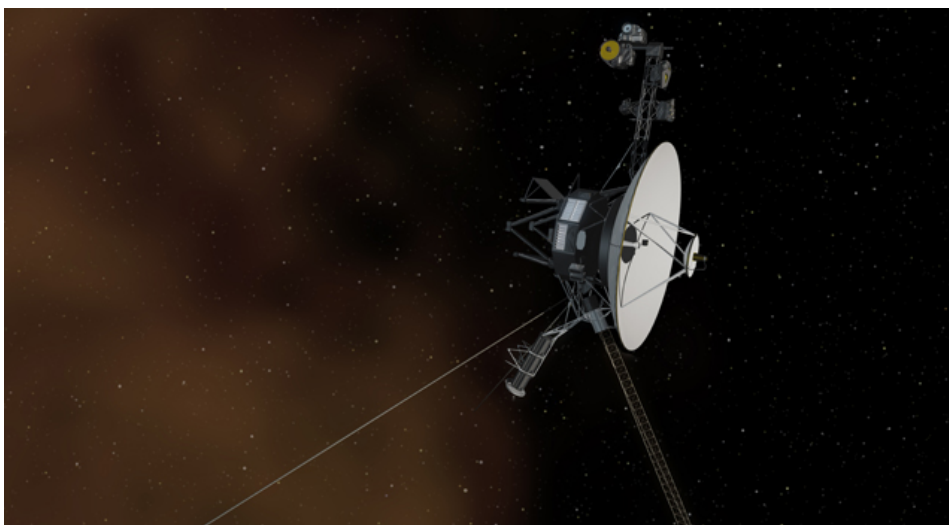


NASA Spacecraft Embarks on Historic Journey Into Interstellar Space



The Space Between: This artist's concept shows the Voyager 1 spacecraft entering the space between stars. Interstellar space is dominated by plasma, ionized gas (illustrated here as brownish haze), that was thrown off by giant stars millions of years ago. Image credit: NASA/JPL-Caltech

[Full image and caption](#)

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PASADENA, Calif. -- NASA's Voyager 1 spacecraft officially is the first human-made object to venture into interstellar space. The 36-year-old probe is about 12 billion miles (19 billion kilometers) from our sun.

New and unexpected data indicate Voyager 1 has been traveling for about one year through plasma, or ionized gas, present in the space between stars. Voyager is in a transitional region immediately outside the solar bubble, where some effects from our sun are still evident. A report on the analysis of this new data, an effort led by Don Gurnett and the plasma wave science team at the University of Iowa, Iowa City, is published in Thursday's edition of the journal *Science*.

"Now that we have new, key data, we believe this is mankind's historic leap into interstellar space," said Ed Stone, Voyager project scientist based at the California Institute of Technology, Pasadena. "The Voyager team needed time to analyze those observations and make sense of them. But we can now answer the question we've all been asking -- 'Are we there yet?' Yes, we are."

Voyager 1 first detected the increased pressure of interstellar space on the heliosphere, the bubble of charged particles surrounding the sun that reaches far beyond the outer planets, in 2004. Scientists then ramped up their search for evidence of the spacecraft's interstellar arrival, knowing the data analysis and interpretation could take months or years.

Voyager 1 does not have a working plasma sensor, so scientists needed a different way to measure the spacecraft's plasma environment to make a definitive determination of its location. A coronal mass ejection, or a massive burst of solar wind and magnetic fields, that erupted from the sun in March 2012 provided scientists the data they needed. When this unexpected gift from the sun eventually arrived at Voyager 1's location 13 months later, in April 2013, the plasma around the spacecraft began to vibrate like a violin string. On April 9, Voyager 1's plasma wave instrument detected the movement. The pitch of the oscillations helped scientists determine the density of the plasma. The particular oscillations meant the spacecraft was bathed in plasma more than 40 times denser than what they had encountered in the outer layer of the heliosphere. Density of this sort is to be expected in interstellar space.

The plasma wave science team reviewed its data and found an earlier, fainter set of oscillations in October and November 2012. Through extrapolation of measured plasma densities from both events, the team determined Voyager 1 first entered interstellar space in August 2012.

"We literally jumped out of our seats when we saw these oscillations in our data -- they showed us the spacecraft was in an entirely new region, comparable to what was expected in interstellar space, and totally different than in the solar bubble," Gurnett said. "Clearly we had passed through the heliopause, which is the long-hypothesized boundary between the solar plasma and the interstellar plasma."

The new plasma data suggested a timeframe consistent with abrupt, durable changes in the density of energetic particles that were first detected on Aug. 25, 2012. The Voyager team generally accepts this date as the date of interstellar arrival. The charged particle and plasma changes were what would have been expected during a crossing of the heliopause.

"The team's hard work to build durable spacecraft and carefully manage the Voyager spacecraft's limited resources paid off in another first for NASA and humanity," said Suzanne Dodd, Voyager project manager, based at NASA's Jet Propulsion Laboratory, Pasadena, Calif. "We expect the fields and particles science instruments on Voyager will continue to send back data through at least 2020. We can't wait to see what the Voyager instruments show us next about deep space."

Voyager 1 and its twin, Voyager 2, were launched 16 days apart in 1977. Both spacecraft flew by Jupiter and Saturn. Voyager 2 also flew

by Uranus and Neptune. Voyager 2, launched before Voyager 1, is the longest continuously operated spacecraft. It is about 9.5 billion miles (15 billion kilometers) away from our sun.

Voyager mission controllers still talk to or receive data from Voyager 1 and Voyager 2 every day, though the emitted signals are currently very dim, at about 23 watts -- the power of a refrigerator light bulb. By the time the signals get to Earth, they are a fraction of a billion-billionth of a watt. Data from Voyager 1's instruments are transmitted to Earth typically at 160 bits per second, and captured by 34- and 70-meter NASA Deep Space Network stations. Traveling at the speed of light, a signal from Voyager 1 takes about 17 hours to travel to Earth. After the data are transmitted to JPL and processed by the science teams, Voyager data are made publicly available.

"Voyager has boldly gone where no probe has gone before, marking one of the most significant technological achievements in the annals of the history of science, and adding a new chapter in human scientific dreams and endeavors," said John Grunsfeld, NASA's associate administrator for science in Washington. "Perhaps some future deep space explorers will catch up with Voyager, our first interstellar envoy, and reflect on how this intrepid spacecraft helped enable their journey."

Scientists do not know when Voyager 1 will reach the undisturbed part of interstellar space where there is no influence from our sun. They also are not certain when Voyager 2 is expected to cross into interstellar space, but they believe it is not very far behind.

JPL built and operates the twin Voyager spacecraft. The Voyagers Interstellar Mission is a part of NASA's Heliophysics System Observatory, sponsored by the Heliophysics Division of NASA's Science Mission Directorate in Washington. NASA's Deep Space Network, managed by JPL, is an international network of antennas that supports interplanetary spacecraft missions and radio and radar astronomy observations for the exploration of the solar system and the universe. The network also supports selected Earth-orbiting missions.

The cost of the Voyager 1 and Voyager 2 missions -- including launch, mission operations and the spacecraft's nuclear batteries, which were provided by the Department of Energy -- is about \$988 million through September.

For a sound file of the oscillations detected by Voyager in interstellar space, animations and other information, visit: <http://www.nasa.gov/voyager> and <http://www.jpl.nasa.gov/interstellaryoyager/> .

For an image of the radio signal from Voyager 1 on Feb. 21 by the National Radio Astronomy Observatory's Very Long Baseline Array, which links telescopes from Hawaii to St. Croix, visit: <http://www.nrao.edu> .

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