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NASA Started a Propeller Set on Board Voyager 1 After 37 Years of Break

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Abstract: If you try to start a car that has been in the garage for decades, you expect the engine not to respond. But a set of propellers onboard the NASA Voyager 1 spacecraft was launched on Wednesday, November 29, 37 years after its last use without any problems. Voyager 1 is the only man-made object that has arrived in interstellar space, being also the space probe created by NASA, which travels at the highest speed and is at the highest distance from Terra. The probe flies for 40 years and can change its position to keep its antenna pointing to the Terra using some small propellers operating in very short halves, in the order of milliseconds. NASA's Voyager team has been able to launch a set of back-up propellants that had not been in use since 1980. The test succeeds in extending Voyager 1's life to a minimum of 2-3 years. In 2014, NASA engineers noticed that Voyager's propellers used to change direction degraded. Over time, propellers end up working longer than normal to get the same effect on the direction of the probe. NASA experts have designed several working scenarios to solve the problem and concluded that it is best to use a series of back-up engines to control the probe's direction. These propellants had not been used for 37 years. NASA has been forced to search for decades old archives and use an obsolete programming language that no one uses to compile commands that have been transmitted by radio waves to the small computer on board to Voyager 1. The probe is more than 20 billion km from Terra. In the early years of the mission, Voyager 1 passed past Jupiter, Saturn and some of the satellites of these planets. In order to maintain the correct distance and orientation of on-board instruments, engineers used a series of Trajectory Correction Maneuvers (TCM) with dedicated, but identical size and functionality to those used for small flight corrections. These propellers used to correct the trajectory are placed on the back of the probe. After the encounter with Saturn, Voyager 1 did not need them, the last use being on November 8, 1980. These propellers had been used in a different way, meaning they were operating for long periods, not for very short-lived pulses. All engines on board Voyager were produced by Aerojet Rocketdyne, the same type of engine being installed on other spacecraft such as Cassini and Dawn. On November 28, Voyager engineers started the four TCM engines and tested their ability to steer the probe using 10 millisecond pulses. Researchers were then forced to wait for the test results to travel through space, in the form of radio waves, to be received after 19 h and 35 min by an antenna from Goldstone, California, part of NASA's Deep Space network.

Keywords: Voyager 1, Propellers, NASA, Space Agency

Introduction

If you try to start a car that has been in the garage for decades, you expect the engine not to respond. But a set of propellers onboard the NASA Voyager 1 spacecraft was launched on Wednesday, November 29, 37 years after its last use without any problems.

Voyager 1 is the only man-made object that has arrived in interstellar space, being also the space probe created by NASA, which travels at the highest speed and is at the highest distance from Terra. The probe flies for 40 years and can change its position to keep its antenna pointing to the Terra using some small propellers operating in very short halves, in the order of milliseconds.

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Voyager 1 is a space probe launched by NASA on September 5, 1977, still in operation. He visited the planets Saturn and Jupiter, being the first probe to transmit images to the satellites of these planets. Her sister, Voyager 2, was launched on August 20, 1977 (before Voyager 1) is the only probe that has visited all four large planets of the Solar System: Jupiter, Saturn, Uranus and Neptune, due to the alignment of these planets. After completing their initial plan to study the planets, the two probes continued their journey into space. Voyager 1 left the heliosphere in August 2012, entering the interstellar space. Voyager 2 will follow in a few years (Petrescu *et al*., 2017a; 2017b; 2017c; 2017d; 2017e; 2017f; 2017g; 2017h; 2017i; 2017j; 2017k; 2017l; 2017m; 2017n; 2017o; 2017p; 2017q; Petrescu, 2016; Aversa *et al*., 2017a; 2017b; 2017c; 2017d; 2017e; 2016a; 2016b; 2016c; 2016d; Mirsayar *et al*., 2017; Petrescu and Petrescu, 2016a; 2016b; 2016c; 2013a; 2013b; 2013c; 2013d; 2012a; 2012b; 2012c; 2012d; 2011a; 2011b; Petrescu, 2012a; 2012b; 2009; Petrescu and Calautit, 2016a; 2016b; Petrescu *et al*., 2016a; 2016b).

Materials and Methods

The National Aeronautics and Space Administration (NASA) is the most renowned and important independent agency of the federal government of the United States, responsible for civilian space programs as well as all aeronautical and aerospace research programs initiated by the United States of America.

President Dwight D. Eisenhower, who set up NASA in 1958, mainly thought of it as having a distinct civil (more than military) orientation in order to be able to create independent, independent missions to conquer the cosmic space, obviously the sea passion and basic mission of humanity, seen as something superior, namely to learn as much as possible about the space we live in and try to conquer it in the next millennium. We can't be locked here on our planet and not think of who we are, where we come from, where we go, what we represent in the giant universe in which we are, how we can know it and explore it, which are its limits and how we can learn other surrounding verses. Too many questions for a small man, but very few for a humanity so big and especially so important!

A Law on Aeronautics and National Space was adopted on 29 July 1958, abolishing NASA's predecessor, the National Aeronautical Advisory Committee (NACA). Thus, the new agency became operational on 1 October 1958.

Immediately, the agency got its rights and started to work, most US space exploration efforts have since been run by NASA, including the Apollo Moon landing missions, the Skylab space station and, later, the space shuttle. The years have passed and NASA has been constantly working with perseverance, sending reconnaissance missions on the Moon, Mars and then on all the planets of the Solar System.

At present, NASA is the main space pillar that supports the international space station and oversees the development of the Orion multi-purpose crew, space launch and commercial crew vehicles at the same time.

The Agency is also responsible for the Service Launch Program (LSP), an important program to oversee launch operations and especially the management of special NASA launch programs.

NASA is also the world's leading international operator, focusing on space exploration programs not only on flights, but also through the creation and use of more and more powerful telescopes capable of scans the whole universe we are in. It is important to know the planets that could provide living conditions for mankind, with the obvious task of conquering, tertifying and colonizing them. The expansion of humanity in outer space has become imperative because our planet's population is constantly multiplying while planet resources diminish.

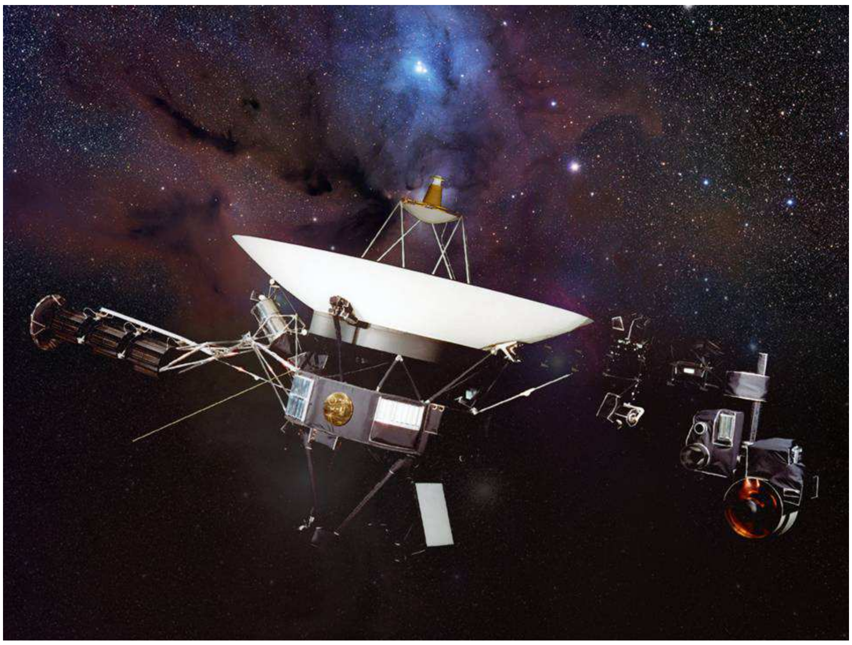
If modern telescopes have the role of exploring cosmic space and finding planets that can provide life, there is a need for huge, fast ships that can travel to them in real time.

NASA is also focusing on a better understanding of the Earth through the Earth Observation System, advancing heliophysics through Heliophysics mission research efforts, exploring bodies throughout the solar system with robotic spaceship missions such as New Horizons and exploring astrophysical topics like the Big Bang through the Observatory Sea and associated programs (NASA, From Wikipedia).

Results

Voyager 1 (Fig. 1) is one of two NASA spacecraft launched on September 5, 1977, to study the outer planets of the Solar System that had previously been observed only by telescopes on Earth. This mission is made possible by an exceptional alignment of the outer planets that only happens every 176 years. The main objective of Voyager 1 is to collect data on the systems of Jupiter and Saturn with a particular emphasis on the main moon of the latter, Titan.

Voyager 1, with its twin probe, is at the origin of a large number of discoveries on the Solar System sometimes calling into question or refining the existing theoretical models.



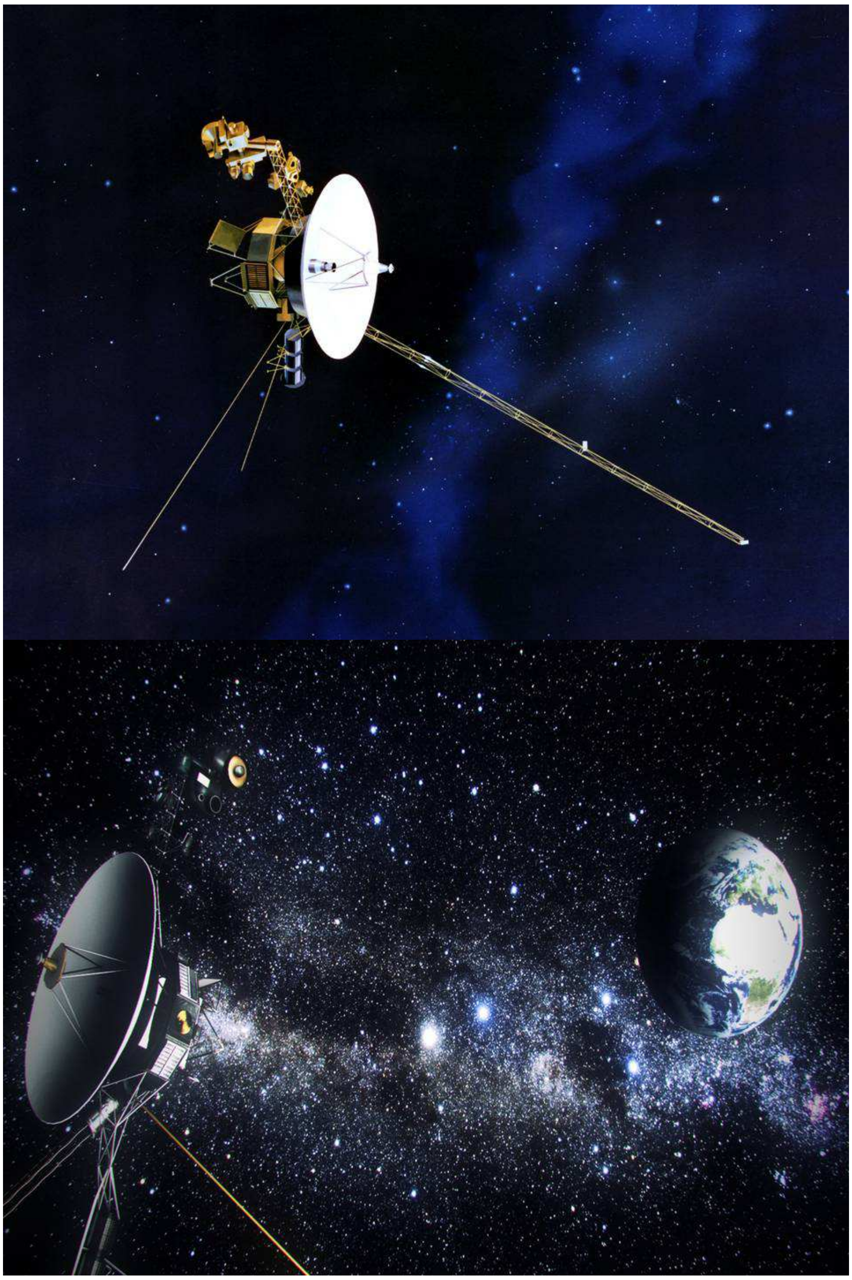


Fig. 1: Voyager 1

As such, it is one of the most successful space missions of the US Space Agency. Among the most remarkable results are the complex functioning of Jupiter's Great Red Spot, the first observation of Jupiter's rings, the discovery of Io's volcanism, the strange structure of the surface of Europe, the composition of the atmosphere of Titan, the unexpected structure of the rings of Saturn as well as the discovery of several small moons of Jupiter and Saturn.

The spacecraft is very long-lived and still has operational instruments in 2015 that collect scientific data on the environment. It left in August 2012 the heliosphere - the region of space under the magnetic influence of the Sun - and is now progressing in the interstellar medium. Starting in 2020, however, the instruments will have to be phased out in order to cope with the weakening of its source of electrical energy, supplied by three thermoelectric radioisotope generators due to the distance of the Sun. Voyager 1 will no longer be able to transmit data beyond 2025.

Voyager 1 is a 825.5 kg space probe (propellant included) centered around a huge 3.66 m diameter parabolic antenna whose size is intended to compensate for the remoteness of the Earth. It carries ten scientific instruments representing a mass of 104.8 kg, part of which is located on a steerable platform. As of October 11, 2017, the spacecraft is approximately 20,944,040,000 km (140 ua) from the Sun and approximately 21,008,710,000 km (140.43 ua) from the Earth.

Voyager 1 is, along with Voyager 2, one of the two probes composing the Voyager program. This space program is set up by the American Space Agency (NASA), to explore the outer planets (Jupiter, Saturn and beyond) which have not been studied so far because of the technical complexity of a such project. The space agency wishes to take advantage of an exceptional conjunction of the outer planets which is only repeated every 176 years and which must allow the probes to fly over several planets practically without spending fuel, by using the gravitational assistance of the objects previously visited.

After giving up budget reasons for a very ambitious project, NASA manages to build two machines perfectly suited to this complex program, as will be proven by the longevity and quality of the scientific equipment collected by the two probes. The project was officially launched on 1 July 1972 and the manufacture of space probes began in March 1975 with the completion of the design phase. The Pioneer 10 (launched in 1972) and 11 (1973) probes, which are responsible for recognizing the route, provide vital information on the shape and intensity of the radiation around the planet Jupiter that is taken into account in the design of the Voyager.

The objective of the Voyager program is to collect scientific data on the outer planets (Jupiter, Saturn, Uranus and Neptune) which at the time were virtually unexplored: Only Pioneer 10 and 11, light probes developed to serve as scouts at Voyager probes but with few instruments, have so far approached Jupiter and Saturn. The main objective assigned to both probes is to collect data to better understand the two giant planets, their magnetosphere and their natural satellites. The latter, some of which are the size of a planet, are very poorly known. The study of the moon Titan, which is already known at the time that it has an evolved atmosphere, is considered as important as the exploration of Saturn, its mother planet. Finally, the collection of data on the two other giant planets of the Solar System, Uranus and Neptune, on which very little information is acquired because of their remoteness, constitutes a major objective insofar as the study of Jupiter and Saturn could be completed.

Voyager 1, which precedes its twin probe, has for initial objective to explore Jupiter and Saturn. It must complete its exploration mission by flying close to Titan, the main moon of Saturn. But it must, to achieve this, perform a maneuver that makes him leave the plane of the ecliptic, excluding any possibility of exploring another outside planet. The overflight and study of Uranus and Neptune are thus entrusted to Voyager 2. To pass from Jupiter to Saturn, the probe uses the gravitational assistance of the first planet which gives it a significant acceleration while placing it in the direction of the second.

Given their good operational status at the end of their primary mission in 1989, new targets were set for space probes after flying over the outer planets. The aim of the Voyager Interstellar Mission (VIM) mission is to study very poorly known regions located at the limits of the Sun's influence zone. The final shock and the heliopause are distinguished before, once the heliogaine crossed, to emerge in the interstellar medium whose characteristics no longer depend on our star.

Voyager 1 is a 825.5 kg probe (propellant included) whose central part consists of a flattened aluminum cylinder with ten lateral facets with a diameter of 188 cm and a height of 47 cm. This structure contains most of the electronics protected by a shield and a tank in which is stored the hydrazine used for propulsion. A parabolic dish with a fixed gain of 3.66 m in diameter is attached to the top of the cylinder. Its large size allows an exceptional 7.2 kilobits per second X-band rate at Jupiter's orbit and partially offsets the weakening of the signal at the Saturn orbit. Voyager 1 has sixteen small redundant boosters burning hydrazine and used for both trajectory changes and orientation changes or corrections. The amount of onboard propellant allows a very modest cumulative speed change of 190 m per second on the entire mission. Three poles fixed on the body of the probe and deployed in orbit serve as support for various scientific equipment and instruments. On one of them are the three thermoelectric radioisotope (RTG) generators that provide energy (470 watts from the Earth) to the space probe. Indeed the solar energy available at the level of the outer planets does not allow to use solar panels. The scientific instruments are fixed on a 2.3 m long pole opposite the RTG to limit the impact of the radiation emitted by the radioactive decay of plutonium 238 on the measurements. The remote sensing instruments (ISS cameras, IRIS and UVS spectrometers and PPS photopolarimeters) are installed on a steerable platform with two degrees of freedom. Other in situ measuring instruments (CRS, PLS, LECP) are attached directly to the pole. The magnetometers are installed on the third pole 13 m long to reduce the magnetic influence of the body of the spacecraft. Finally two antennas 10 m long beryllium and copper at a 90° angle between them serve as sensors for the measurement of plasma waves.

The Voyager 1 spacecraft is stabilized along all three axes, reflecting the priority given to remote sensing instruments, that is, the study of planets and moons.

The orientation of the probe is controlled using two sensors: A star finder and a solar collector installed on the satellite dish. When the target star deviates from the sensor's field of view by more than 0.05°, the rocket engines automatically perform a correction. For short periods (a few days) the control of the orientation is entrusted to a set of gyroscopes, for example when the sun is masked or during course corrections.

The space probe carries eleven scientific instruments representing a total mass of 104.8 kg distributed between remote sensing instruments used for the observation of planets and moons and in situ measuring instruments to characterize the medium traversed.

The four remote sensing instruments are:

- The two standard wide-angle color cameras forming the ISS assembly
- The interferometer, spectrometer, infrared radiometer IRIS which makes it possible to determine the temperature of a body, to identify the presence of certain substances in an atmosphere or on the surface
- The PPS photopolarimeter, which measures the intensity and the polarization of the light of eight wavelengths between 235 and 750 nanometers
- The ultraviolet UVS spectrometer

The instruments of observation of the crossed medium - cosmic rays, solar wind and magnetospheres of Jupiter, Saturn, Uranus and Neptune - are:

- The cosmic ray detector CRS
- The PLS plasma detector
- The low energy particle detector LECP
- The MAG magnetometer for measuring the variations of the solar magnetic field

The receiver of waves emitted by the plasmas (PWS) and the astronomical radio receiver of planet (PRA) are intended for the listening of the radio signals emitted by the Sun, the planets, the magnetospheres.

Like Voyager 2, Voyager 1, which is to approach a nearby planetary system in about 40,000 years, symbolically carries a record of various manifestations of humanity.

The Voyager 1 spacecraft was launched on September 5, 1977, by a Titan 3E rocket, three weeks after its twin probe. Small trajectory correction maneuvers are performed with the rocket engines 150 days after launch and 12 days before arrival in the Jovian system. Thanks to a tighter trajectory and a higher speed (15.517 km/s) it reaches Jupiter four months before Voyager 2. This configuration allows scientists to have observations by instruments of two probes of the evolution of the atmosphere of Jupiter over a continuous period of six months.

Voyager 1 begins its observations of Jupiter 80 days before the flight on December 14, 1978 and the first photographs are taken in January 1979 when the distance allows to obtain images of the bands of clouds that encircle the giant planet with a definition better than that provided by Earth-based telescopes.

The spacecraft begins to benefit from permanent coverage of NASA's telecommunications antenna network 30 days prior to flying over Jupiter. Voyager 1 passes close to the giant planet on March 5, 1979 at a distance of 349,000 km from its center (or 278,000 km from its surface).

The main phase of the scientific observations, which includes the study of Jupiter, the Galilean moons, the rings of Jupiter and its magnetic field begins on March 4 and lasts only two days: March 5 Voyager 1 flies at a very short distance (18 460 km) the moon Io then Ganymede (112,030 km) and Europe (732,270 km). The next day the space probe passes 123,950 km from Callisto. The observation phase of Jupiter ends at the end of April. At the end of this overview, the space probe took 19,000 photographs of Jupiter and its five main moons. Passing near Jupiter, the speed of the probe increases to 16 km/s. About 5 kg of hydrazine are used to make a final course correction before Voyager 1 goes to Saturn.

The main discovery is that of the volcanism of the moon Io. This is the first time that a volcanic phenomenon was observed on another celestial body than the Earth. The collected data made it possible to realize that this phenomenon has a great influence on all the Jovian system: The materials ejected by the volcanoes are dispersed by the very powerful magnetic field of Jupiter and constitute the essential of the matter present in the magnetosphere of the giant planet. Voyager 1 makes the first short-distance photographs of Jupiter's clouds that highlight the complexity of the processes at work. The Great Red Spot turns out to be a gigantic storm moving counter-clockwise while other storms are uncovered. Voyager 1 discovers and photographs the rings of Jupiter much more tenuous than those of Saturn. Within these rings, the probe discovers two small moons: Thebe, about 100 km in diameter, is the furthest away from the group of Jupiter's internal satellites; while Métis about twice as small and the innermost of this group. The European images taken by the space probe cameras show a network of lines on the surface of this moon that seem to be of tectonic origin. Their resolution is low because the spacecraft has gone quite far but the photographs taken later by Voyager 2 will exclude this origin and will be the origin of the theory of the frozen ocean covering the whole of this celestial body (Fig. 2-11).

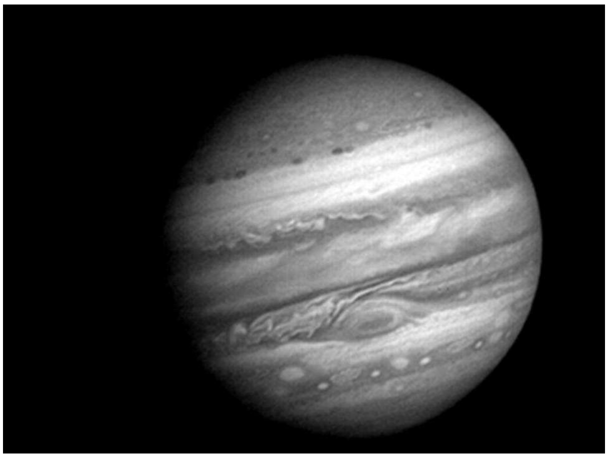


Fig. 2: Approaching Jupiter

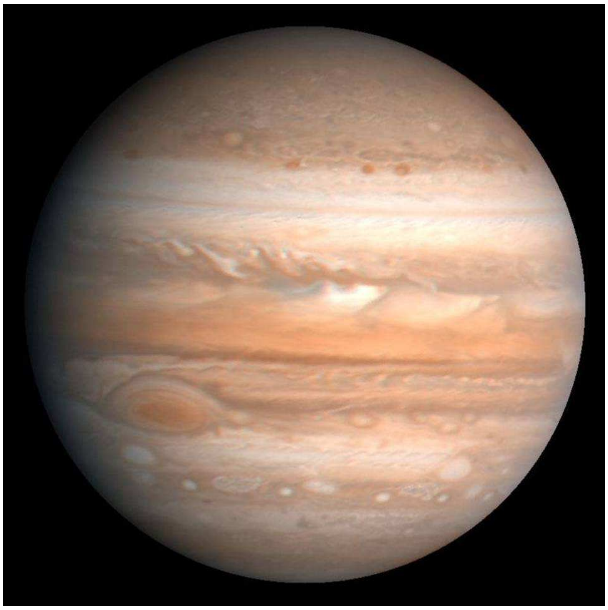


Fig. 3: View of Jupiter in true colors

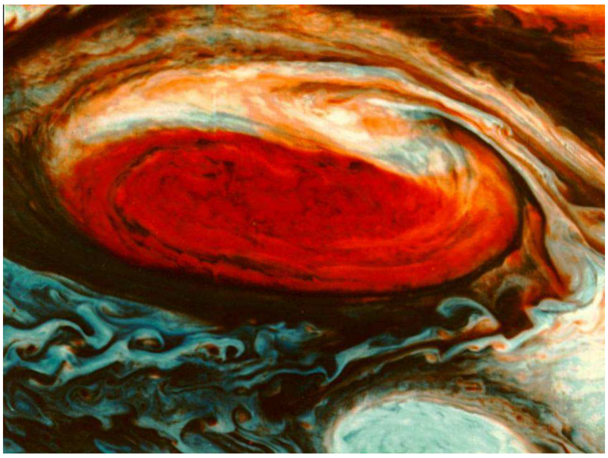


Fig. 4: The great red spot of Jupiter in false colors

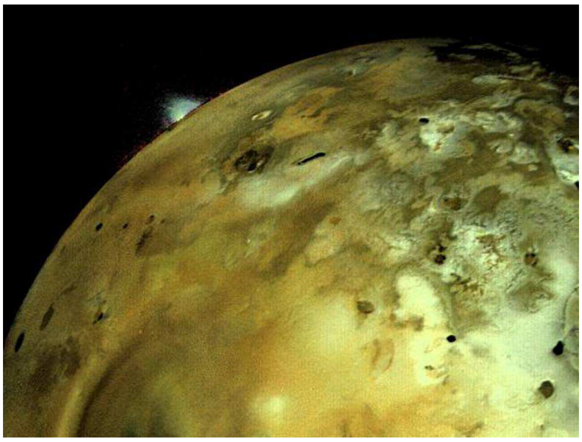


Fig. 5: Volcanic eruption on Io

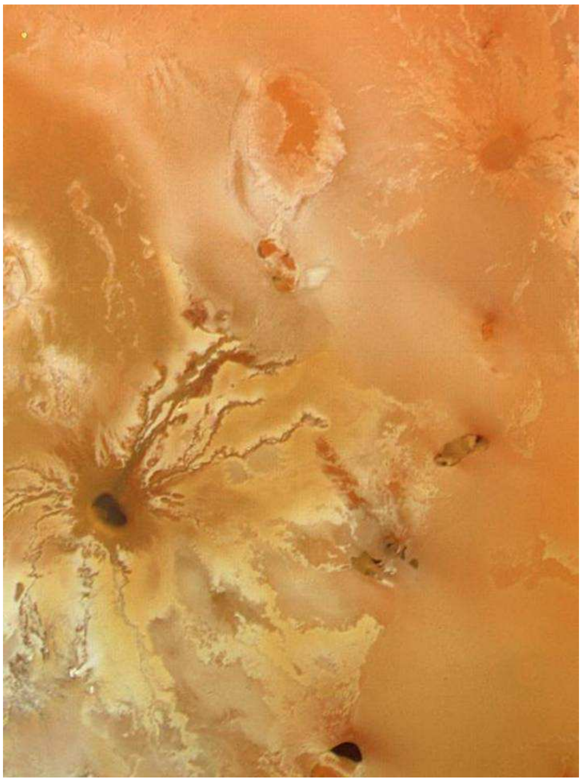


Fig. 6: Close-up of an active volcano of Io (we can see the lava flows)

The next day, the spacecraft will fly very close (6,940 km) to the moon Titan, one of the most interesting celestial bodies in the Solar System.

Scientists knew before this flyover that Titan has a methane atmosphere and some of them had speculated that life forms could have developed in this environment created by the greenhouse effect, but well before the rendezvous with the moon, the photos taken show that Titan is surrounded by a layer of continuous clouds, opaque in visible light that does not distinguish the surface.

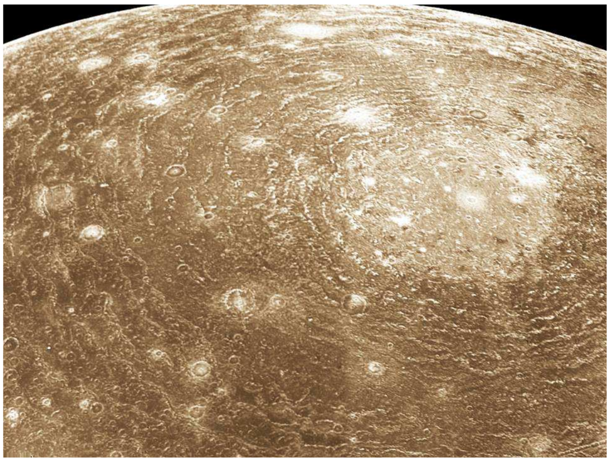


Fig. 7: Callisto and the crater Valhalla

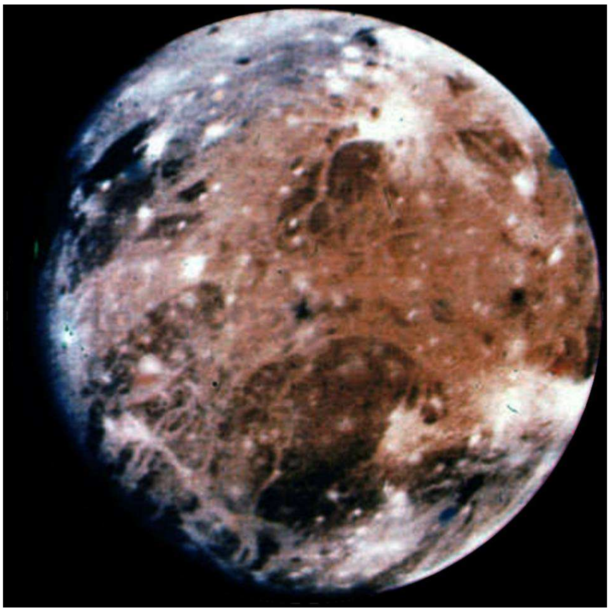


Fig. 8: The Ganymede satellite

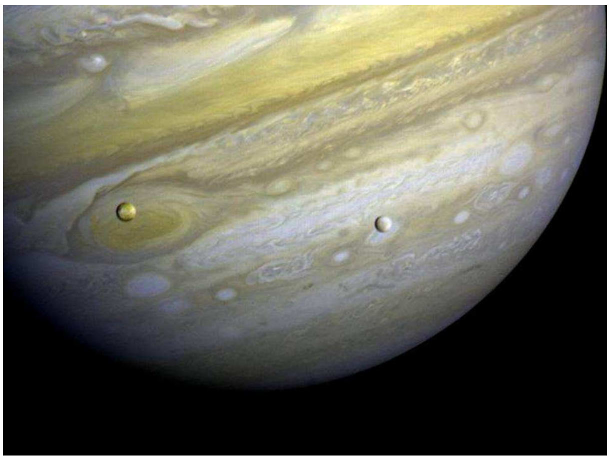


Fig. 9: Io and Europe in front of Jupiter

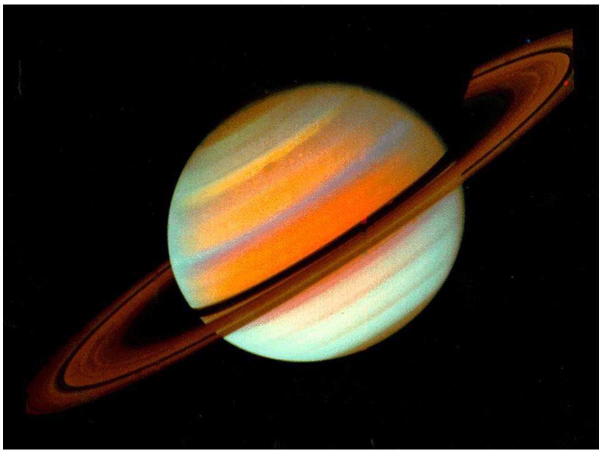


Fig. 10: Saturn in false colors

Fig. 11: The Dioné satellite

On November 10, 1980, Voyager 1 entered the heart of Saturn's planetary system.

IRIS and UVS instruments are used to determine the characteristics of the atmosphere.

Traces of ethylene and other hydrocarbons are detected while a temperature probably too low for life is measured.

After these observations Voyager 1 flies over the south pole of Saturn, passing 124 000 km from its center on November 12, 1980.

The rings and other satellites whose observation is scheduled (Dioné, Mimas and Rhéa) are all very close to the giant planet since the overflight must last, in all, barely ten hours: The orientable platform carrying the main scientific instruments used for the collection of planetary data is programmed for rapid changes of orientation to the limit of its capacities but manages to execute pre-programmed instructions.

Since 1989, the spacecraft has begun a new mission called Voyager Interstellar Mission (VIM) to study the regions located on the edge of the solar system and, after crossing the limits of the Sun's influence zone, to study the characteristics interstellar medium.

On February 14, 1990, the ISS cameras were used one last time to make a mosaic of 60 photos including six of the planets of the solar system seen from a new angle. This mosaic, called "Family Portrait", is particularly known for the image it gives of the Earth that appears, given the distance (40.11 ua), as a barely visible pale blue dot, which will be an inspiration for a book by Carl Sagan (Voyager 1, From Wikipedia).

Discussion

Over the following years, instruments and equipment are gradually extinguished to cope with the gradual disintegration of RTG plutonium, which results in a decrease in energy production of 4.2 watts per year. Remote sensing instruments used primarily to observe planets and moons were the first to be decommissioned: The ISS cameras in 1990 and the IRIS infrared spectrometer in 1998.

In its progression Voyager 1 leaves the plane of the ecliptic taking a lead on Voyager 2; it continues on its way to the confines of the solar system. On April 17, 2010, Voyager 1 is 112.38 ua (16.857 billion km or 15:38:31 light hours) from Earth.

The human artifact farthest from the Earth, it exceeds the "terminal shock", that is to say leaves the sphere of influence of the solar wind, penetrating into the heliogaine.

His goal now is to reach the heliopause, a region on the boundary between the Sun's influence zone and the interstellar medium and to study its physical characteristics. In June 2011, the probe sends indicative data on the nature of the Sun's magnetic shield, at the limits of the heliosphere, indicating that at 17.4 billion km it is a "kind of large heterogeneous bubble", composed of other bubbles of about one astronomical unit, a little less than 150 million km.

In December 2011, NASA announced that the probe is now close to the heliopause. By using the Voyager 1 instruments in the spring and summer of 2011, the probe measured the solar wind speed, the energy particle flux and the magnetic field generated by our Sun. According to these measurements Voyager 1 has entered a so-called stagnation zone in which the influence of the Sun is counterbalanced by that of the interstellar space: The magnetic field of the Sun is reinforced because the lines of the field are tightened under the external pressure, the solar wind is almost zero while the energy particles emitted by the Sun are becoming rarer and those coming from the interstellar medium are increasing.

After several polemical exchanges between specialists, NASA finally announced on September 12, 2013 that Voyager 1 left a little more than a year ago, around August 25, 2012, the region of space under the direct influence of the Sun. the heliosphere, which is defined as the field of action of the solar wind created by our star. This event occurred when the space probe was at a distance of 121 astronomical units (about 18 billion km) from the Sun. Leaving the heliopause, this border region with poorly defined contours, the space probe enters the interstellar medium whose content (particles, radiation) is no longer influenced by the Sun. This new phase of the probe's mission will provide valuable information on this region of space in which man had never previously sent any gear. The space probe will make the first direct measurements of the physical conditions prevailing in the interstellar medium, which should give crucial clues to the origin and nature of the Universe on a large scale. Voyager 1 will be able to measure in particular the characteristics of cosmic rays blocked largely by the heliosphere. It is based in particular on the increase of this radiation measured by the instrument Plasma Wave Science (PWS) intersected by the measurements of the magnetic field that the scientific leaders of the mission came to the conclusion that the spacecraft had left the magnetic influence zone of the Sun. Voyager 1, however, is still under the gravitational influence of the Sun and can't escape in a few tens of thousands of years. As such, the space probe is still in the Solar System.

Voyager 1 moves away from the Sun at a speed of 3.5 ua (about 500 million km) per year. Its trajectory is at an angle of 35° to the plane of the ecliptic, north of it. It moves towards the solar apex, that is to say the group of stars towards which the Solar System is moving itself. In forty thousand years, the probe must pass to 1.7 al of a minor star, AC +79 3888, located in the constellation of the Giraffe and better known under the name of Gliese 445.

By 2020, the instruments must be phased out to deal with the weakening of the source of electrical energy provided by the three thermoelectric radioisotope generators. It is expected that in 2013 the last remote sensing instrument, the UVS ultraviolet spectrometer, will be extinguished, which made observations of different UV sources (stars, etc.). In 2015, the use of gyroscopes, which consume 14.4 watts, will no longer be possible. Finally, as of 2020, in situ scientific instruments will either have to be phased out or alternately operated.

Voyager 1 will no longer be able to collect and transmit data beyond 2025.

On December 1, 2017, NASA relaunches 4 probe thrusters after 37 years of inactivity. This allows NASA's calculations to gain 2 to 3 years of longevity by reorienting transmission antennas to Earth.

Conclusion

If you try to start a car that has been in the garage for decades, you expect the engine not to respond. But a set of propellers onboard the NASA Voyager 1 spacecraft was launched on Wednesday, November 29, 37 years after its last use without any problems.

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The probe flies for 40 years and can change its position to keep its antenna pointing to the Terra using some small propellers operating in very short halves, in the order of milliseconds.

NASA's Voyager team has been able to launch a set of back-up propellants that had not been in use since 1980.

The test succeeds in extending Voyager 1's life to a minimum of 2-3 years. In 2014, NASA engineers noticed that Voyager's propellers used to change direction degraded.

Over time, propellers end up working longer than normal to get the same effect on the direction of the probe.

NASA experts have designed several working scenarios to solve the problem and concluded that it is best to use a series of back-up engines to control the probe's direction. These propellants had not been used for 37 years.

NASA has been forced to search for decades old archives and use an obsolete programming language that no one uses to compile commands that have been transmitted by radio waves to the small computer on board to Voyager 1. The probe is more than 20 billion km from Terra.

In the early years of the mission, Voyager 1 passed past Jupiter, Saturn and some of the satellites of these planets. In order to maintain the correct distance and orientation of on-board instruments, engineers used a series of Trajectory Correction Maneuvers (TCM) with dedicated, but identical size and functionality to those used for small flight corrections. These propellers used to correct the trajectory are placed on the back of the probe.

After the encounter with Saturn, Voyager 1 did not need them, the last use being on November 8, 1980. These propellers had been used in a different way, meaning they were operating for long periods, not for very short-lived pulses.

All engines on board Voyager were produced by Aerojet Rocketdyne, the same type of engine being installed on other spacecraft such as Cassini and Dawn. On November 28, Voyager engineers started the four TCM engines and tested their ability to steer the probe using 10 millisecond pulses.

Researchers were then forced to wait for the test results to travel through space, in the form of radio waves, to be received after 19 h and 35 min by an antenna from Goldstone, California, part of NASA's Deep Space network.

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Author’s Contributions

All the authors contributed equally to prepare, develop and carry out this manuscript.

Ethics

Authors declare that are not ethical issues that may arise after the publication of this manuscript. This article is original and contains unpublished material.

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