

VOYAGER 1 AND 2: THE INTERSTELLAR MISSION

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ABSTRACT

The Voyager program is an American scientific program that employs two robotic interstellar probes. The Voyager 1 and 2 spacecraft launched from Earth in 1977. Their mission was to explore Jupiter and Saturn and beyond to the outer planets of our Solar System. No human-made object had ever attempted a journey like that before. In August 2012, Voyager 1 made the historic entry into interstellar space, the region between stars, filled with material ejected by the death of nearby stars millions of years ago. Voyager 2 entered interstellar space on November 5, 2018 and scientists hope to learn more about this region. The mission objective of the Voyager Interstellar Mission (VIM) is to extend the NASA exploration of the Solar System beyond the neighborhood of the outer planets to the outer limits of the Sun's sphere of influence, and possibly beyond.

Key words: space probes, planets, moons, interstellar space

Introduction

The Voyager program is a science program of the American Space Agency (NASA) that includes two spacecraft, Voyager 1 and Voyager 2. Voyager 1 was the first spacecraft to travel beyond the Solar System and into interstellar space. The spacecraft was launched on September 5, 1977, about two weeks after its twin Voyager 2, and is currently about 24 billion kilometers from our planet, making it the most distant spacecraft from Earth. Voyager 1 is currently traveling through space at about 17 km/s. In 2024, the Voyager spacecraft are still operating beyond the outer limit of the heliosphere in interstellar space, collecting and transmitting data to Earth (the heliosphere, a region of the Solar System dominated by solar wind particles).

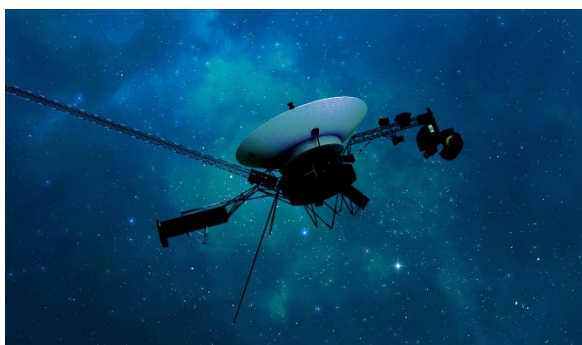


Fig 1 - NASA's Voyager 1 spacecraft is depicted in this artist's concept traveling through interstellar space, or the space between stars, which it entered in 2012.

Voyager 1 entered interstellar space in August 2012, nearly 35 years after its journey began, and Voyager 2 in December 2018. Voyager 1 was the second of the twin spacecraft to be launched, but

it was the first of which came close to the planets Jupiter and Saturn. The Voyager missions took advantage of a special alignment of the outer planets that occurs only once every 176 years. This alignment allowed space probes to use the planets' gravitational assistance, moving from one planet to another, making the most efficient use of their limited fuel. Voyager 2 studied Jupiter, Saturn, Uranus, and Neptune, while Voyager 1 focused on Jupiter and Saturn. On board each spacecraft is a golden disc, a collection of images, sounds, and greetings from Earth. There are 117 pictures and greetings in 54 languages on each disc, as well as a variety of natural and man-made sounds such as storms, volcanoes, rocket launches, airplanes and animals, should any of these space probes be found by the aliens.

Materials and methods

Both spacecraft are powered by three radioisotope thermoelectric generators, devices that convert the heat released by the radioactive decay of plutonium into electricity. The space probes were equipped with 11 scientific instruments, including a two-camera imaging system, multiple spectrometers, a magnetometer, and scientific instruments to study celestial objects as they traveled through space. Due to the decrease in available electrical power, the team had to prioritize which instruments to keep and which to turn off on the Voyager 1 spacecraft. According to NASA, Voyager 1 has fuel to keep at least one science instrument working until at least 2025. Voyager probes have about 3 million times less memory than mobile phones in use today and transmit data about 38,000 times slower than a 5G Internet connection.

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Fig 2 - The Voyager "Sounds of Earth" Record

JUPITER

Voyager 1's first images of Jupiter were beamed back to Earth in April 1978, when the probe was 266 million kilometers from home.

Voyager 1 made a surprising discovery in March 1979, Voyager 1 observed a thin ring surrounding the giant planet. Jupiter's rings are made up of fine dust particles thought to be left over from collisions between the planet's small moons. He also found two new moons - Theba and Metis. In addition, Voyager 1 sent back detailed images of Jupiter's Galilean moons (Io, Europa, Ganymede, and Callisto). Voyager 1 made some interesting discoveries about these natural satellites. For example, the numerous volcanoes of Io, and the smooth surface of the satellite Europa, indicate ice and an underground ocean. Subsequent observations and analysis revealed that Europa likely harbors a huge subsurface liquid water ocean that may even support Earth-like life. The twin Voyager 2 probe began transmitting images of Jupiter 2 years after launch. During its encounter, it transmitted spectacular photos of the entire Jovian system, including its moons (at a distance of about 206,000 kilometers, much closer than Voyager 1), scientists made videos from its images of Jupiter that showed how changed the planet since Voyager 1's visit. During its journey to Jupiter, Voyager 2 explored the giant planet, its magnetosphere, and its moons in more detail than the Pioneer spacecraft that previously studied the planet. Voyager 2 detected many significant changes, observing the Great Red

Spot, the images showed changes in shape and color of this huge storm in the Solar System.



Fig 3 - This Voyager 2 image shows the region of Jupiter extending from the equator to the southern polar latitudes in the neighborhood of the Great Red Spot

With the images obtained from the two Voyager spacecraft, at least 80% of the surfaces of Ganymede and Callisto were mapped.

SATURN

Scientists only had to wait about a year, until 1980, to get close-up images of Saturn from Voyager 1. One of Voyager 1's targets was the F ring, a thin structure discovered only a year earlier previously by NASA's Pioneer 11 probe. Voyager's higher-resolution camera observed two new moons, Prometheus and Pandora, whose orbits keep the icy material in the F ring in a defined orbit. It also discovered Atlas and a new ring, the G ring, and took images of several other moons of Saturn. Of interest to astronomers was Titan, the second largest moon in the Solar System (after Jupiter's Ganymede). Close-up images showed nothing but a dense atmosphere, leading to years of speculation about what it was like underneath. It wasn't until the mid-2000s that humanity would find out, thanks to photographs taken by the European Space Agency's Huygens atmospheric probe. The Saturn encounter marked the end of Voyager 1's primary mission. Then, attention shifted to monitoring the 720 kg spacecraft as it was headed for interstellar space. Two decades before reaching interstellar space, Voyager 1 took one of the most iconic photos in the history of spaceflight. On February 14, 1990, the probe returned to Earth and took an image of its home planet from (6 billion km) away. The photo shows the Earth as a tiny dot, also called the pale blue dot.

URANUS AND NEPTUNE - Voyager 2 was the first man-made object to come close to the planet

Uranus. Observations of the planet began on November 4, 1985, when information took about 2.5 hours to reach Earth. During its flyby, Voyager 2 discovered 10 new moons (with names like Puck, Portia, Juliet, Cressida, Rosalind, Belinda, Desdemona, Cordelia, Ophelia and Bianca – names inspired by the writings of Shakespeare), two new rings in plus nine "older" rings.

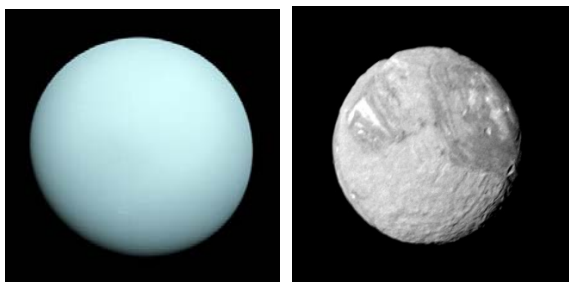


Fig 4 - This is an image of the planet Uranus taken by the spacecraft Voyager 2 on January 14th 1986 from a distance of approximately 12.7 million km.

Fig 5 - Miranda satellite of the planet Uranus

Its rings were found to be extremely variable in thickness and opaqueness. Research has shown that the rings of Uranus are different from those of Jupiter and Saturn. The Uranian ring system may be relatively young and did not form at the same time as Uranus. Voyager 2 also took spectacular photos of Miranda, Oberon, Ariel, Umbriel and Titania, five of Uranus' larger moons. The Voyager 2 spacecraft passed within 26,000 kilometers of Miranda on January 24, 1986, photographing the Southern Hemisphere of the Miranda satellite. The photos showed that Miranda has a bizarre, deformed surface. The Miranda satellite with a diameter of 480 km has a rugged terrain with traces of crustal fractures, being crossed by dark and irregular canyons, they are 12 times deeper than the Grand Canyon. Following the Uranus encounter, the spacecraft made a single mid-course correction on February 14, 1986—the largest ever made by Voyager 2—to set it on a precise course toward Neptune. Voyager 2's encounter with Neptune completed a journey (7 billion kilometers) when, on August 25, 1989, its 10 instruments were still operational at the time. During the encounter, the spacecraft discovered six new moons and four new rings. The planet itself turned out to be more active than previously thought, with winds of 1,100 kilometers per hour. Hydrogen was found to be the most common atmospheric element, although abundant methane gives the planet its blue appearance. While near the planet Neptune, Voyager

2 discovered an anticyclonic storm, called the Great Dark Spot, which has since disappeared, according to observations made 5 years later by the Hubble Space Telescope. Voyager imaged two-thirds of Neptune's largest moon, Triton, revealing volcanoes spewing liquid nitrogen that instantly freezes at temperatures as low as -235 degrees Celsius on Triton's surface. The visit to Neptune concluded Voyager 2's planetary encounters, which had lasted an astonishing 12 years, effectively completing the "Grand Tour" of the solar system. Once past the Neptune system, Voyager 2 continued its mission (about 56 million kilometers) after the encounter, Voyager 2's instruments were put into low-power mode to conserve energy. Voyager 2 remains in contact with Earth via the NASA Deep Space Network. Communications are the responsibility of the DSS communications antenna in Australia. When the spacecraft cannot communicate with Earth, the Digital Tape Recorder (DTR) can record data for transmission at another time. In October 2020, astronomers reported an unexpectedly significant increase in density in space beyond the Solar System, as detected by the Voyager 1 and Voyager 2 spacecraft. Voyager 2 is not headed for any particular star, although in about 42,000 years, will pass by the star Ross 248 at a distance of 1.7 light years. If undisturbed for 296,000 years, Voyager 2 should pass the star Sirius at a distance of 4.3 light years. Voyager continued to provide power for five science instruments until early 2023, In NASA's Eyes on the Solar System app, you can see the actual trajectories of Voyagers' spacecraft, which are updated every five minutes. Distance and speeds are updated in real time.

Conclusions

The mission objective of the Voyager Interstellar Mission (VIM) is to extend the NASA exploration of the solar system beyond the neighborhood of the outer planets to the outer limits of the Sun's sphere of influence, and possibly beyond. The twin Voyager 1 and 2 spacecraft are exploring where nothing from Earth has flown before. Continuing on their more-than-45-year journey since their 1977 launches, they each are much farther away from Earth and the Sun than Pluto.

Rezumat

Programul Voyager este un program științific al Agenției Spațiale Americane (NASA) din care fac parte două sonde spațiale, Voyager 1 și Voyager 2. Voyager 1 a fost prima sondă spațială care a călătorit dincolo de Sistemul Solar și a ajuns

în spațiul interstelar. Sonda spațială a fost lansată pe 5 septembrie 1977, la aproximativ două săptămâni după geamăna sa Voyager 2 și în prezent, se află la aproximativ 24 miliarde de kilometri de planeta noastră, ceea ce o face cea mai îndepărtată sondă spațială de pe Pământ. Voyager 1 se deplasează în prezent prin spațiu cu aproximativ 17 km/s. În 2024, sondele spațiale Voyager sunt încă în funcțiune dincolo de limita exterioară a heliosferei în spațiul interstelar, ele colectează și transmit date pe Pământ (heliosferă, o regiune a Sistemului Solar dominată de particule de vânt solar).

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