Voyager 1: Earth's Farthest Spacecraft

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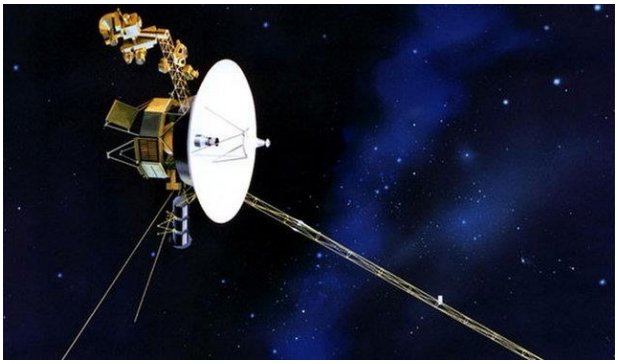
Voyager 1 is the first spacecraft to reach interstellar space. It originally was launched (along with Voyager 2) in 1977 to explore the outer planets in our solar system. However, it has remained operational long past expectations and continues to send information about its journeys back to Earth.

The spacecraft officially entered interstellar space in August 2012, almost 35 years after its voyage began. The discovery wasn't made official until 2013, however, when scientists had time to review the data sent back from Voyager 1.

Voyager 1 was actually the second of the twin spacecraft to launch, but it was the first to race by Jupiter and Saturn. The images it sent back have been used in schoolbooks and newspaper outlets for a generation. Also on board was a special record, carrying voices and music from Earth out into the cosmos.

Voyager 2 launched on Aug. 20, 1977, and Voyager 1 launched about two weeks later, on Sept. 5. Since then, the spacecraft have been traveling along different flight paths and at different speeds. The Voyager missions were intended to take advantage of a special alignment of the outer planets that happens every 176 years. It would allow a spacecraft to slingshot from one planet to the next, assisted by the first planet's gravity.

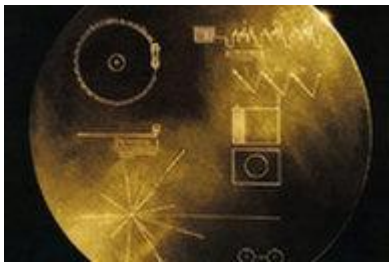
The spacecraft's next big encounter will take place in 40,000 years, when Voyager 1 comes within 1.7 light-years of the star AC +79 3888. (The star itself is roughly 17.5 light-years from Earth.) However, Voyager 1's falling power supply means it will stop transmitting data by about 2025, meaning no data will flow back from that distant location.



An artist's illustration of NASA's Voyager 1 spacecraft, the farthest human-built object from Earth, which launched in 1977 and is headed for interstellar space.
Credit: NASA

The grand tour

NASA originally planned to send two spacecraft past Jupiter, Saturn and Pluto and two other probes past Jupiter, Uranus and Neptune. Budgetary reasons forced the agency to scale back its plans, but NASA still got a lot out of the two Voyagers it launched. Voyager 2 flew past Jupiter, Saturn, Uranus and Neptune, while Voyager 1 focused on Jupiter and Saturn.



NASA's twin Voyager spacecraft launched in August and September 1977. Aboard each spacecraft is a golden record, a collection of sights, sounds and greetings from Earth. There are 117 images and greetings in 54 languages, with a variety of natural and human-made sounds like storms, volcanoes, rocket launches, airplanes and animals.
Credit: NASA

Recognizing that the Voyagers would fly out of the solar system, NASA authorized the production of two records to be placed on board the spacecraft. Sounds ranging from whale calls to the music of Chuck Berry were placed on board, as well as spoken greetings in 55 languages.

The 12-inch, gold-plated copper disks also included pictorials showing how to operate it, and the position of the sun among nearby pulsars in case extra-terrestrials were wondering where the spacecraft came from.

Eye on Jupiter

Voyager 1 almost didn't get off the ground at its launch, as its rocket came within 3.5 seconds of running out of fuel on Sept. 5, 1977.

But it made it safely, and raced past its twin after launch, leaving the asteroid belt before Voyager 2 did. Voyager 1's first pictures of Jupiter beamed back to Earth in April 1978, when it was 165 million miles away.

To NASA's surprise, in March 1979 Voyager 1 spotted a thin ring circling the planet. It found two new moons as well — Thebe and Metis. Additionally, Voyager 1 sent back detailed pictures of the Galilean moons (Io, Europa, Ganymede and Callisto) as well as Amalthea.

Like the Pioneer spacecraft before it, Voyager's look at Jupiter's moons revealed them to be active worlds of their own. Voyager 1 came out with some intriguing findings, as well. Io's volcanoes and mottled yellow-brown-orange surface were intriguing finds, proving that, like planets, moons could have active interiors.

Additionally, Voyager 1 sent back ephemeral pictures of Europa showing a smooth surface broken up by lines, hinting at ice and maybe even an ocean underneath.

Voyager 1's closest approach to Jupiter was on March 5, 1979, when it came within 174,000 miles of the turbulent cloud tops. Then it was time to aim for Saturn.

Saturn's rings and moons

Scientists only had to wait about a year, until 1980, to get close-up pictures of Saturn. The ringed planet turned out to be full of surprises.

One of Voyager 1's targets was the F ring, a thin ring discovered only the year previously by Pioneer 11. Voyager's higher-resolution camera spotted two new moons, Prometheus and Pandora, whose orbits keep the debris in the F ring in a defined orbit. It also discovered Atlas, and a new ring (called the "G" ring), and took images of several other Saturnian moons.

One puzzle for astronomers was the moon Titan. Close-up pictures of the moon showed nothing but orange haze, leading to years of speculation about what it was like underneath. It wouldn't be until the mid-2000s that humanity would send the probe Huygens into the haze.

With Voyager 1's primary mission over, the focus shifted on tracking the small probe as it sped out of the solar system.

Entering interstellar space

Voyager 1's official departure from the solar system occurred in August 2012; the discovery was made public in a study published in Science the following year.

The results came to light after a powerful solar eruption was recorded in Voyager 1's plasma wave instrument between April 9 and May 22, 2013. The eruption caused electrons near Voyager 1 to vibrate. From the oscillations, researchers discovered Voyager 1's surroundings had a higher density than what is found inside the heliosphere, or the region of space in which the sun's environment predominates.

It seems contradictory that electron density is higher in interstellar space than it is in the sun's neighborhood, but the researchers explained that at the edge of the heliosphere, electron density is dramatically low compared with locations nearby Earth.

Researchers then backtracked through Voyager 1's data and nailed down the official departure date to sometime in August 2012. The date was fixed not only by the electron oscillations, but also by its measurements of charged solar particles.

On Aug. 25, the probe saw a 1,000-fold drop in these particles and a 9-percent increase in galactic cosmic rays that come from outside of the solar system. At that point, it was 11.25 billion miles (18.11 billion km) from the sun, approximately 121 times the Earth-sun distance.

Voyager 1's interstellar adventures

As of February 2018, Voyager is roughly 141 astronomical units (sun-Earth distances) from Earth. That's roughly 13.2 billion miles, or 21.2 billion kilometers. You can look at its current distance on the NASA website.

Since flying past the solar system's boundary into interstellar space, Voyager 1 sent back valuable information about conditions in this zone of the universe. Its discoveries include showing that cosmic radiation is very intense, and demonstrating how charged particles from the sun interact with those of other stars, said project scientist Ed Stone in a September 2017 interview.

The spacecraft's capabilities continue to astound engineers. In December 2017, NASA announced that Voyager 1 successfully used its backup thrusters to orient itself to "talk" with Earth. These "trajectory correction maneuver" (TCM) thrusters hadn't been used since November 1980, during Voyager's last planetary flyby of Saturn. Since then, Voyager used its standard attitude-control thrusters to swing the spacecraft in the right orientation to talk with Earth.

As the performance of the attitude-control thrusters began to deteriorate, however, NASA decided to test using the TCMs to extend Voyager 1's lifespan. That test ultimately succeeded. "With these thrusters that are still functional after 37 years without use, we will be able to extend the life of the Voyager 1 spacecraft by two to three years," Voyager project manager Suzanne Dodd, also of JPL, said in a statement.

The Voyager spacecraft each celebrated 40 years in space in 2017, prompting celebrations from NASA and celebrities such as "Star Trek" star William Shatner. In September 2017, Shatner read out a message to the spacecraft originally crafted on Twitter, by Oliver Jenkins: "We offer friendship across the stars. You are not alone." Jet Propulsion Laboratory engineer Annabel Kennedy then transmitted the message to Voyager 1; it was projected to reach the spacecraft in about 19 hours.

"None of us knew, when we launched 40 years ago, that anything would still be working, and continuing on this pioneering journey," Stone said in a NASA statement from August 2017. "The most exciting thing they find in the next five years is likely to be something that we didn't know was out there to be discovered."