https://science.nasa.gov/blogs/voyager/2024/10/01/nasa-turns-off-science-instrument-to-save-voyager-2-power/>

NASA Turns Off Science Instrument to Save Voyager 2 Power



Engineers work on NASA's Voyager 2 at JPL in March 1977, ahead of the spacecraft's launch that August. The probe carries 10 science instruments, some of which have been turned off over the years to save power. Credit: NASA NASA

Mission engineers at NASA have turned off the plasma science instrument aboard the Voyager 2 spacecraft due to the probe's gradually shrinking electrical power supply.

Traveling more than 12.8 billion miles (20.5 billion kilometers) from Earth, the spacecraft continues to use four science instruments to study the region outside our heliosphere, the protective bubble of particles and magnetic fields created by the Sun. The probe has enough power to continue exploring this region with at least one operational science instrument into the 2030s.

Mission engineers have taken steps to avoid turning off a science instrument for as long as possible because the science data collected by the twin Voyager probes is unique. No other human-made spacecraft has operated in interstellar space, the region outside the heliosphere.

The plasma science instrument measures the amount of plasma (electrically charged atoms) and the direction it is flowing. It has collected limited data in recent years due to its orientation relative to the direction that plasma is flowing in interstellar space.

Both spacecraft are powered by decaying plutonium and lose about 4 watts of power each year. After the twin Voyagers completed their exploration of the giant planets in the 1980s, the mission team turned off several science instruments that would not be used in the study of interstellar space. That gave the spacecraft plenty of extra power until a few years ago. Since then, the team has turned off all onboard systems not essential for keeping the probes working, including some heaters. In order to postpone having to shut off another science instrument, they also adjusted how Voyager 2' voltage is monitored.

Monitoring Results

On Sept. 26, engineers issued the command to turn off the plasma science instrument. Sent by NASA's Deep Space Network, it took 19 hours to reach Voyager 2, and the return signal took another 19 hours to reach Earth.

Mission engineers always carefully monitor changes being made to the 47-year-old spacecraft's operations to ensure they don't generate any unwanted secondary effects. The team has confirmed that the switch-off command was executed without incident and the probe is operating normally.

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An artist's concept depicts one of NASA's Voyager probes. The twin spacecraft launched in 1977.
NASA/JPL-Caltech

Where are Voyager 1 and Voyager 2 Now? Excerpt

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Where Are Voyager 1 and 2 Now? - NASA Science

Voyager diagram
NASA/JPL-Caltech

Instrument	Voyager 1	Voyager 2
Cosmic Ray Subsystem (CRS)	Off to save power (Feb 25, 2025)	On
Low-Energy Charged Particles (LECP)	On	Off to save power (Mar 24, 2025)
Magnetometer (MAG)	On	On
Plasma Wave Subsystem (PWS)	On	On
Plasma Science (PLS)	Off because of degraded performance (Feb 1, 2007)	Off to save power (Sep 26, 2024)
Imaging Science Subsystem (ISS)	Wide-angle and narrow-angle cameras off to save power (Feb. 14, 1990)	Wide-angle and narrow angle cameras off to save power (Oct 10 and Dec 5, 1989)
Infrared Interferometer Spectrometer and Radiometer (IRIS)	Off to save power (Jun 3, 1998)	Off to save power (Feb 1, 2007)
Photopolarimeter Subsystem (PPS)	Off because of degraded performance (Jan 29, 1980)	Off because of degraded performance (Apr 3, 1991)
Planetary Radio Astronomy (PRA)	Off to save power (Jan 15, 2008)	Off to save power (Feb 21, 2008)

Plasma Science/USO Turned off September