Galactic Observer

John J. McCarthy Observatory

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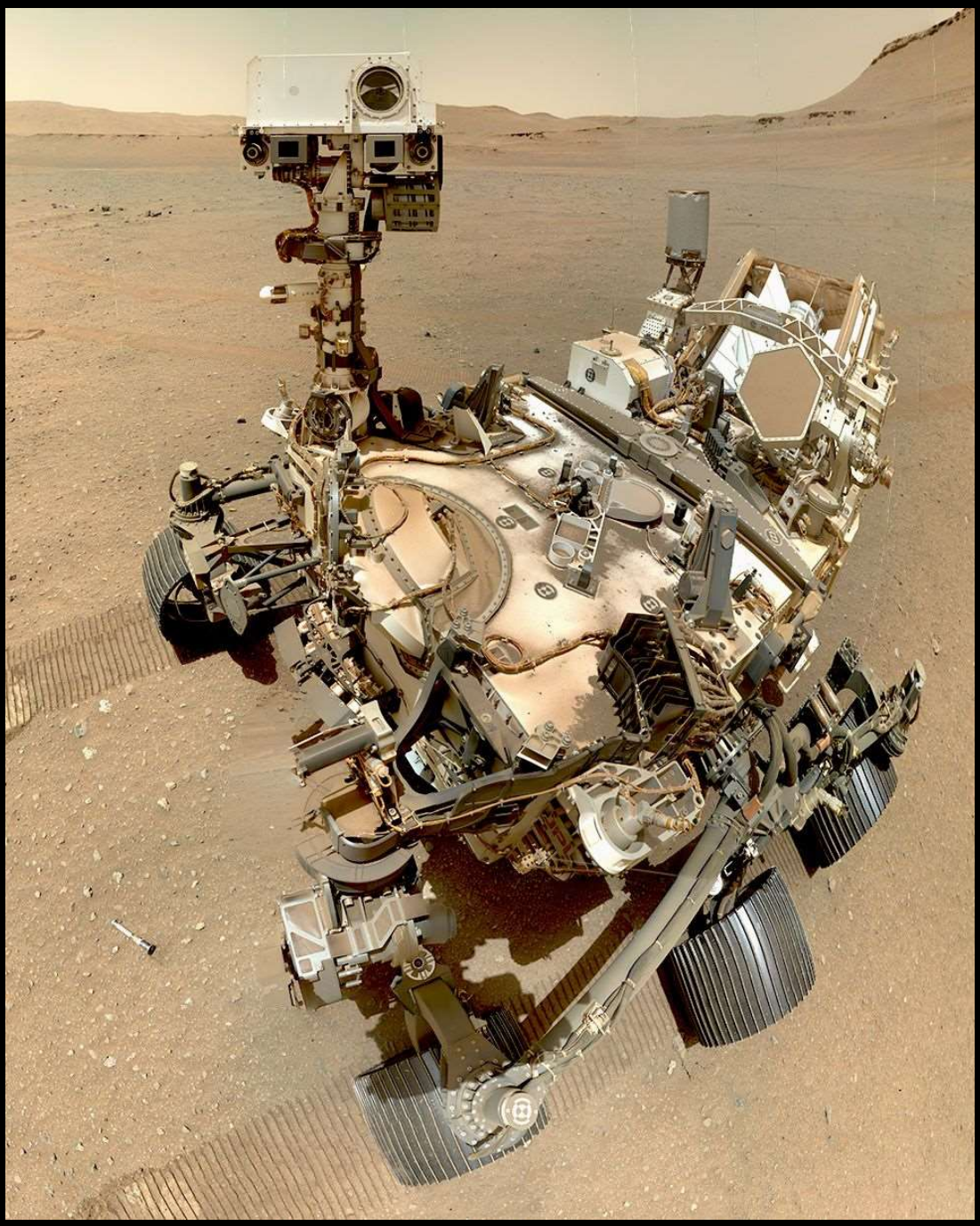
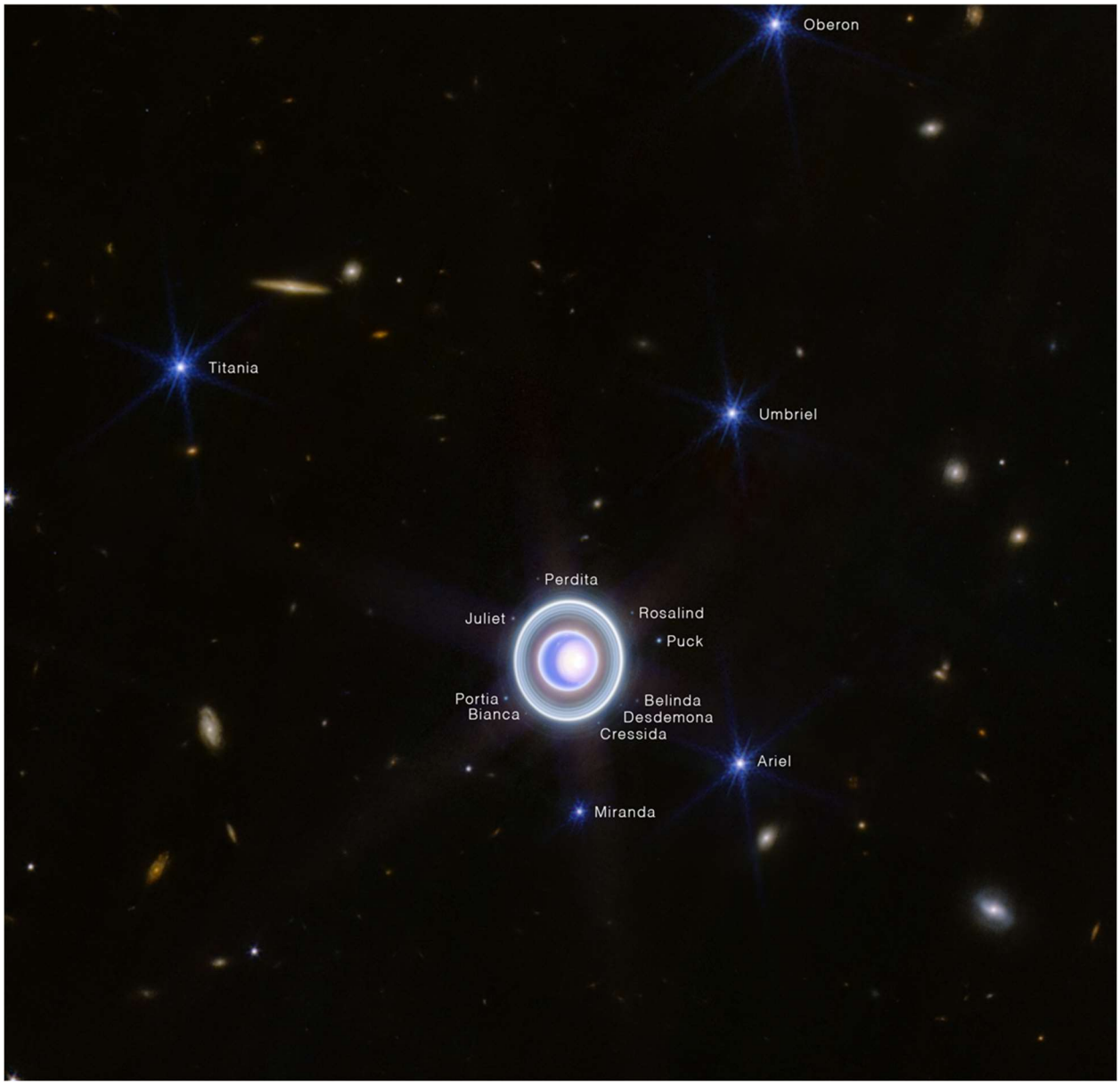


NASA's Perseverance rover completes three Earth-years on Mars
Image Credit: NASA/JPL-Caltech

February Astronomy Calendar and Space Exploration Almanac



The ice giant Uranus, orbiting on its side and encircled by rings, captured by the James Webb Space Telescope's Near-Infrared Camera (NIRCam). Tilted at 98° relative to the plane of the solar system, Webb's image shows the planet's white northern polar cap, bright storms near and below the southern border of the cap, as well as 14 of the planet's 27 moons. Several galaxies are also visible in the background. The near-infrared wavelengths of light recorded by NIRCam, invisible to the human eye, have been translated into visible-light colors.

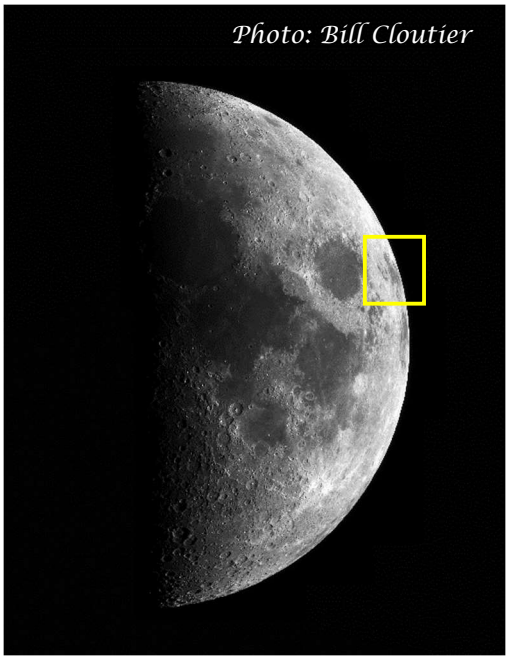
Image Credit: NASA, ESA, CSA, STScI

In This Issue

"Out the Window on Your Left"

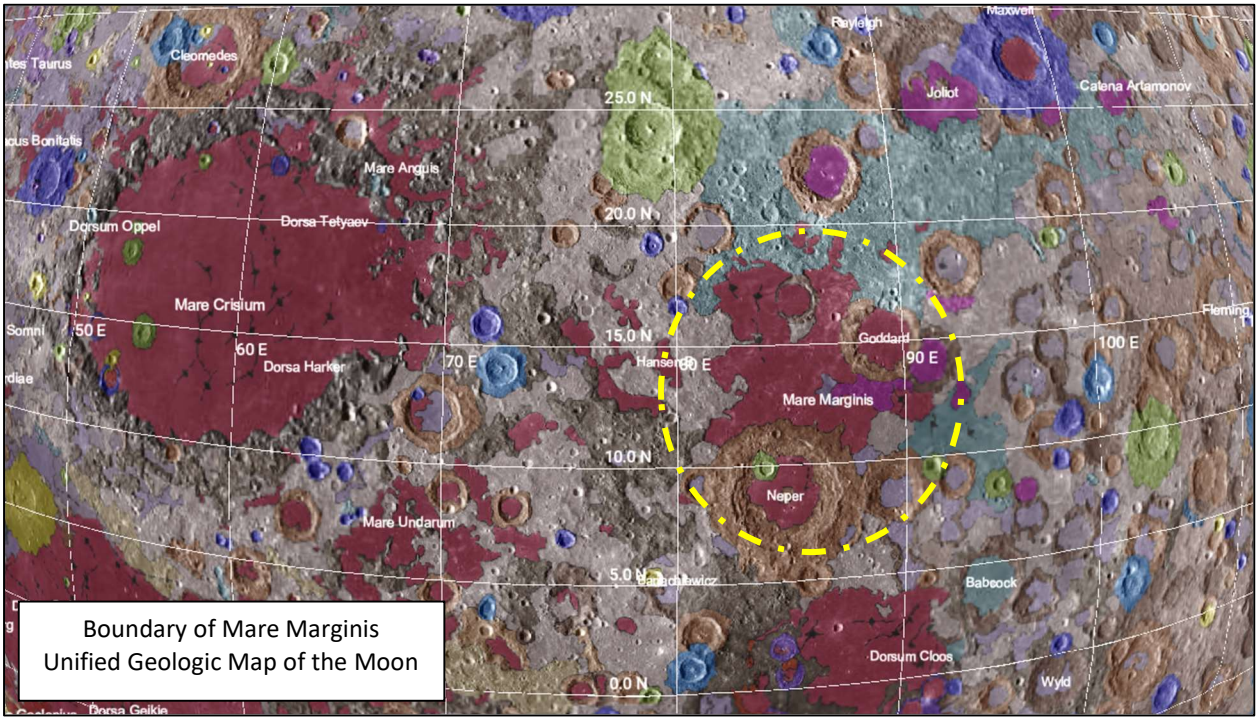
It's been more than 51 years since Apollo astronaut Gene Cernan left the last boot print on the Moon's surface. As a nation founded on exploration and the conquest of new frontiers, today's commitment to return to the Moon has been as fleeting as the funding. But what if the average citizen had the means to visit our only natural satellite; what would they see out the window of their spacecraft as they entered orbit around the Moon? This column may provide some thoughts to ponder when planning your visit (if only in your imagination).

Mare Marginis ("Sea of the Edge") is an irregular basaltic area located on the Moon's eastern limb, as viewed from Earth. Its center is listed at 86.5° longitude, with portions extending as far east as 93.4°. The lava patch is best seen during times of favorable longitudinal libration (a week or so after the Moon's closest approach to the Earth when it is possible to view lunar features up to an additional 7° over the eastern limb).



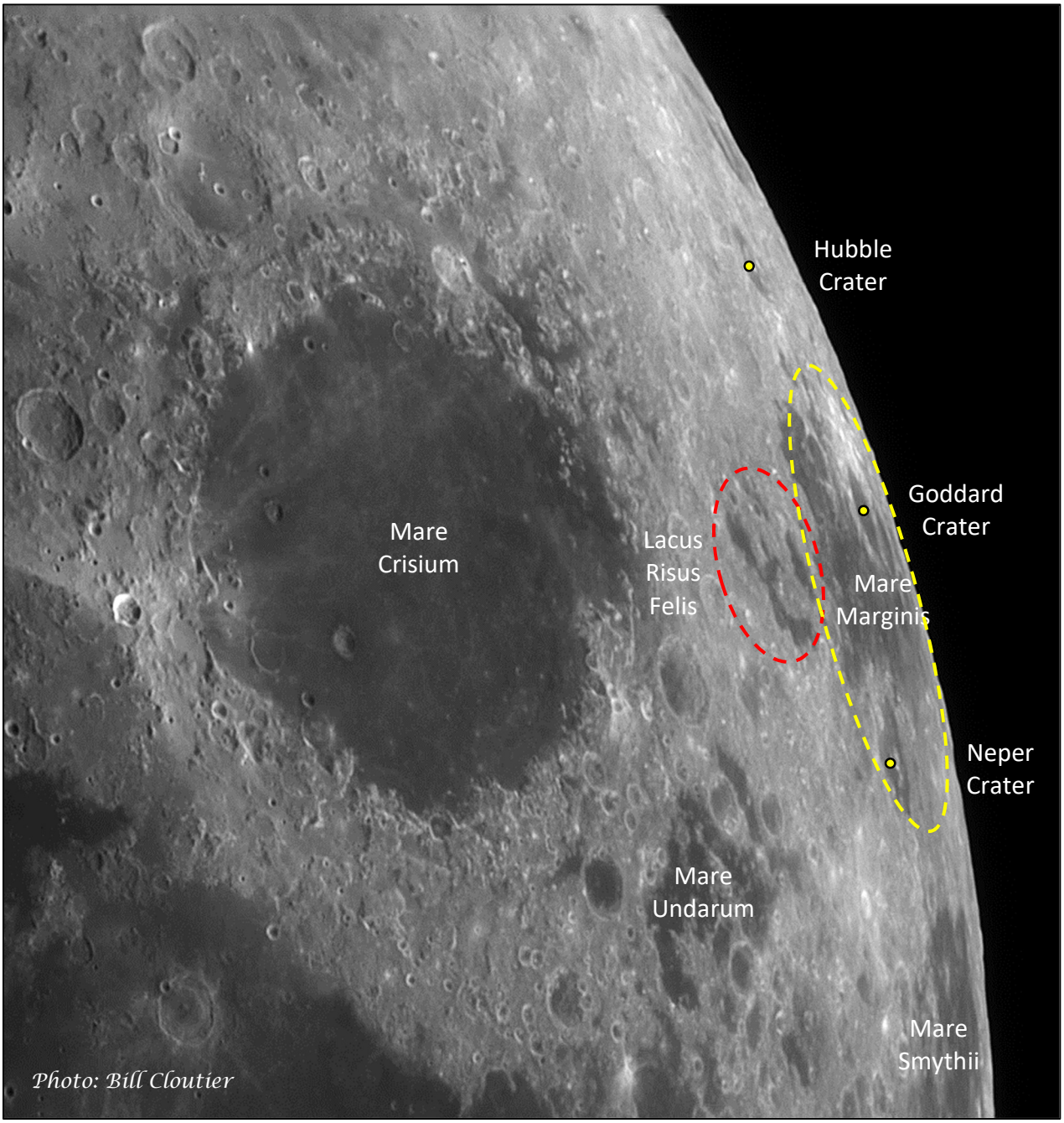
Location of Mare Marginis

The mare, bounded by the crater Goddard to the northeast and Neper to the south, doesn't appear to be associated with an impact basin and its basalts (estimated to be between 3.38 to 3.88 billion years old) are relatively thin. Mare Marginis might just be a low-lying region where near-surface lavas erupted and filled in the hollows over an area of about 25,000 square miles (64,900 square km). The mare contains several magnetic anomalies or lunar swirls, like Reiner Gamma, of unknown origin.



Boundary of Mare Marginis
Unified Geologic Map of the Moon

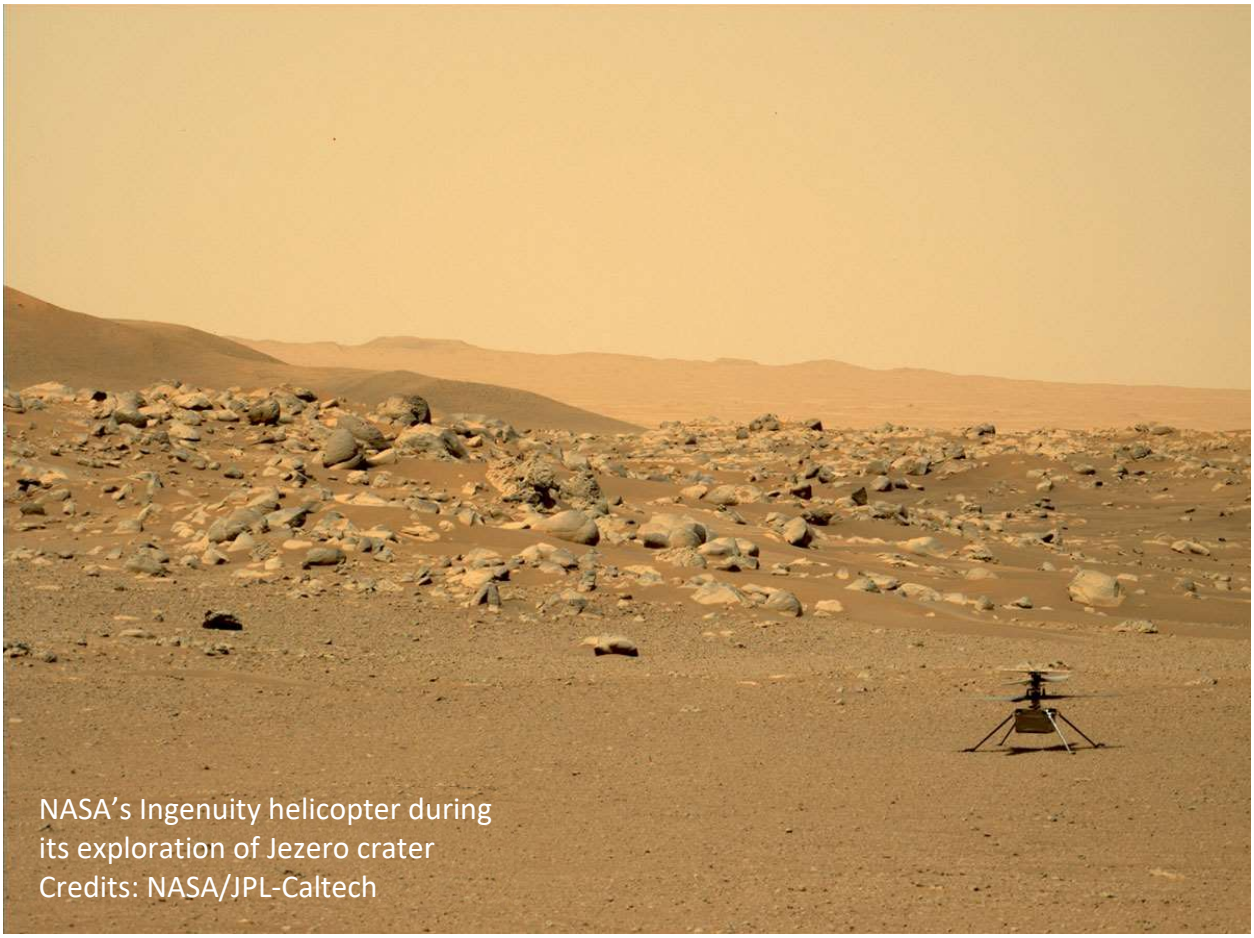
Mare Marginis



The lunar seas along the eastern limb of the Moon during a period of favorable libration (features were visible as far east as 96° in longitude). The photograph was captured with a 19th century antique refractor with a clear aperture of 4.2 inches.

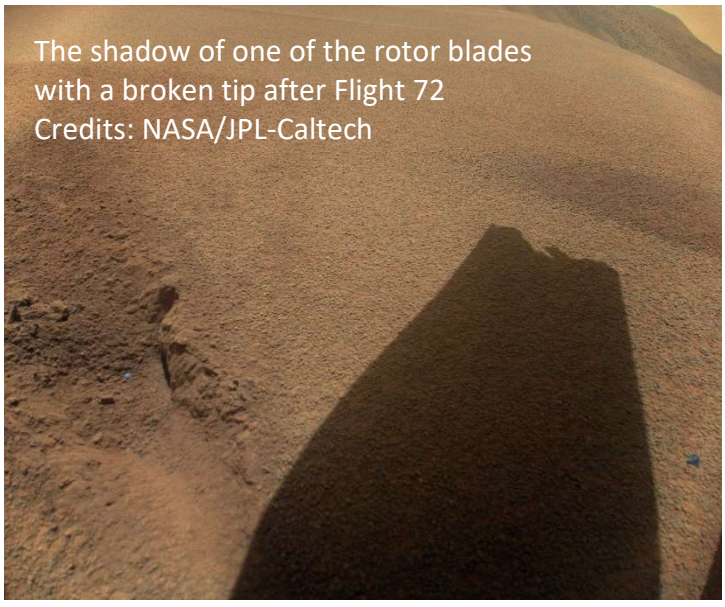
Charles Wood, a lunar scientist, gave the lava lakes to the west of the mare (circled in red) the informal name of Lacus Risus Felis - the Cat's Smile.

Final Flight



NASA's Ingenuity helicopter during its exploration of Jezero crater
Credits: NASA/JPL-Caltech

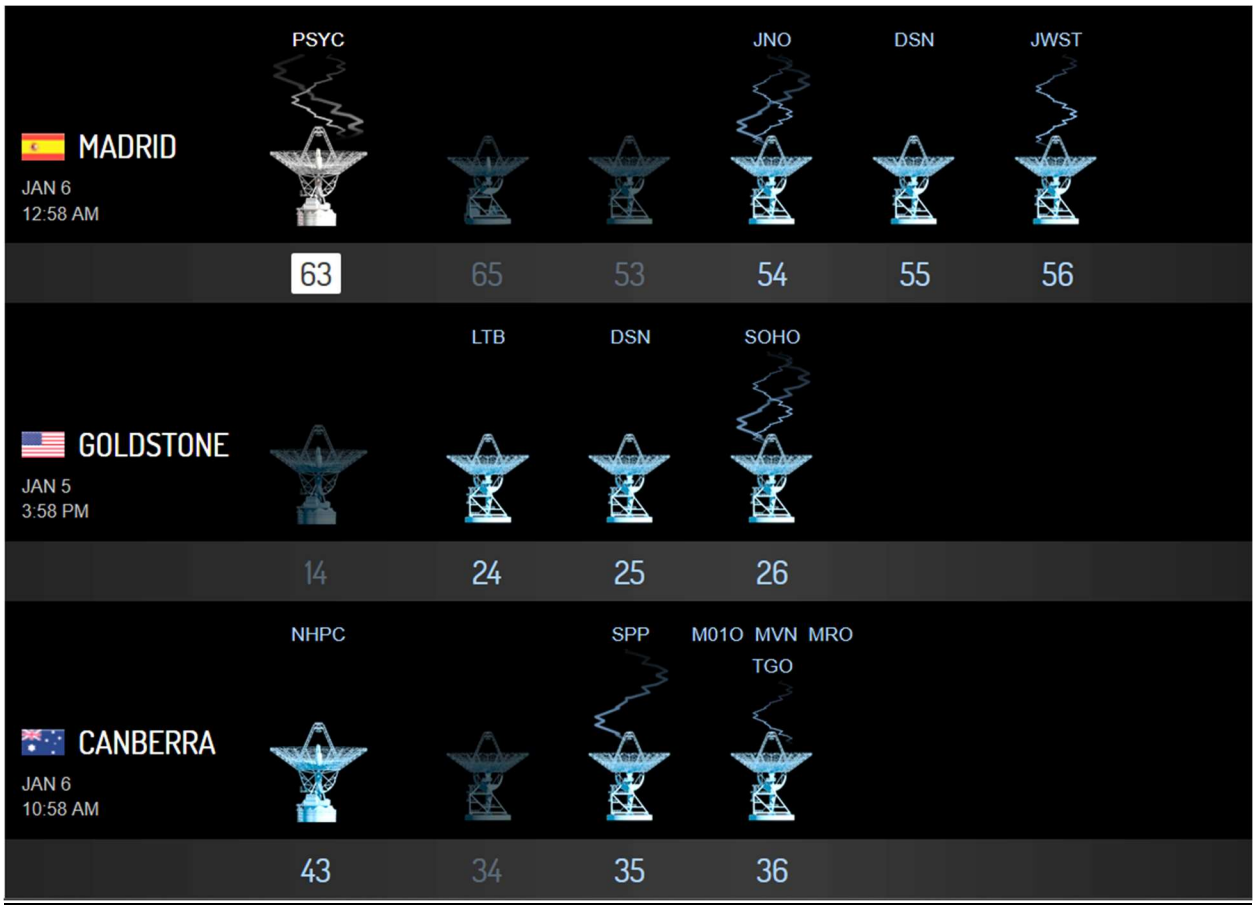
The Mars helicopter was a technology demonstration. Nicknamed "Ingenuity," it rode to the Red Planet attached to the underside of the Perseverance rover, which landed on Mars on February 18, 2021. The little rotorcraft first flew on April 19th – a 39 second flight that achieved an altitude of about 10 feet or 3 meters. Designed for up to five flights within the 30-day test period, Ingenuity's flawless performance convinced NASA to repurpose the helicopter as an aerial scout for the rover.



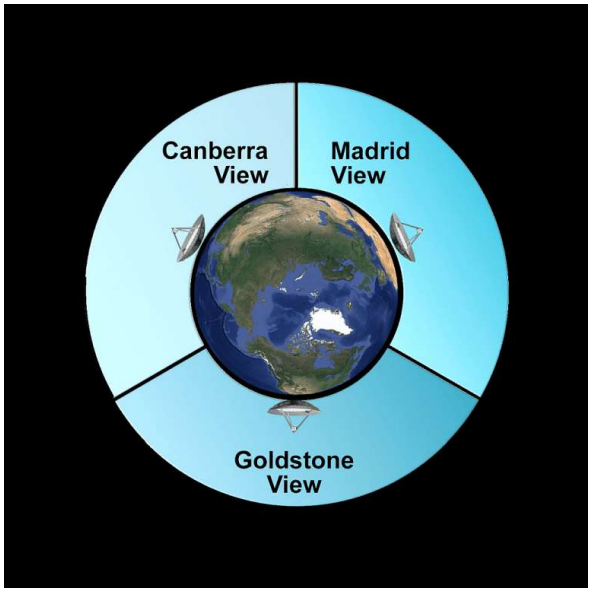
The shadow of one of the rotor blades with a broken tip after Flight 72
Credits: NASA/JPL-Caltech

During almost three Earth-years on Mars, Ingenuity conducted 72 sorties, operating in conditions well outside its design envelop. On January 18th, NASA lost communications with Ingenuity about 3 feet (1 meter) above the surface during the conclusion of Flight 72. After reestablishing contact, images from the helicopter revealed a at least one broken rotor tip. The exact cause of the rough landing is still under investigation, but for Ingenuity, its extraordinary mission is now complete.

Deep Space Network at 60



Deep Space Network facilities are positioned 120 degrees apart to give total sky coverage. Image: NASA/JPL



NASA's Deep Space Network (DSN) marked its 60th year of continuous operations on December 24th. DSN, operated by NASA's Jet Propulsion Laboratory (JPL), consists of three facilities spaced equidistant from one another – approximately 120 degrees apart in longitude around the world. Each facility, at Goldstone, California, Madrid, Spain, and Canberra, Australia - and has several antennas, the largest of which is 230 feet (70 meters) in diameter.

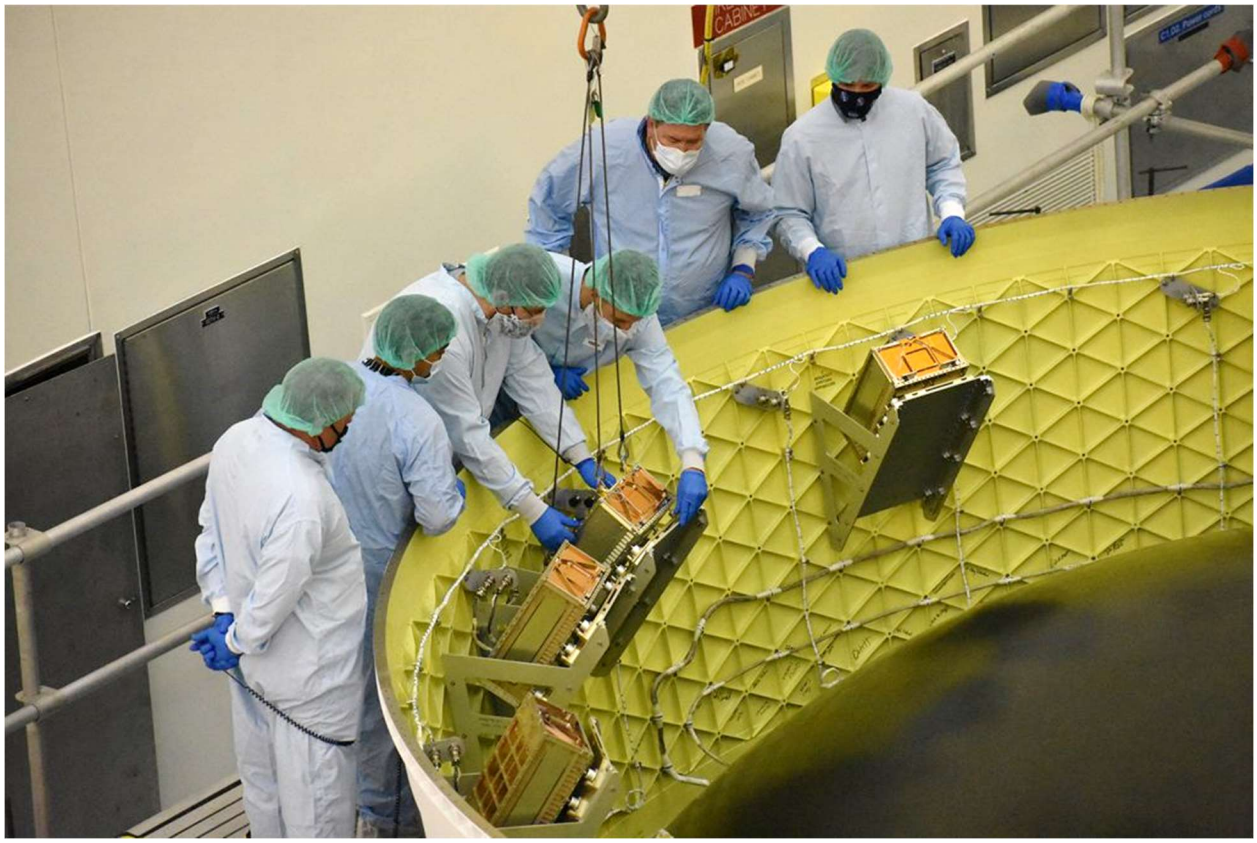
The antennas are used to communicate with space craft across the solar system, transmit and receive information from the Martian rovers and collect the image data from space telescopes, including the James Webb Space Telescope.

More than 40 missions, from nearly 30 countries, depend on DSN and the number is expected to double in the future. Oversubscription of DSN's services is a significant concern for NASA with

some missions already affected by network demand (over the last five years, the Mars Odyssey, Voyager 2, and the New Horizons missions each received between 8,500 and 15,000 fewer tracking hours than requested).

New mission such as the Webb telescope and the NASA/European Space Agency's Solar and Heliospheric Observatory (SOHO) have only added to the strain on the system. In 2022, of the 77,000 hours DSN supplied to NASA and international partners, 6,732 (almost 9%) were devoted to the Webb telescope, with another 5,309 hours (almost 7%) to SOHO.

Artemis 1, a lunar test flight that lasted less than a month, used 1,774 DSN hours – a large portion devoted to the 10 CubeSats that were launched with the mission (nearly half of the total DSN hours Artemis 1 used were to track lost CubeSats with their low-power transmitters).



Technicians installing the last of 10 CubeSats in the Space Launch System (SLS) rocket's Orion stage adapter for the Artemis 1 flight in November 2022.
Credit: NASA

NASA is working with international partners to find additional antennas that could be added to the system and increase the network's capacity. The agency's Aperture Enhancement Program, started in 2010, is well behind schedule and over budget, with only four of six planned new 34-meter antennas constructed to date. Meanwhile DSN's budget for operations and maintenance has contracted. DSN is expected to reach 50% oversubscription by the 2030s, a deficit that could compromise critical mission activities and result in loss of science data. NASA is exploring other ways to reduce the load on the system, including tracking multiple spacecraft with a single antenna and applying machine learning to increase system efficiency.

Goldstone's 70-Meter (230-Foot) Dish

Photo provided by Kyle Cloutier

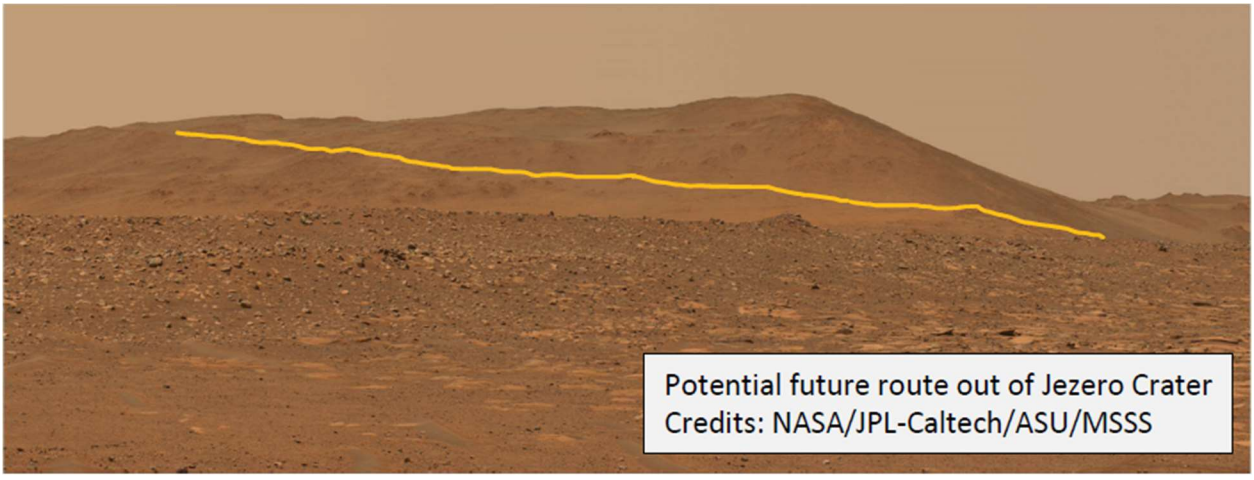
3 Earth-Years on Mars

A 2.38 billion pixel, 360-degree mosaic comprised of 993 individual images. The images were captured by NASA's Perseverance rover while parked on "Airey Hill," during the most recent solar conjunction (when the Sun-Earth alignment interferes with communications).
Credits: NASA/JPL-Caltech/ASU/MSSS

It has been 3 Earth-years and over 1,000 Martian Sols since the Perseverance rover landed in Jezero Crater. Since that day in February 2021, the rover has explored the basaltic crater floor around the landing site, the front face of the ancient river delta residing within the crater, and climbed up onto the top of delta to follow the river bed towards the crater wall.

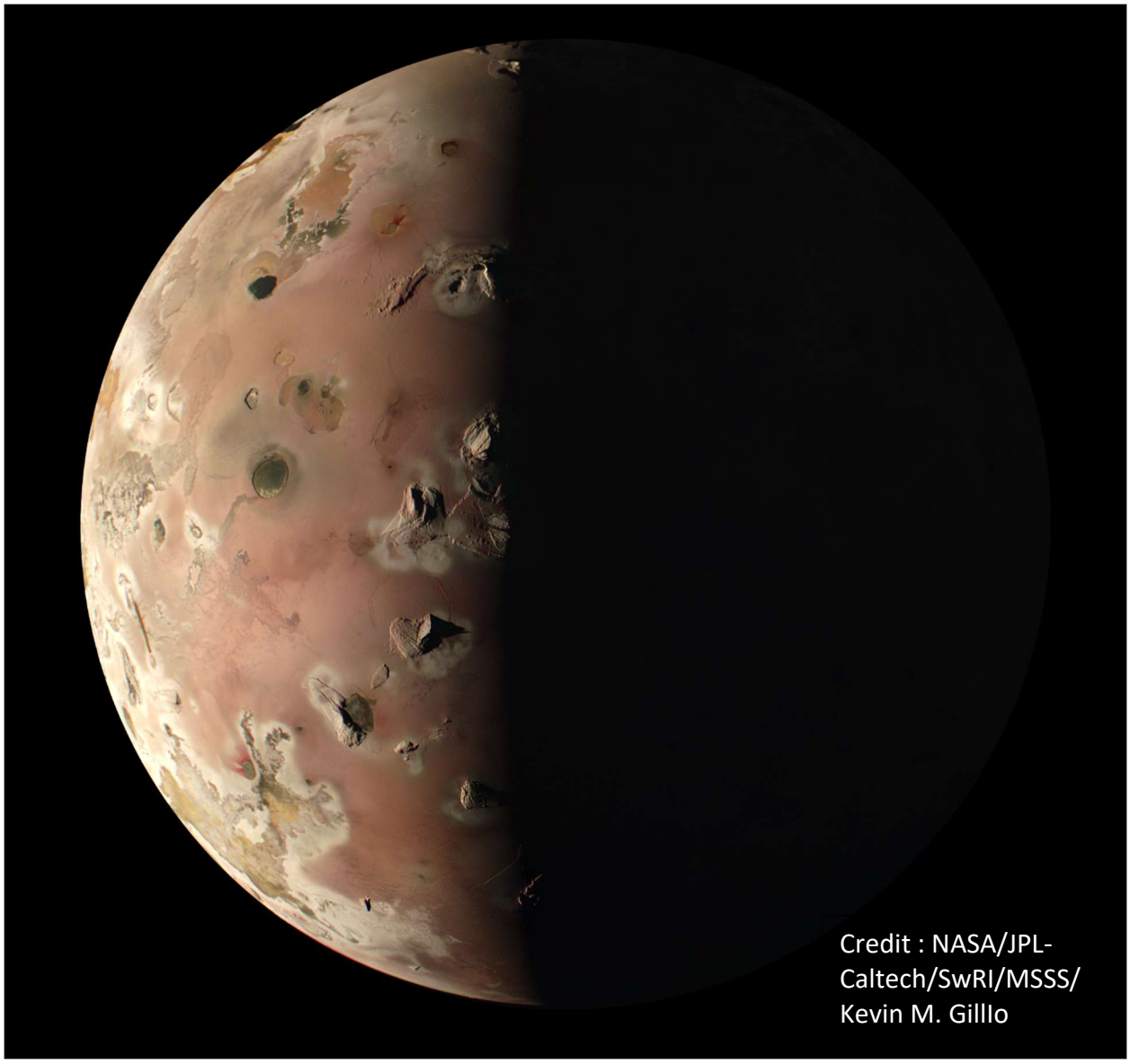
Along the way, the rover has collected 23 samples of rock and regolith that, when returned to Earth, will provide a record of changes in the Martian environment over the past 3.5 billion years and, possibly, include signs of past or current microbial life. Prior to climbing the delta formation, Perseverance deposited 10 sample tubes in a cache to be retrieved in the future, should the rover not be available to participate in the sample return mission.

The rover will continue to move upstream towards a break in the crater wall where the river once entered. From there, Perseverance will ascend a natural ramp to the rim as it makes its way out of Jezero crater.



The rover has covered almost 15 miles (24 km) in the three years. Perseverance is NASA's second rover operating on Mars, joining Curiosity, which has been exploring Gale Crater since 2012.

Juno's Close Encounter with Io

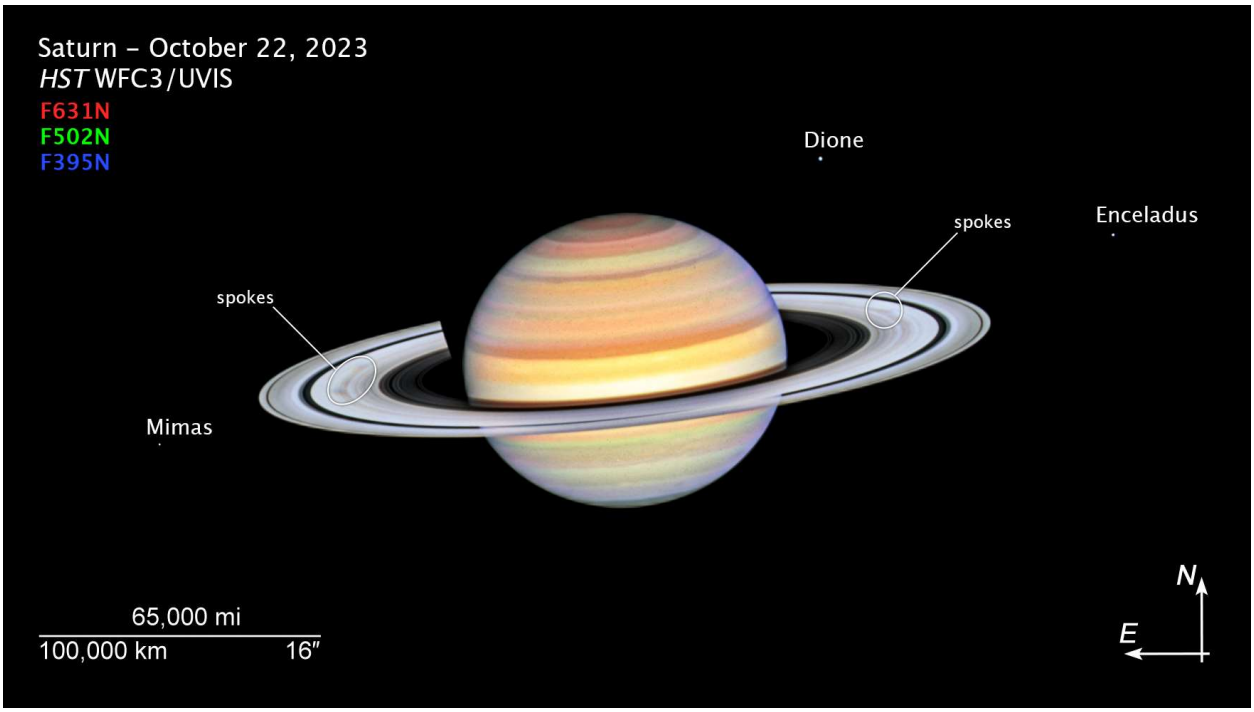


On December 30th, NASA's Juno spacecraft came within 930 miles (1,500 km) of the surface Jupiter's moon Io, the most volcanic world in our solar system. The close encounter occurred at the conclusion of Juno's 57th flyover of Jupiter's cloud tops or Perijove.

NASA's Juno spacecraft has been orbiting the gas giant since arriving in July 2016. With its Prime Mission concluded in 2021, the space agency authorized a mission extension through September 2025, or until the spacecraft's end of life. Over the past two years, the trajectory of the planetary orbiter has been gradually modified to extend its data gathering to Jupiter's rings and four Galilean moons. During Perijove 57, Juno made the closest flyby of Io that any spacecraft has made in over 20 years. The spacecraft will make a second close pass of the volcanic moon on February 3rd.

Scientists expect that the close encounters will reveal more about the source of Io's volcanic activity, whether a magma ocean lurks underneath its crust, and how Jupiter's proximity, tidal forces and magnetosphere affect the tortured moon.

Spoke Season

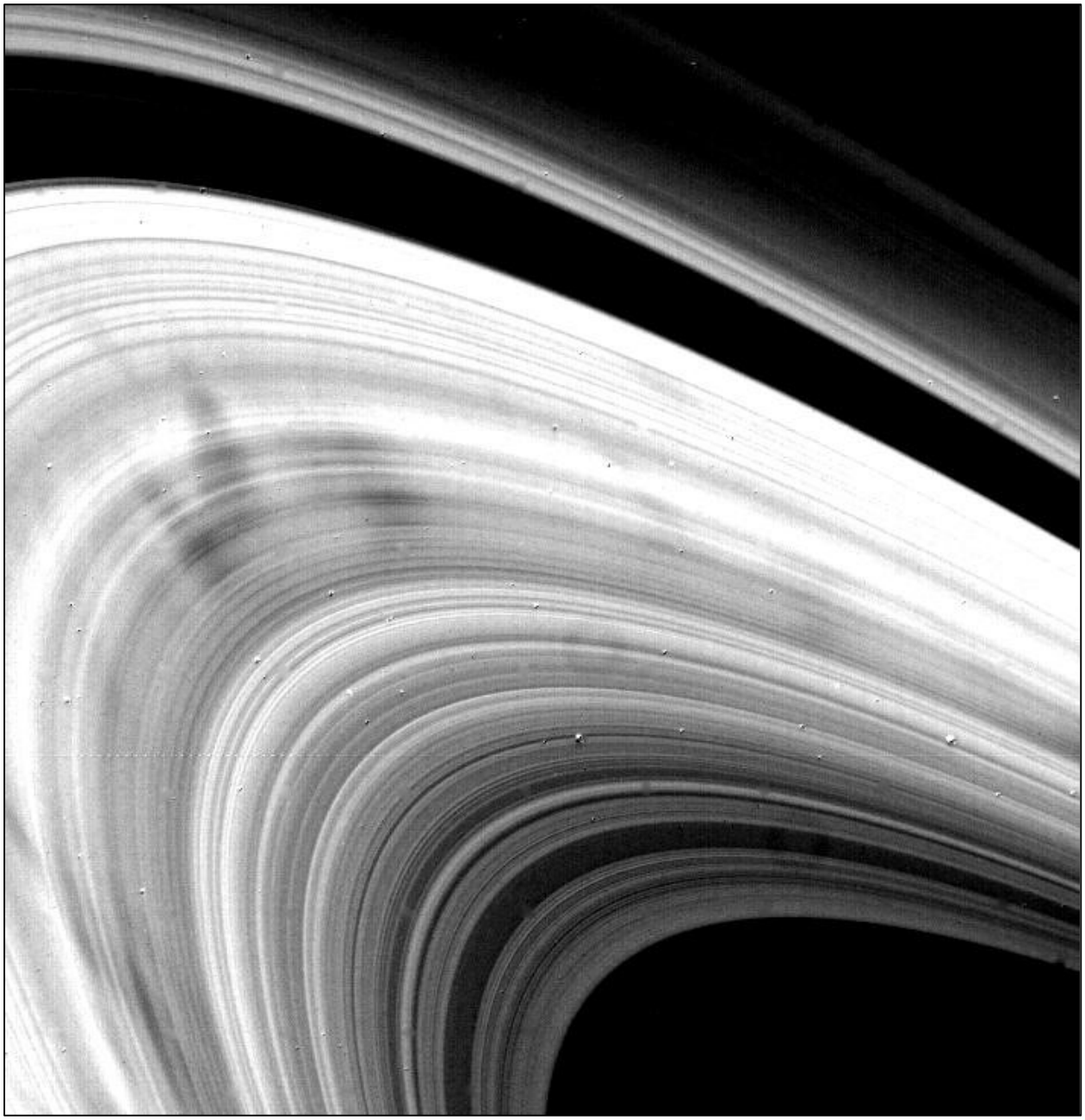


Ultraviolet-Visible image of cloud bands and rings spokes captured by NASA's Hubble Space Telescope Wide Field Camera 3.
Credit: NASA, ESA, STScI, Amy Simon (NASA-GSFC)

In 1981, NASA's Voyager 2 spacecraft first photographed spoke-like features on Saturn's rings. The spokes, that rotate along with the rings, are transient features, sometimes only lasting two or three rotations around the planet. Their appearance and frequency also appears to be seasonally-driven (seasons on Saturn with its Earth-like tilt are each approximately seven years in length). The spokes disappear around Saturn's winter and summer solstices, but reappear at the planet's fall and spring equinoxes.

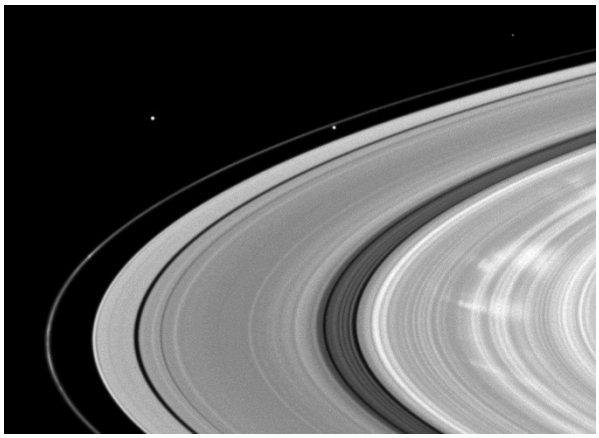
The spokes were also observed by NASA's Cassini spacecraft during its 13-year-long mission that ended in 2017. Since that time, Hubble has been observing the ringed-world as part of its Outer Planet Atmospheres Legacy (OPAL) program. Hubble's observations, with the northern hemisphere's autumnal equinox approaching in May of 2025, will be compared to Cassini's observations in 2009, during the vernal equinox. The spokes appeared in OPAL data in 2021, but only on the morning (left) side of the rings. In 2022, they appeared on both sides of the planet concurrently. While they seem small from our perspective, the spokes can be longer than the diameter of the Earth.

Despite the scrutiny by spacecraft and space telescopes, the spokes remain a mystery. Their rotation rate does not quite coincide with the rotation of the rings or the planet's magnetic field, although scientists suspect that their appearance is associated with the solar wind's interaction with Saturn's magnetic field. Other theories suggest the levitation of dust or ice above the ring to form the spokes, but questions remain and additional observations are needed.



High resolution image from Voyager 2's flyby of Saturn's rings in August 1981 (above) with the ghostly dark spokes crossing the rings.
Image Credit: NASA/JPL

When the spokes are viewed from a low angle, they appear dark. At angles higher than 45°, they appear bright as in this image (right) captured by the Cassini spacecraft in 2009.
Credit: NASA/JPL/Space Science Institute



Japan's Moon Lander – A Qualified Success

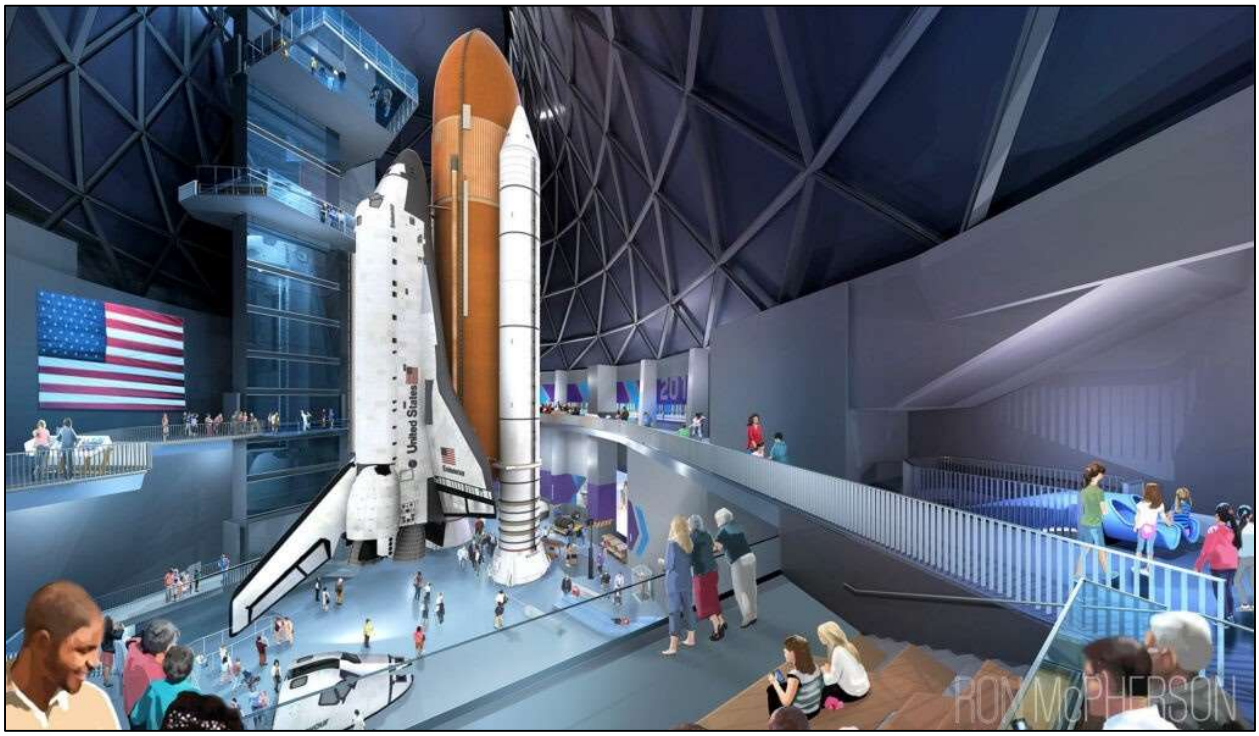
Photo of SLIM resting on the surface nose down captured by one of the two mini-probes
Credit: Japan Aerospace Exploration Agency (JAXA)

On January 20th, Japan became the fifth country (after the Soviet Union, U.S., China and India) to successfully soft-land a spacecraft on the Moon. The jubilation was, however, short-lived. The robotic Smart Lander for Investigating Moon (SLIM) experienced an anomaly about 165 feet (50 meters) above the surface when one of its two main engines failed. This resulted in the spacecraft's solar cells facing west and in shadow upon touchdown.

The SLIM moon lander arrived in lunar orbit on Christmas Day after a low-energy, four-month journey. Over the following weeks, its orbit was lowered as it prepared for a landing on the ejecta blanket of Shioli crater, situated on the western, cratered shore of Mare Nectaris. The lander was designed to demonstrate pinpoint landing technology (which it accomplished), with an accuracy of 330 feet (100 meters) or less, and obstacle detection methods in preparation for future sample return missions. Just a few seconds prior to landing, SLIM deployed (JAXA believes successfully) two mini probes, known as LEV-1 and LEV-2. The probes were designed to provide still images of the landing area (LEV-1 can independently communicate with Earth while LEV-2 needs to relay data through SLIM) and mobility technology demonstrations. NASA's Deep Space Network confirmed that they did receive telemetry from SLIM and/or one of the tiny rovers an hour after landing.

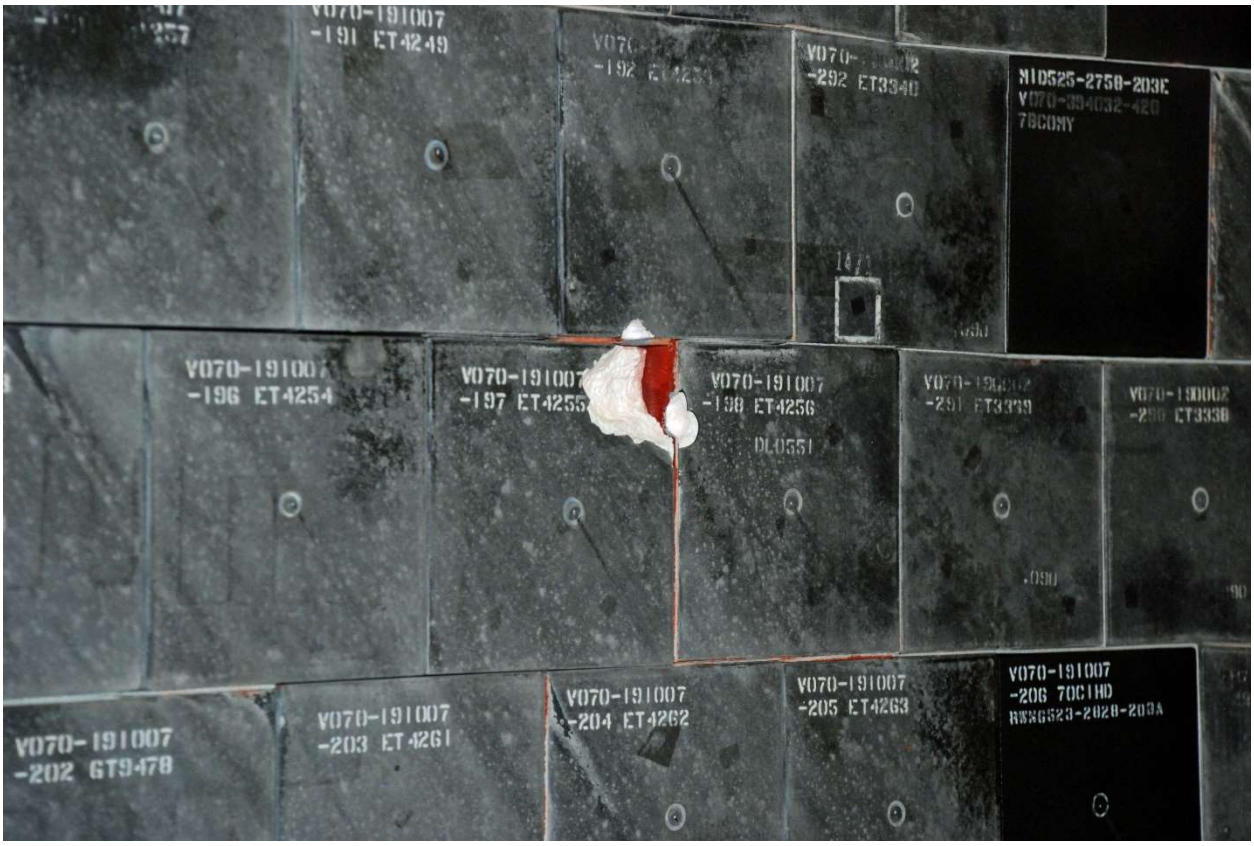
With the lander's battery switched off after three hours to retain what little charge was left, JAXA was hoping that a change in the direction of sunlight would allow the solar cells to generate enough power to revive the spacecraft. Ten days after landing, the spacecraft woke up and reestablished contact. However, the landing site will soon be in darkness and it is unclear whether the spacecraft can survive the harsh environment during the long lunar night.

Endeavour – Go for Stack



Artist's rendering of the future vertical space shuttle Endeavour exhibit in the future Samuel Oschin Air and Space Center at the California Science Center in Los Angeles
Credit: (California Science Center/Ron McPherson

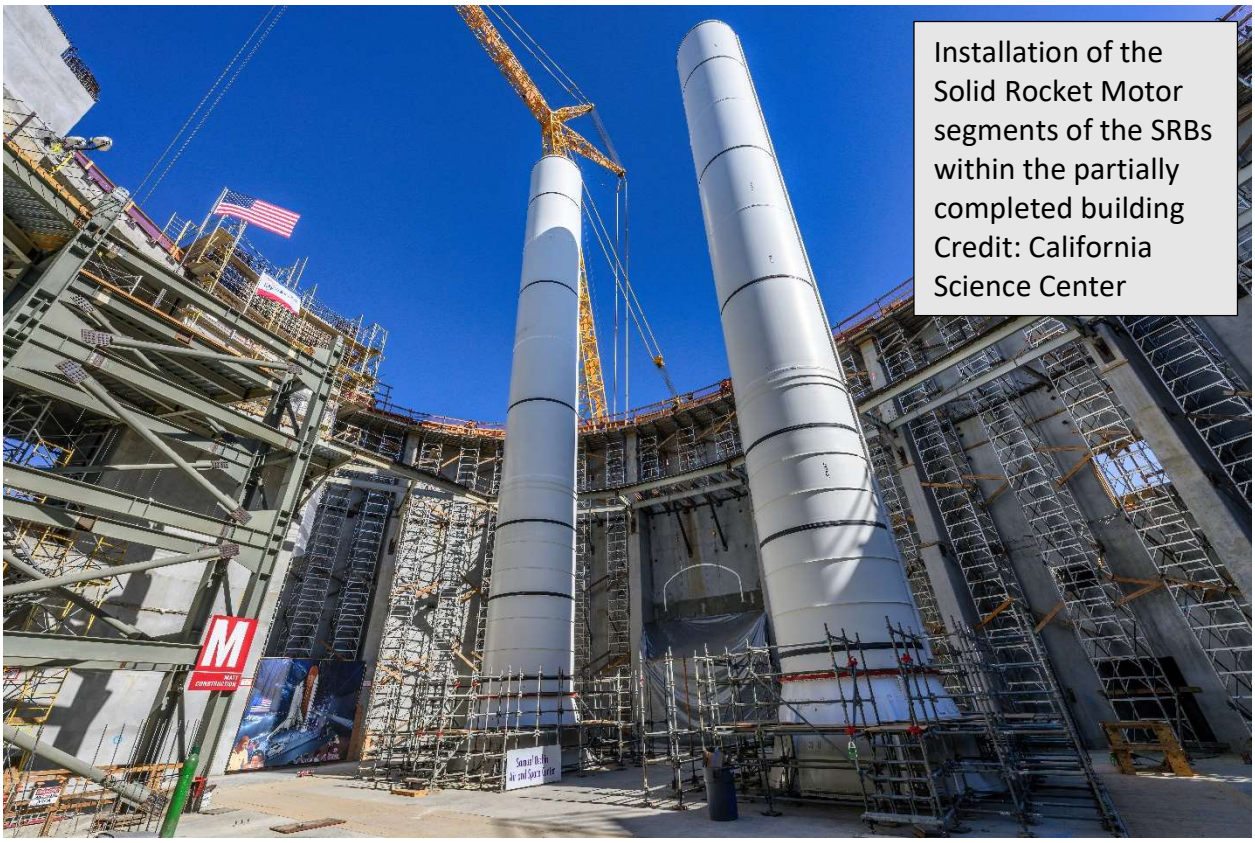
Since its arrival at the California Science Center in late 2012, the space shuttle Endeavour has been on display in a temporary building awaiting the design, funding and construction of the Samuel Oschin Air and Space Center. The orbiter was displayed in a horizontal position, atop its mobile transporter, allowing visitors to walk beneath the tiled underside of the reusable space plane.



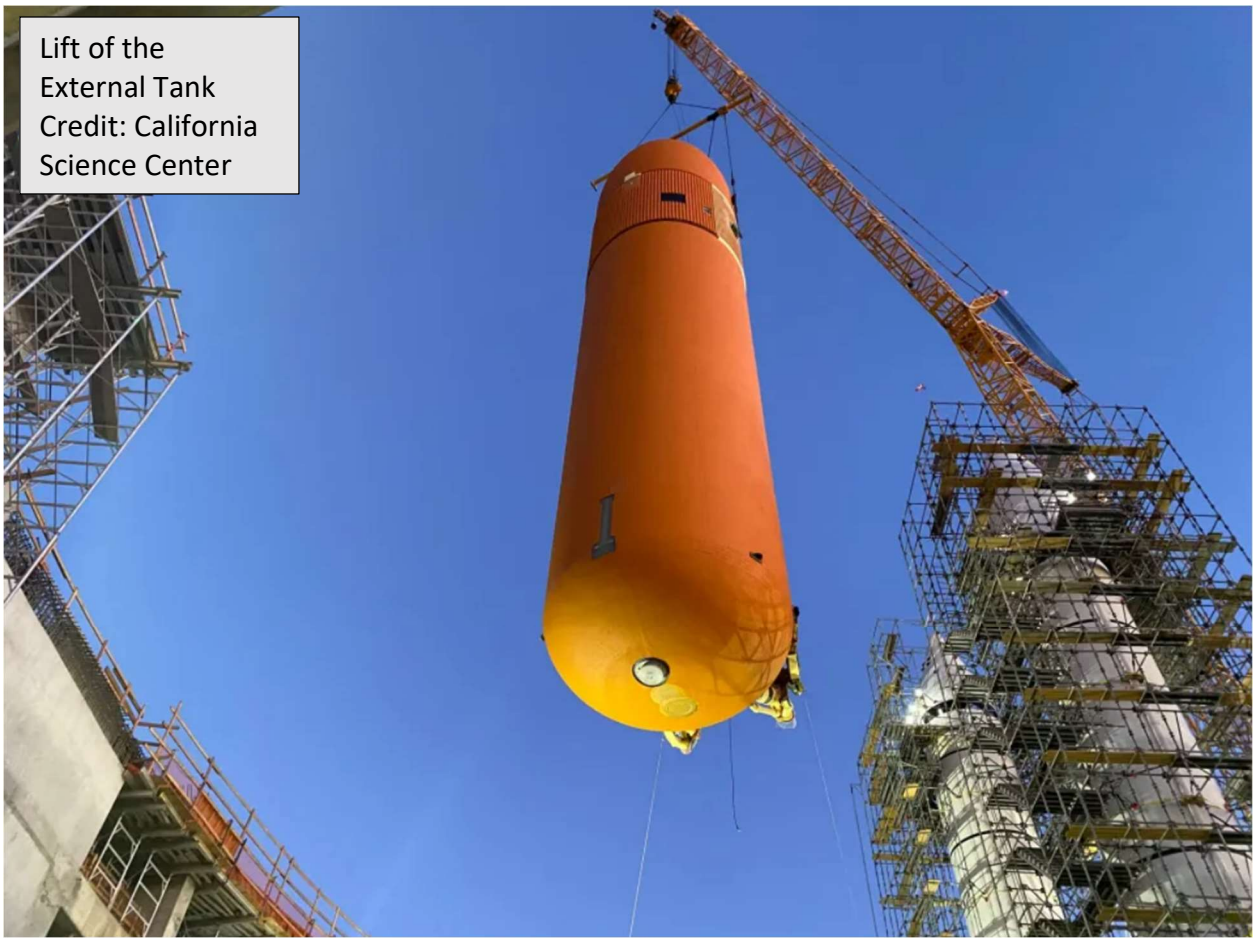
Closeup view of the black HRSI (high-temperature reusable surface insulation) tiles that provided passive thermal control in orbit and shielded the shuttle from the searing heat of re-entry when temperatures reached 1,200 -2,300°F (650 - 1,260°C). Damage incurred during its last flight is also visible in a number of the 23,000 HRSI tiles on the vehicle.
Photo: Bill Cloutier

In June of 2022, the California Science Center broke ground on the Samuel Oschin Air and Space Center. The 200,000-square-foot addition to the center will contain 150 educational exhibits and showcase the space shuttle Endeavour in a vertical launch position, along with an external tank and twin solid rocket boosters (SRBs). The walls of the center have now reached a height where the shuttle components need to be brought in before the building is enclosed. One of challenges of displaying a 20-story vertical display in California is protecting an irreplaceable piece of space history during a seismic event. This risk has been mitigated by having the SRBs anchored to an 1,800-ton (1,633-metric ton) concrete slab which sits atop six friction-pendulum seismic isolators that break the horizontal connection between the orbiter stack and the ground. This will allow the entire shuttle exhibit to glide gently back and forth on low-friction sliders in the event of an earthquake.

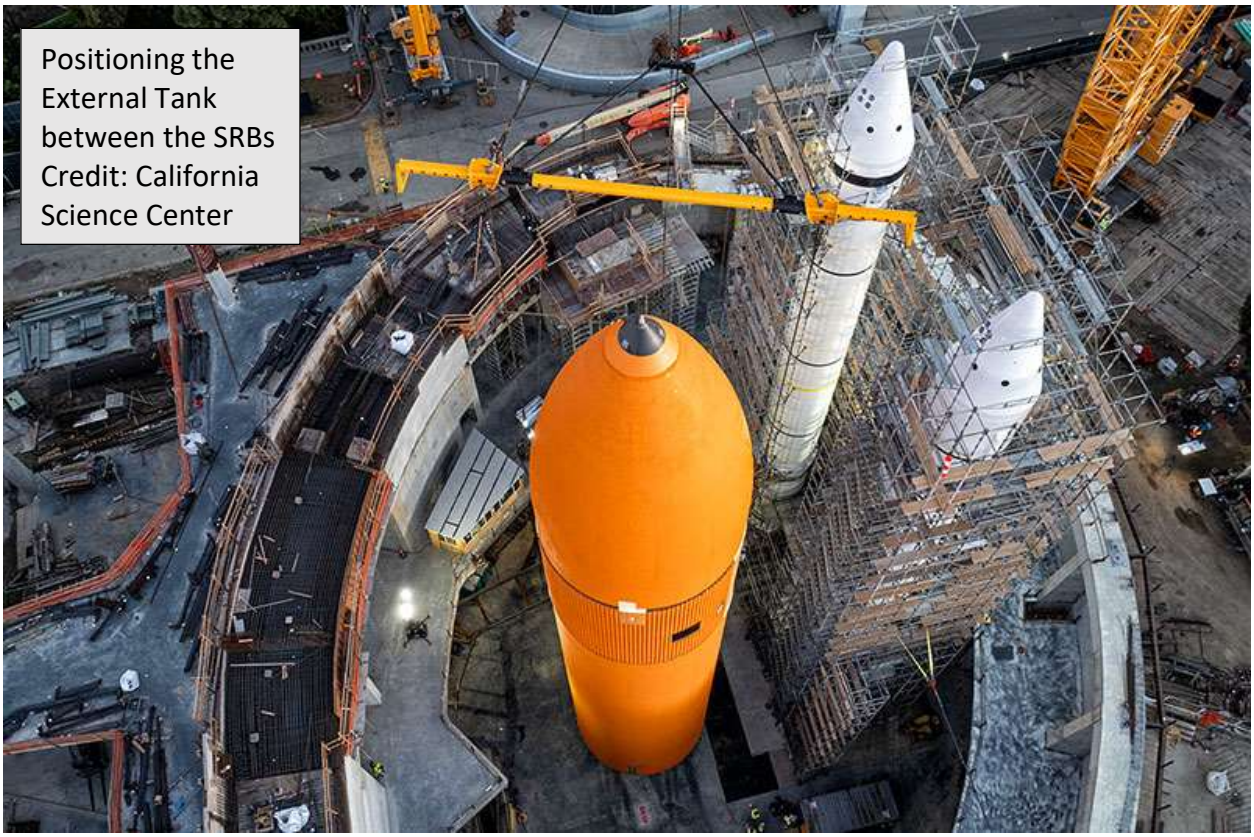
The Science Center's ambitious "Go for Stack" operation began in early December with the installation of the two SRBs. The SRBs are assembled from flight-worthy or previous launched parts donated by Northrop Grumman and NASA. The external tank (the only remaining tank built for flight in existence) was lifted into the building by an overhead crane on January 12th and placed between two 149-foot-tall (45 meter) SRBs. Endeavour, shrink-wrapped to protect the orbiter from construction dust, joined the stack in the early morning on the 30th.



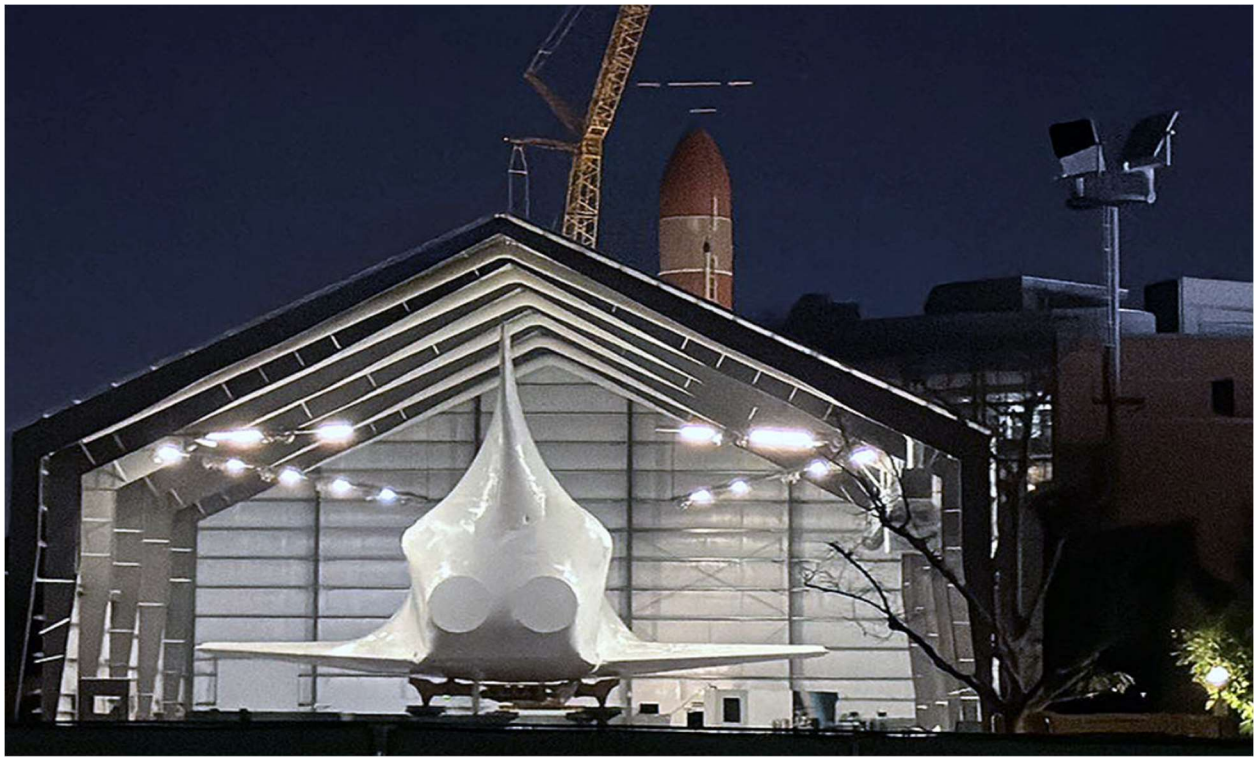
Installation of the Solid Rocket Motor segments of the SRBs within the partially completed building Credit: California Science Center



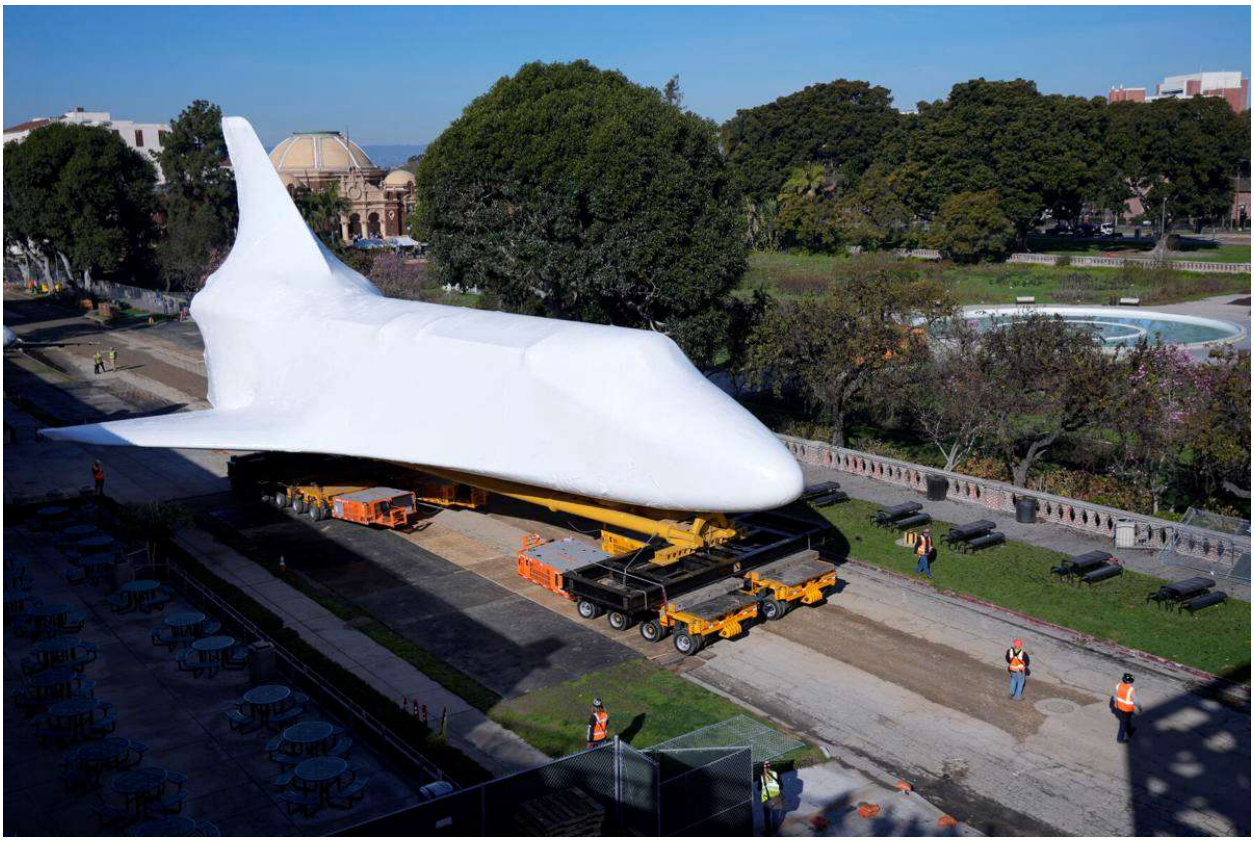
Lift of the External Tank Credit: California Science Center



Positioning the External Tank between the SRBs
Credit: California Science Center



Space shuttle Endeavour, covered in shrink wrap, waits to be lifted and stacked while the crane moves the External Tank in the background.
Photo: Matt Hartman/Shorealone Films



Shrink-wrapped shuttle Endeavour being moved and lifted into the Samuel Oschin Air and Space Center, completing the "stack" Credit: California Science Center

Good News, Bad News

First certification launch of United Launch Alliance's (ULA) Vulcan rocket on January 8th
Photo credit: ULA

Pre-launch photo of Astrobotic's Peregrine lunar lander prior to being encased within the payload fairings (nose cone) of ULA's Vulcan rocket
Credit: ULA

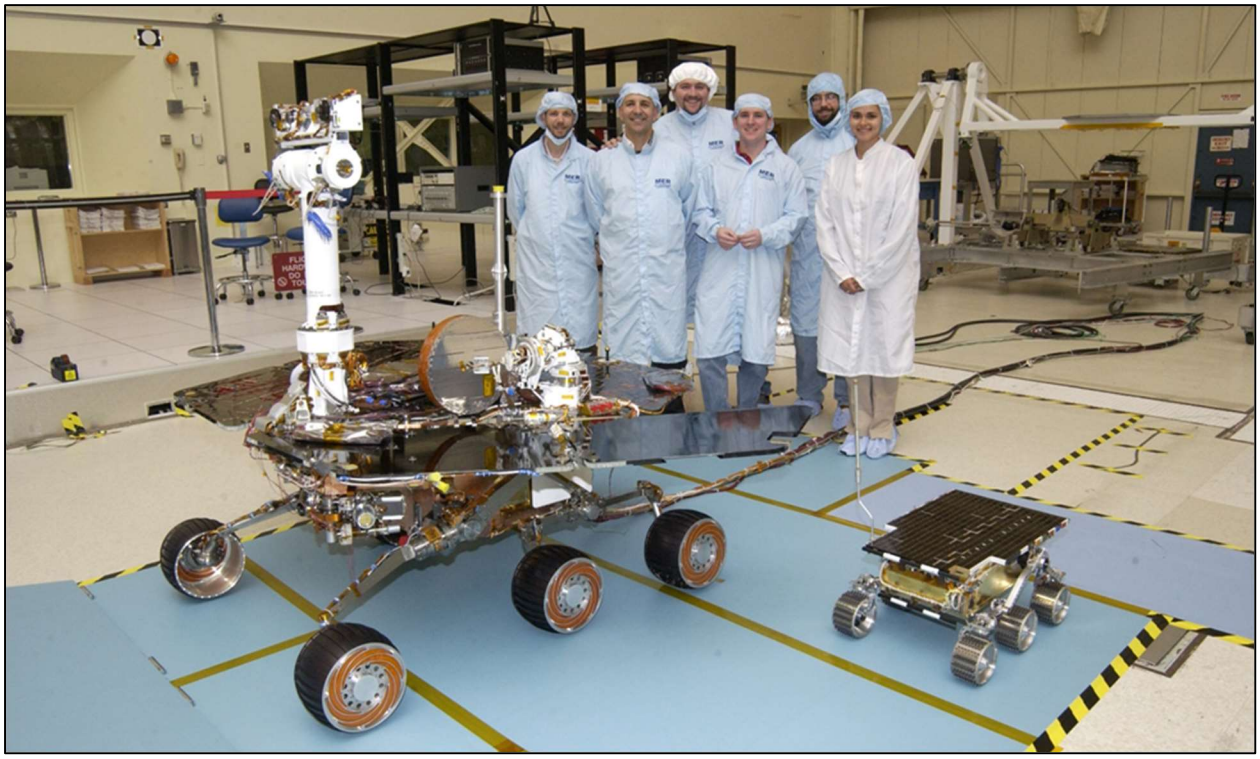
The countdown and inaugural flight of United Launch Alliance's (ULA) Vulcan rocket went off without a hitch. After almost a decade in development, ULA's new rocket lifted off in the early morning hours of January 8th from Space Launch Complex-41 at the Cape Canaveral Space Force Station, powered by two BE-4 methane-fueled engines developed by Blue Origin, and two GEM 63XL solid rocket boosters supplied by Northrop Grumman. The flight was the first of two certification flights required by the Defense Department before the booster can carry national security payloads. The second is expected to launch Sierra Space's Dream Chaser spaceplane.

Unfortunately, while ULA's rocket successfully placed its payload, the Peregrine moon lander, into a trans-lunar injection orbit, the spacecraft suffered a mission-ending event shortly thereafter. The lander, developed by Astrobotic Technology, was to set down on Sinus Viscositatis ("Bay of Stickiness") on February 23rd, not far from the Gruithuisen lava domes. (Astrobotic is one of 14 vendors eligible to carry NASA payloads to the Moon through the Commercial Lunar Payload Services initiative.)

Astrobotic believes that, shortly after launch, a valve between the helium pressurizer and the oxidizer tank failed to reseal, over-pressurizing and rupturing the oxidizer tank. The leaking oxidizer caused perturbations in the spacecraft's orbit and precluded any landing attempt on the Moon. After traveling out past the Moon's orbit and looping back towards Earth, Astrobotic orientated the spacecraft such that it reentered the Earth's atmosphere, burning up safely over unpopulated areas on January 18th.

Opportunity Remembered

Twenty years ago, NASA's Mars Exploration Rover "Opportunity" bounced to a landing on the likely site of an ancient lake called Meridiani Planum. Five years ago, NASA declared mission end for Opportunity, after more than six months of attempting to reestablish contact with the solar powered rover (the rover had experienced a power failure after encountering a global dust storm in June 2018). Between those two milestone, the little robotic geologist found conclusive evidence of standing water on the Martian surface over long time periods.

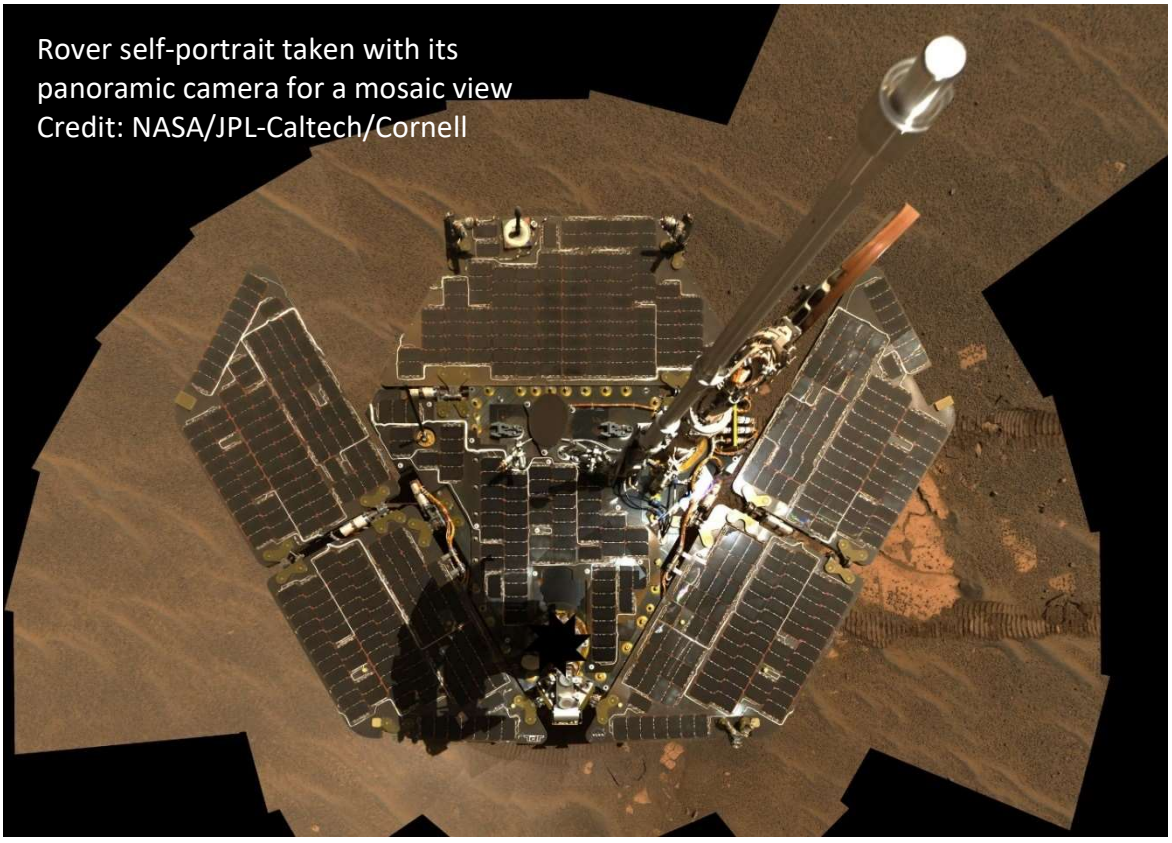


One of the twin Mars Exploration Rovers prior to launch posing with a flight spare of the Pathfinder mission's Sojourner rover. Credit: NASA

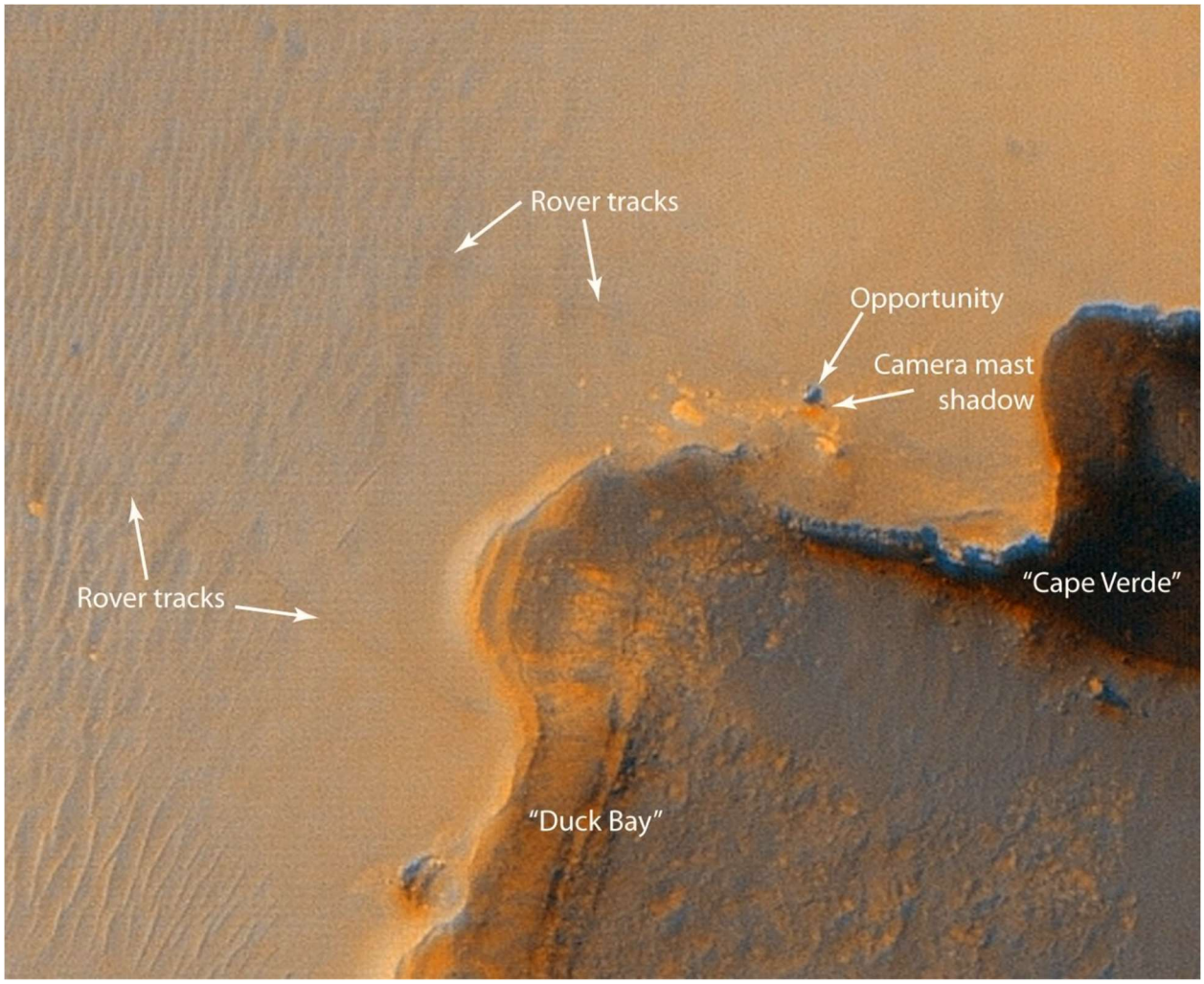
Opportunity, and its twin "Spirit," landed on Mars in January 2004, each with an expected 90-day-long Prime Mission. The twins represented a tremendous leap in technology and capability over the first rover on Mars - Sojourner (which had landed 7 years earlier and traveled a total of 330 feet or 100 meters, all while staying within sight of its lander). Spirit would operate for over six years after landing in Gusev Crater and travel about 4.8 miles (7.73 kilometers) before becoming mired in soft sand from which it could not escape or maneuver to optimize the orientation of its solar panels during the long Martian winter months.

Opportunity operated for well over a decade and by mission end had traveled 28.06 miles (45.16 km) across the surface. By happenstance, the rover landed in a small crater with a partially exposed outcrop of rock. Scattered among the rock layers were tiny sphere-shaped nodules rich in hematite, a mineral formed in the presence of water. The robotic geologist would find other rocks and minerals along its journey across the Martian plains that would confirm a watery past and also evidence of ancient hydrothermal systems.

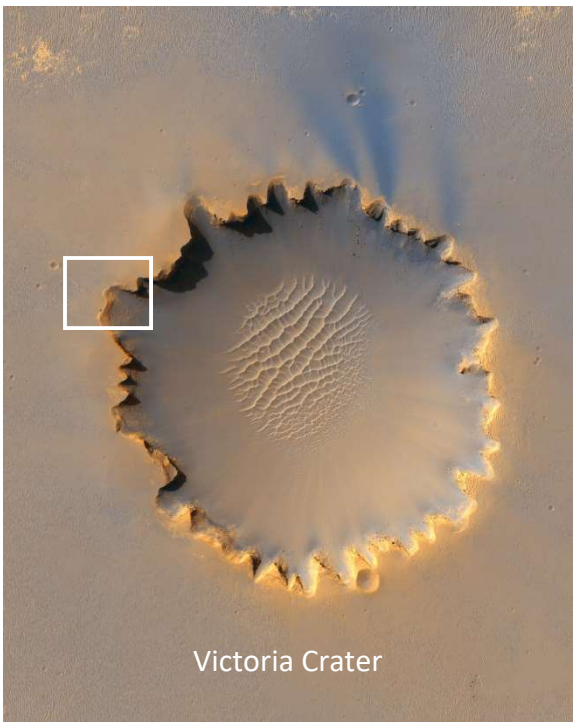
The landing of the Mars Exploration Rovers was cushioned with a cluster of double-bladder airbags (with the rover cradled inside) which were released about 40 - 60 feet (15 – 20 meters above the surface. Credit: NASA/JPL-Caltech



Rover self-portrait taken with its panoramic camera for a mosaic view
Credit: NASA/JPL-Caltech/Cornell

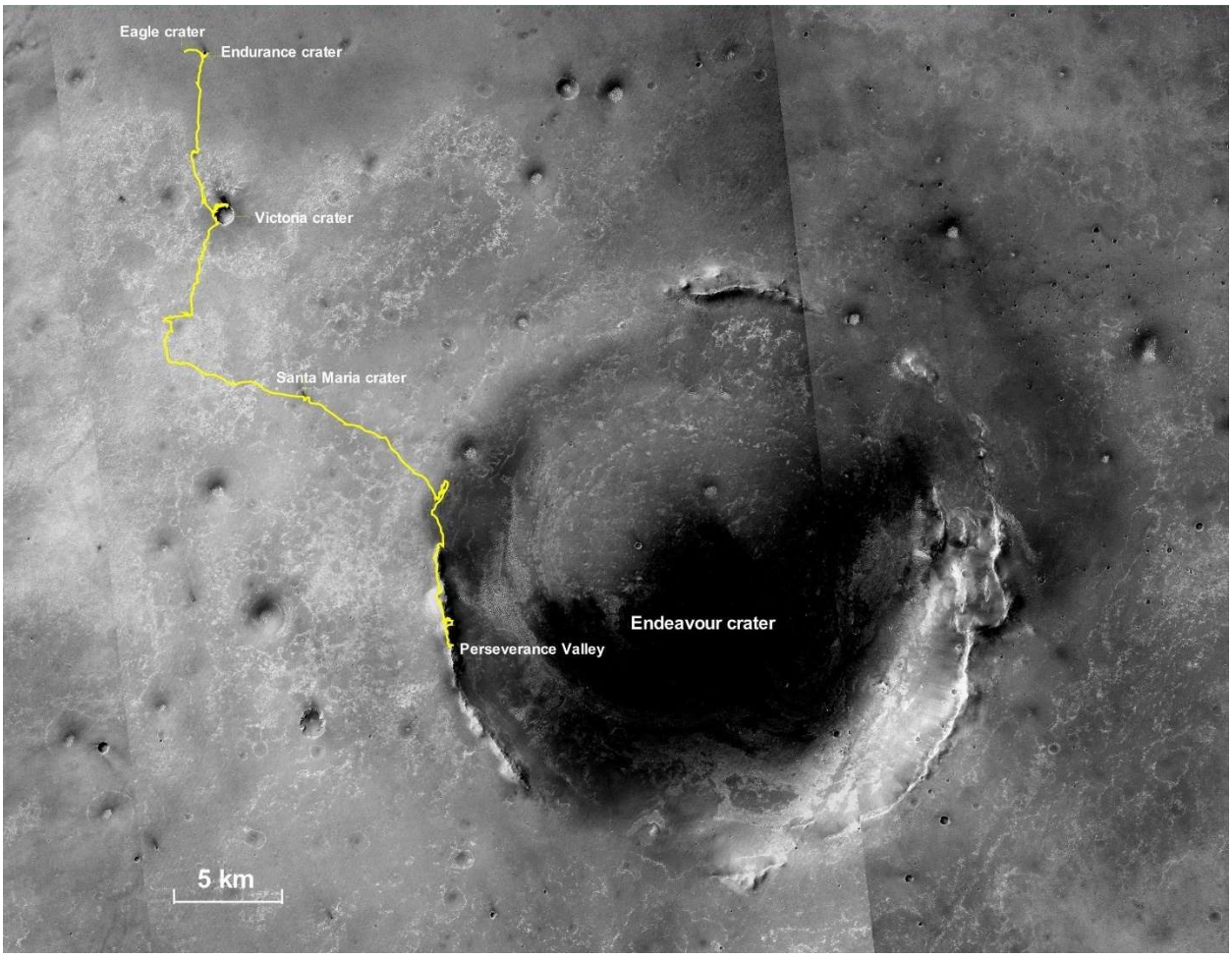


Opportunity spent 14 months exploring Victoria, a crater about one-half mile (800 meters) in diameter, reaching the rim in September 2006. The High Resolution Imaging Science Experiment (HiRISE) camera onboard the Mars Reconnaissance Orbiter spacecraft was able to capture the 384-pound rover on a Martian summer afternoon shortly after it arrived at the crater and while engineers back on Earth weighed possible entry points into the crater. After traveling along the rim, the rover would return to "Duck Bay," near the point of its arrival, and drive down a sandy incline to explore the interior of the crater.



Images of Victoria (right) and Opportunity (above) captured by MRO's HiRISE camera from an altitude of about 168 miles (269 km).

NASA/ JPL-Caltech/ Univ. of Arizona

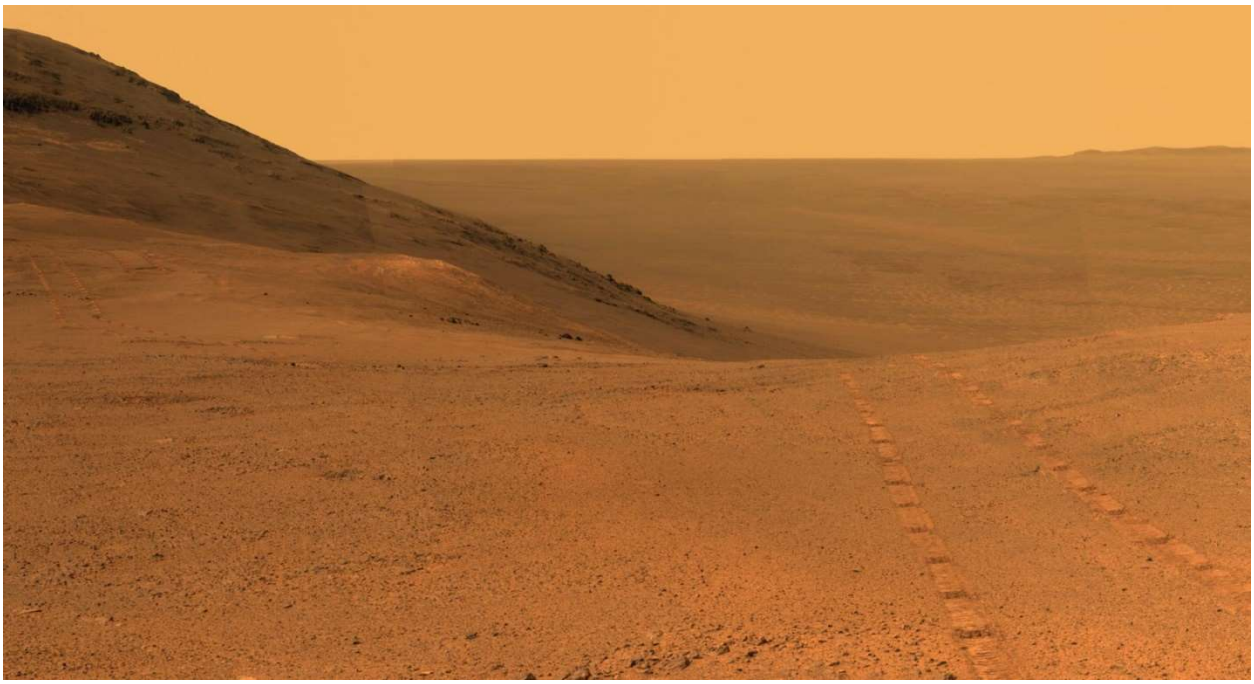


Fourteen year, four month long journey of the rover Opportunity, from its landing site in Eagle crater to its final resting place in Perseverance Valley on the rim of Endeavour crater, overlaid on images from NASA's Mars Reconnaissance Orbiter
Credits: NASA/JPL-Caltech/MSSS

Opportunity's Martian triumphs were not without challenges. In 2005, the little rover plowed into a 12-inch-high (30 centimeters) sand dune just days after it lost the use of its right-front wheel when the steering motor became jammed. It took engineers at NASA Jet Propulsion Laboratory, working with a model in a Martian "sandbox" at the lab, five weeks to free Opportunity. The rover encountered another sand trap the following year, but lessons-learned from the first encounter allowed for a quick escape.

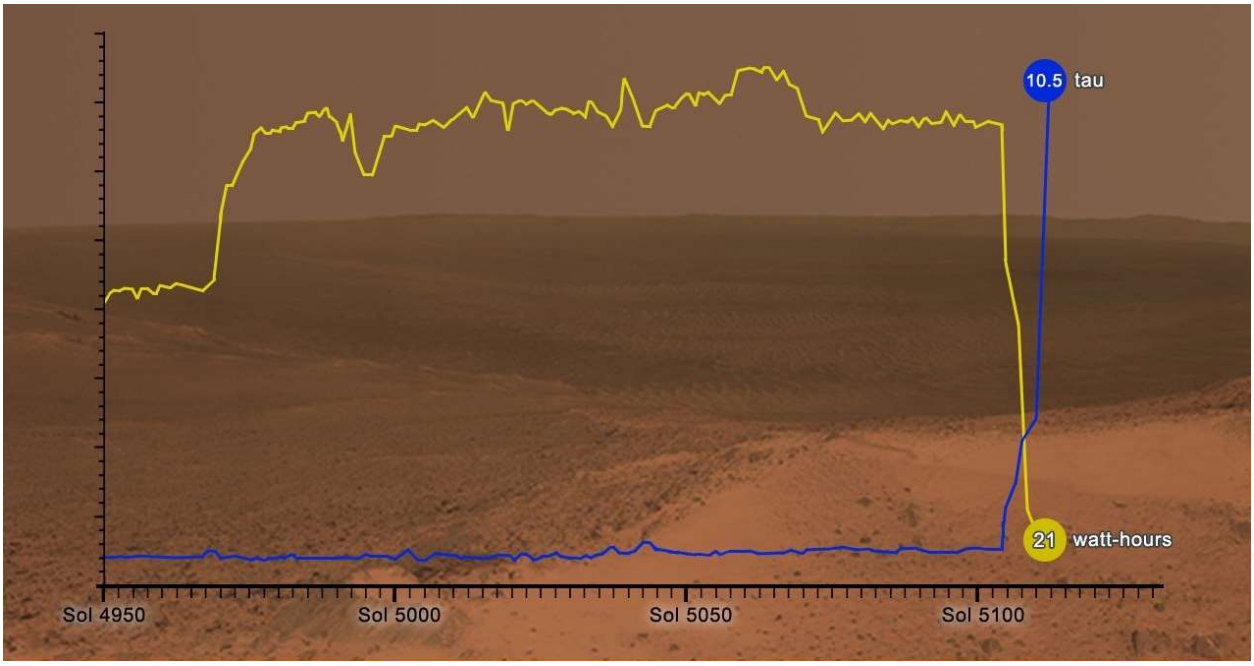
In July 2007, as Opportunity was entering Victoria crater, a dust storm struck. Power levels on the solar-powered rover dropped to critical levels, but Opportunity managed to pull through, complete its exploration, and climb back out.

As the rover aged, problems developed with its flash memory (used to store data when the rover was powered off). By 2015, NASA was only using the rover's random-access memory, requiring any high-priority data to be transmitted before the rover entered a sleep cycle or the information would be lost. Opportunity's luck would run out in May 2018 when a global dust storm would turn day into night.



Looking down towards Perseverance Valley and Endeavour's crater floor
Credit: NASA/JPL-Caltech/Cornell/Arizona State University

The rover requires a tau (a measure of atmospheric opacity) of less than 2.0 to recharge its batteries. Opportunity measured a tau of 10.8 on June 10, 2018, the last time the rover was able to transmit data back to Earth.

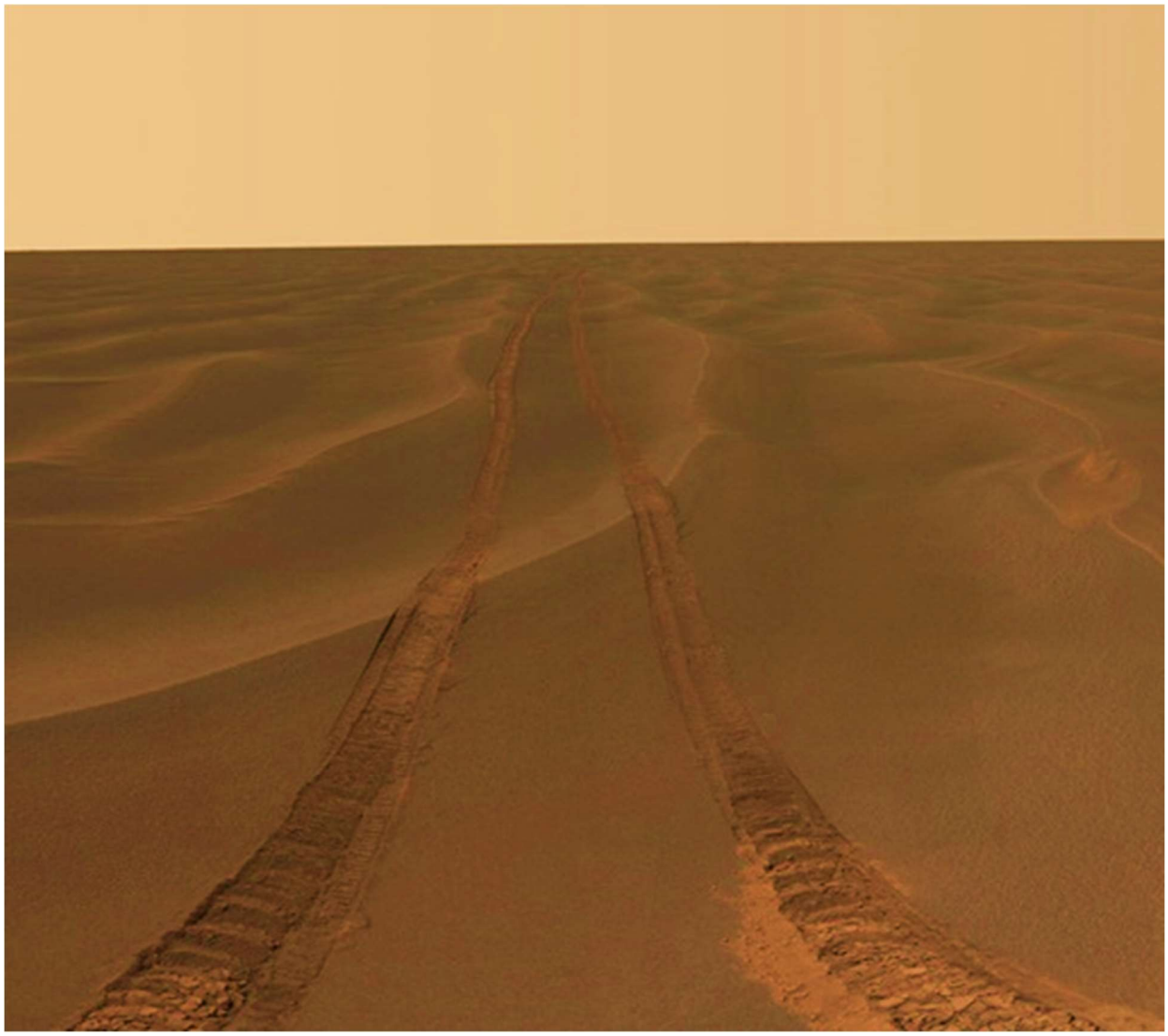


Energy available to Opportunity (in watt-hours) as compared to the clarity of the Martian atmosphere (measured in a value called tau) over the rover's last 150 Martian days of operation. NASA/JPL-Caltech

It would be mid-September before the skies cleared and NASA would begin a campaign to reestablish contact. After five months of listening and waiting for a response, the mission was declared over on February 2019, fifteen years after landing.

It had been a morning routine since landing in 2004 for the engineers at NASA's Jet Propulsion Laboratory to start the day off with a "wake-up song." Mission engineers played The Turtles' "So Happy Together" once Opportunity joined Spirit on Mars and when the rover first rolled down the lander's ramp onto the surface, it was met with Bruce Springsteen's "Born to Run."

After sending its last series of recovery commands on February 13, 2019, mission engineers queued up one last wake-up song. Selected by Dr. Steve Squyres, the principal investigator of the Mars Exploration Rover Mission, the tune was "I'll Be Seeing You," sung by Billie Holiday.



Looking back on its tracks as Opportunity crosses the desolate plains of Meridiani
Credits: NASA/JPL-Caltech/Cornell

Remembering Columbia

Columbia crew photo from an undeveloped film canister recovered from the debris. From left (bottom row): Kalpana Chawla, Rick Husband, Laurel Clark and Ilan Ramon. From left (top row): David Brown, William McCool and Michael Anderson. (Image credit: NASA/JSC)

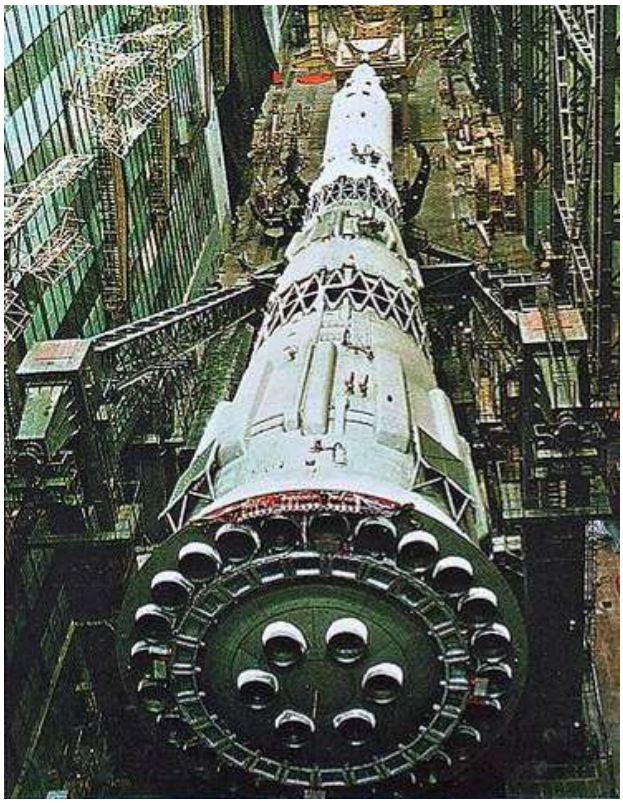
Twenty-one years ago on February 1st, the nation's first space shuttle to fly in space broke apart as it returned to Earth, killing all seven crew members aboard. The accident investigation board determined that a large piece of foam fell from the Columbia's external tank during launch, striking the orbiter's left wing. The resulting hole in the carbon-carbon composite insulation allowed hot gases to enter the wing during reentry, resulting in the loss of control and eventual destruction of the vehicle on its 28th flight. In the largest ground search in history, volunteers combed an area of east Texas the size of Rhode Island and Delaware for the remains of the shuttle and her crew. Eventually, almost 40 percent of the dry weight of the spacecraft was recovered (84,000 pieces), as well as all of the crew members.

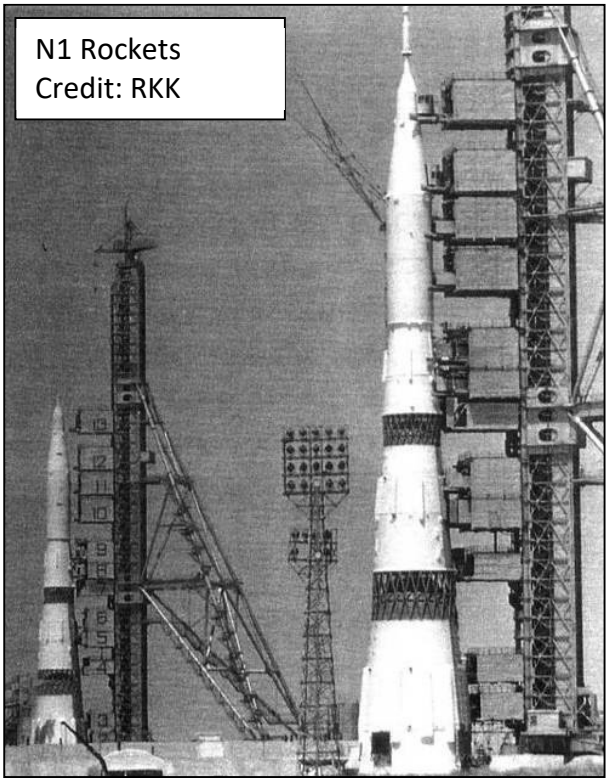
It would be 907 days before another space shuttle flew and, despite all the work to make the vehicle safer, Discovery's external tank shed several large pieces of foam. The largest piece missed the orbiter and the smaller ones caused only minimal damage, based on on-orbit inspections. STS-114, commanded by Eileen Collins, would return safely to Earth at the end of the 14-day mission.

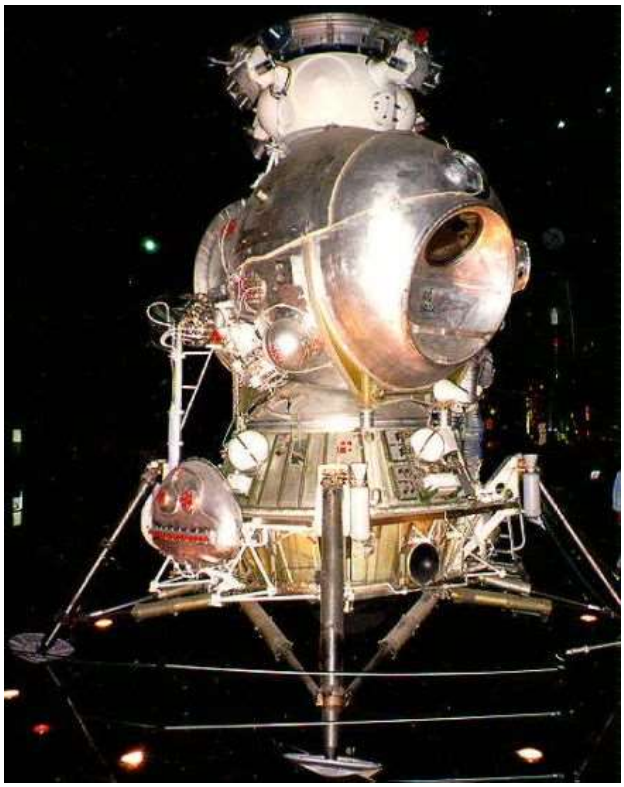
Soviet Moon Program

February 1969 marked the beginning of the end of the Soviet Moon program. While publicly denying its intentions to send cosmonauts to the Moon during the 1960s, the Soviets were secretly constructing rockets of mammoth proportions (rivaling the Saturn V). On February 21, 1969, the N1 moon rocket exploded during its first test flight. The rocket fell back to Earth after a safety system mistakenly shut down all 30 engines when a fire was detected in the first stage less than 70 seconds after liftoff. Three more failures would follow before the Soviet government would abandon their manned-Moon program.

The historic photos on the right shows 1) the N1 under construction with the 30-engine first stage, 2) the Soviet lunar lander and 3) two N1 rockets on pads at the Baikonur Cosmodrome (also known as Tyuratam) in Kazakhstan. The five stage rockets stood approximately 340 feet high.



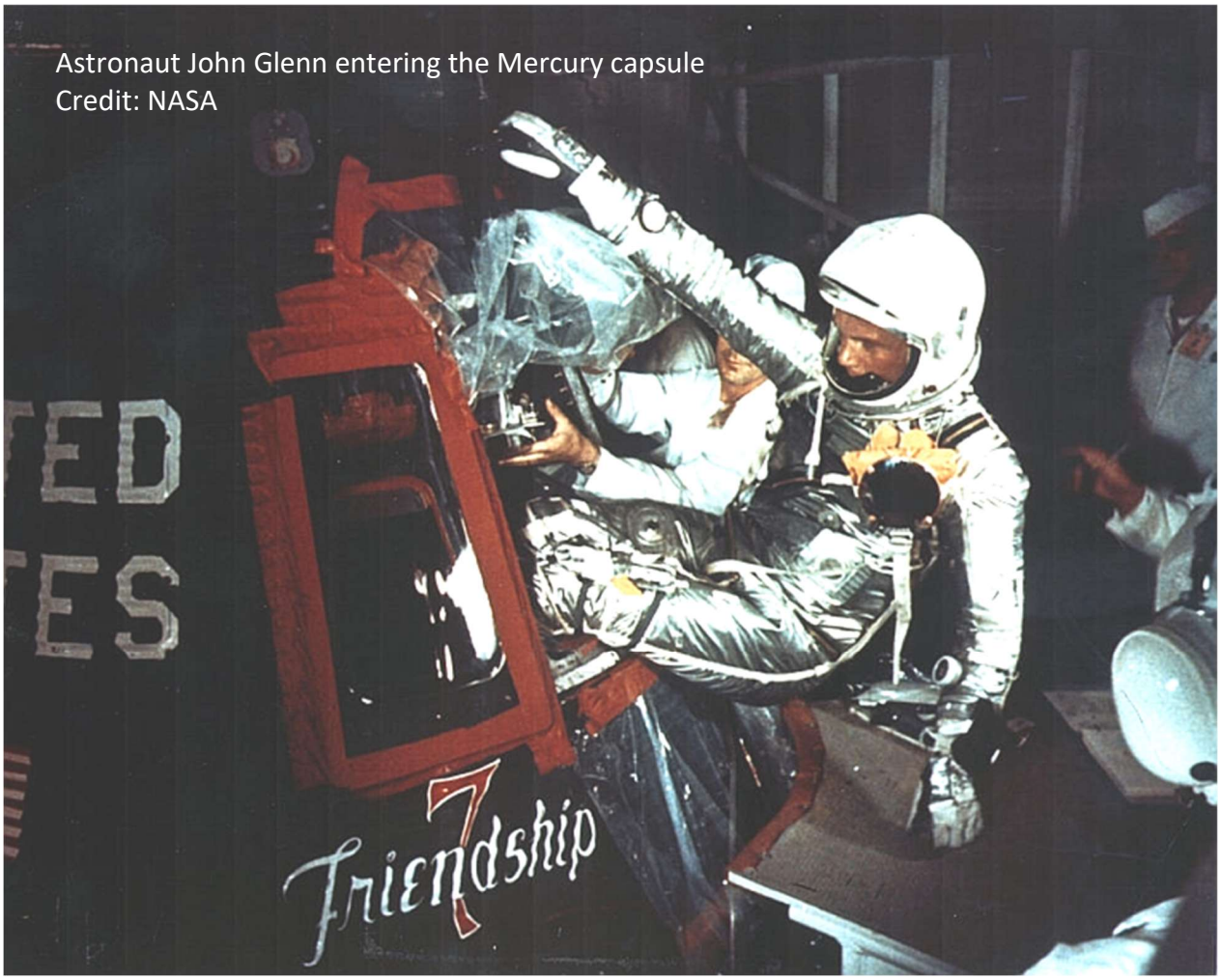




John Glenn and the Flight of Freedom 7

On the morning of February 20, 1962, John Glenn became the first American to orbit the Earth aboard a Mercury space capsule that Glenn named Friendship 7. Originally scheduled for the previous December, the launch was delayed by several technical and mechanical issues, including a fuel leak, and by weather.

Glenn served with the Marine Corps prior to being selected by NASA for its manned spaceflight program. As a fighter pilot, he flew 59 combat missions in the South Pacific during World War II. Following service in the Korean War (baseball Hall of Fame legend Ted Williams was one of his wingmen), he set a speed record for a transcontinental flight on July 16, 1957 when he flew a Vought F8U Crusader from California non-stop to New York in 3 hours 23 minutes in a test of a new Pratt & Whitney engine (it did require 3 mid-air refuelings).



Astronaut John Glenn entering the Mercury capsule
Credit: NASA

Glenn's trip around the Earth lasted 4 hours and 55 minutes and 23 seconds, completing 3 orbits before splashing down in the Atlantic Ocean southeast of Bermuda. While a public relations success, the flight was not without problems, the most serious of which was an indication that the capsule's heat shield had come loose and its landing bag deployed. Not knowing whether it was a faulty indicator, mission control asked Glenn to leave the retro-pack on during reentry. (The retro-pack consisted of three small rockets that were used to slow the spacecraft down. It was attached to the spacecraft by three straps that extended over the heat shield.) Fortunately, the indicator was

faulty and the flaming debris that Glenn saw streaming by his window during reentry was from the retro-pack and not the heat shield.

John Glenn would not return to space for another 36 years. In 1998, at the age of 77, Glenn joined the crew of the space shuttle Discovery for a nine-day mission. He was the oldest person to fly in space. John Glenn died Thursday, Dec. 8, 2016 at the age of 95. He was the last of the original Mercury 7 astronauts selected by NASA in 1958 for the agency's fledgling manned spaceflight program.

Sunrise and Sunset (from New Milford, CT)

Sun	Sunrise	Sunset
February 1st (EST)	07:05	17:08
February 15th	06:49	17:26
February 29th	06:28	17:43

Astronomical and Historical Events

1st History: loss of the space shuttle Columbia upon reentry (2003)
2nd Last Quarter Moon
2nd Closest approach of Apollo class Near-Earth Object and Potentially Hazardous Asteroid (PHA) 2008 OS7
2nd History: Soviet space station Salyut 4 reenters the Earth's atmosphere (1977)
3rd History: Apollo 14, with astronauts Alan Shepard, Stuart Roosa and Edgar Mitchell, lands in the Moon's Fra Mauro region; 3rd manned Moon landing (1971)
3rd History: Soviet spacecraft Luna 9 becomes first spacecraft to soft land on the Moon (1966)
4th Closest approach of Apollo class Near-Earth Object and Potentially Hazardous Asteroid (PHA) 2019 CC5
4th History: launch of Lunar Orbiter 3; photographed potential Apollo landing sites (1967)
4th History: Clyde Tombaugh born (1906); discovered the dwarf planet Pluto in 1930
5th History: flyby of Venus by the Mariner 10 spacecraft on its way to Mercury; first U.S. spacecraft to photograph Venus, first to use gravity of one planet to propel itself to another, and the first spacecraft to visit Mercury (1974)
6th Closest approach of Apollo class Near-Earth Object and Potentially Hazardous Asteroid (PHA) 2023 SP1
6th History: Soviet space station Salyut 7 reenters Earth's atmosphere (1991)
6th History: Apollo 14 astronaut Alan Shepard attempts to golf on the Moon (1971)
7th History: launch of the Stardust spacecraft for a rendezvous with Comet Wild 2 (1999)
7th History: Bruce McCandless makes first untethered spacewalk using a jet-powered backpack (1984)
7th History: Astronomical Society of the Pacific founded (1889)
7th History: William Huggins born, pioneered work in astronomical spectroscopy and first to differentiate nebular and galactic spectra (1824)
8th History: Allende Meteorite fall (meteorites from the fall were the first extraterrestrial rocks analyzed in the NASA Lunar Receiving Laboratory which had just been completed in September of 1967 to support the Apollo program) (1969)

Astronomical and Historical Events

8th History: discovery of GRV 99027 Martian Meteorite on the ice sheet near the Grove Mountain region of Antarctica; the 9.97-gram meteorite was later characterized as a shergottite (2000)
8th History: discovery of the SAU 094 Mars meteorite in Sayh al Uhaymir, Oman; one of the largest Mars meteorites recovered and the only one with a documented strewn field (2001)
8th History: flyby of Jupiter by the Ulysses spacecraft on its way to study the polar regions of the Sun (1992)
8th History: return of Skylab III crew (astronauts Gerald Carr, William Pogue and Edward Gibson) to Earth after a 3 month stay on the space station (1974)
8th History: Jules Verne born, author and futurist (1828)
9th New Moon
9th Scheduled launch of a Russian Progress cargo-carrying spacecraft from the Baikonur Cosmodrome, Kazakhstan to the International Space Station
9th History: United Arab Emirates Hope (Al-Amal) spacecraft enters orbit around Mars (2021)
9th History: launch of the ESA's Solar Orbiter on an Atlas 5 rocket from the Cape Canaveral Air Force Station, Florida
10th McCarthy Observatory – Second Saturday Stars
10th Moon at perigee (closest distance from Earth)
10th History: China's Tianwen-1 enters orbit around Mars (2021)
10th History: flyby of Venus by the Galileo spacecraft (for a gravity assist) on its way to Jupiter; the encounter provided the first views of mid-level clouds on Venus and confirmed the presence of lightning (1990)
10th History: flyby of Mars by the Soviet Mars 4 spacecraft; failed to enter orbit but did detect night-side ionosphere (1974)
10th History: MIT, using Millstone Hill radar in Westford, MA, bounces radar off Venus (1958)
10th History: discovery of Asteroid 624 *Hecktor*, largest Jupiter Trojan, by August Kopff (1907)
11th History: launch of NASA's Solar Dynamics Observatory from Cape Canaveral, Florida; the first mission in the space agency's "Living with a Star" program; five-year mission to study the Sun's energy and its influence on space weather (2010)
11th History: launch of the space shuttle Discovery (STS-82), second Hubble Space Telescope servicing mission; **shuttle tire** on display at the Observatory is from this mission (1997)
11th History: launch of first Japanese satellite: Oshumi (1970)
12th Closest approach of Aten class Near-Earth Object 2020 DK
12th History: landing of the Near-Earth Asteroid Rendezvous (NEAR) – Shoemaker spacecraft on the asteroid *Eros* (2001)
12th History: Soviet spacecraft Mars 5 enters orbit around Mars, providing information on surface temperatures, CO_2 concentrations, and detecting a thin ozone layer and water vapor concentrations near the Tharsis region (1974)
12th History: Sikhote Alin meteorite fall in Russia, one of the largest modern falls at 28 tons (1947)
14th History: flyby of Comet *Tempel 1* by the Stardust spacecraft (2011)

Astronomical and Historical Events (continued)

14th History: NEAR-Shoemaker enters orbit around *Eros*, one of the largest of the near-Earth asteroids (2000)
14th History: Voyager 1 points its camera back towards the Sun and takes a family portrait, capturing six planets (Venus, Earth, Jupiter, Saturn, Uranus and Neptune) from a distance of approximately 4 billion miles; Mercury was too close to the Sun to be seen and Mars was lost in the scattered sunlight (1990)
14th History: launch of the Solar Maximum Mission (1980) to study the Sun during the peak of the solar cycle; a malfunction less than a year later cut the mission short. However, the satellite was recovered and repaired by the Space Shuttle Challenger in April 1984; operated successfully until burning up in the Earth's atmosphere in December 1989
14th History: launch of Luna 20, Soviet Moon sample return (1972)
14th History: launch of Syncom 1, the first geosynchronous satellite (1963)
15th Closest approach of Apollo class Near-Earth Object 2024 AO
15th History: meteor explodes over the Russian city of Chelyabinsk causing hundreds of minor injuries (2013)
15th History: discovery of Centaur Object *Chariklo* by Jim Scotti (1997)
15th History: flyby of the Moon by the Hiten spacecraft; Earth orbiting satellite designed by the Japanese Space Agency to test technologies for lunar and planetary missions (1992)
15th History: Pioneer 10 becomes the first spacecraft to traverse the Main Asteroid Belt (1973)
15th History: Galileo Galilei born (1564)
16th First Quarter Moon
16th History: Gerard Kuiper discovers Uranus' moon *Miranda* (1948)
17th History: discovery of the Plutino *90482 Orcus* with its large moon, Vanth, by American astronomers Michael Brown of Caltech, Chad Trujillo of the Gemini Observatory, and David Rabinowitz of Yale University (2004)
17th History: Ann Harch discovers *Dactyl*, the first natural satellite of an asteroid (*Ida*) discovered from Galileo Images (1994)
17th History: launch of Ranger 8; lunar impact mission (1965)
17th History: launch of NEAR spacecraft, asteroid orbiter/lander; first of NASA's Discovery missions and the first mission to go into orbit around an asteroid (1996)
17th History: launch of Vanguard 2; designed to measure cloud-cover distribution over Earth (1959)
18th History: landing of the Mars 2020 Perseverance rover in Jezero crater (2021)
18th History: Mike Brown and Jean-Luc Margot's discovery of *Romulus*, the larger of two moon that orbit Asteroid 87 *Sylvia* (2001)
18th History: American astronomer Clyde Tombaugh discovers Pluto (1930)
19th History: Nicolas Copernicus born (1473)
20th History: Clementine spacecraft enters lunar orbit and starts photographic survey; joint project between the Strategic Defense Initiative Organization and NASA, first of a new class of small spacecraft to enable long-duration, deep space missions at low cost using lightweight satellite technology (1994)
20th History: launch of the core module of the Soviet space station Mir (1986)
20th History: launch of Mercury-Atlas 6 and Friendship 7 with astronaut John Glenn; first American in orbit (1962)

Astronomical and Historical Events (continued)

21st History: launch of Israel's SpaceIL, privately-funded, lunar lander aboard a SpaceX Falcon 9 rocket from the Cape Canaveral Air Force Station, Florida
21st History: Soviet moon rocket (N-1) explodes during first test flight (1969)
22nd History: launch of Viking, Sweden's first satellite (1986)
22nd History: launch of Soviet spacecraft Kosmos 110, with dogs Veterok and Ugolyok (1966)
22nd History: Max Wolf discovers asteroid 588 *Achilles* – the first Trojan asteroid (1906)
23rd History: Supernova 1987A detected in the Large Magellanic Cloud (1987)
24th Full Moon
24th History: launch of the Space Shuttle Discovery (STS-133) on its final mission. The shuttle delivered space parts and critical components to the ISS (2011)
24th History: launch of Mariner 6; Mars flyby mission returned images showing the south polar cap as being composed predominantly of carbon dioxide; refined estimates of the mass, radius and shape of Mars (1969)
24th History: Jocelyn Bell announces discovery of rapidly rotating radio sources, later determined to emanate from neutron stars or pulsars (1968)
24th History: launch of Bumper WAC, first two-stage liquid-propellant rocket and the first human-made object to achieve hypersonic speeds (1949)
25th Moon at apogee (furthest distance from Earth)
25th History: flyby of Mars by the Rosetta spacecraft (2007)
25th History: Soviet spacecraft Luna 20 returns lunar soil sample (30 grams) to Earth (1972)
26th History: launch of the first Saturn 1B rocket booster (1966)
26th History: original crew of Gemini 9, Elliot See and Charles Bassett killed in plane crash at the McDonnell Aircraft building in St. Louis (1966)
27th History: discovery of Jupiter's moon Herse was by Brett J. Gladman, John J. Kavelaars, Jean-Marc Petit, and Lynne Allen (2003)
28th History: flyby of Jupiter by the New Horizons spacecraft bound for Pluto (2007)
28th History: launch of Discoverer 1; first of a series of satellites which were part of the Corona reconnaissance satellite program and first satellite launched into polar orbit (1959)

Net February 14th

Tentative launch of the IM-1 mission with the Nova-C lander built and owned by Intuitive Machines from the Kennedy Space Center, Florida. The IM-1 mission will attempt to deliver a suite of science payloads to the surface of the moon for NASA's Commercial Lunar Payload Services program.

Commonly Used Terms

- Apollo: a group of near-Earth asteroids whose orbits also cross Earth's orbit; Apollo asteroids spend most of their time outside Earth orbit.
- Aten: a group of near-Earth asteroids whose orbits also cross Earth's orbit, but unlike Apollos, Atens spend most of their time inside Earth orbit.
- Atira: a group of near-Earth asteroids whose orbits are entirely within Earth's orbit

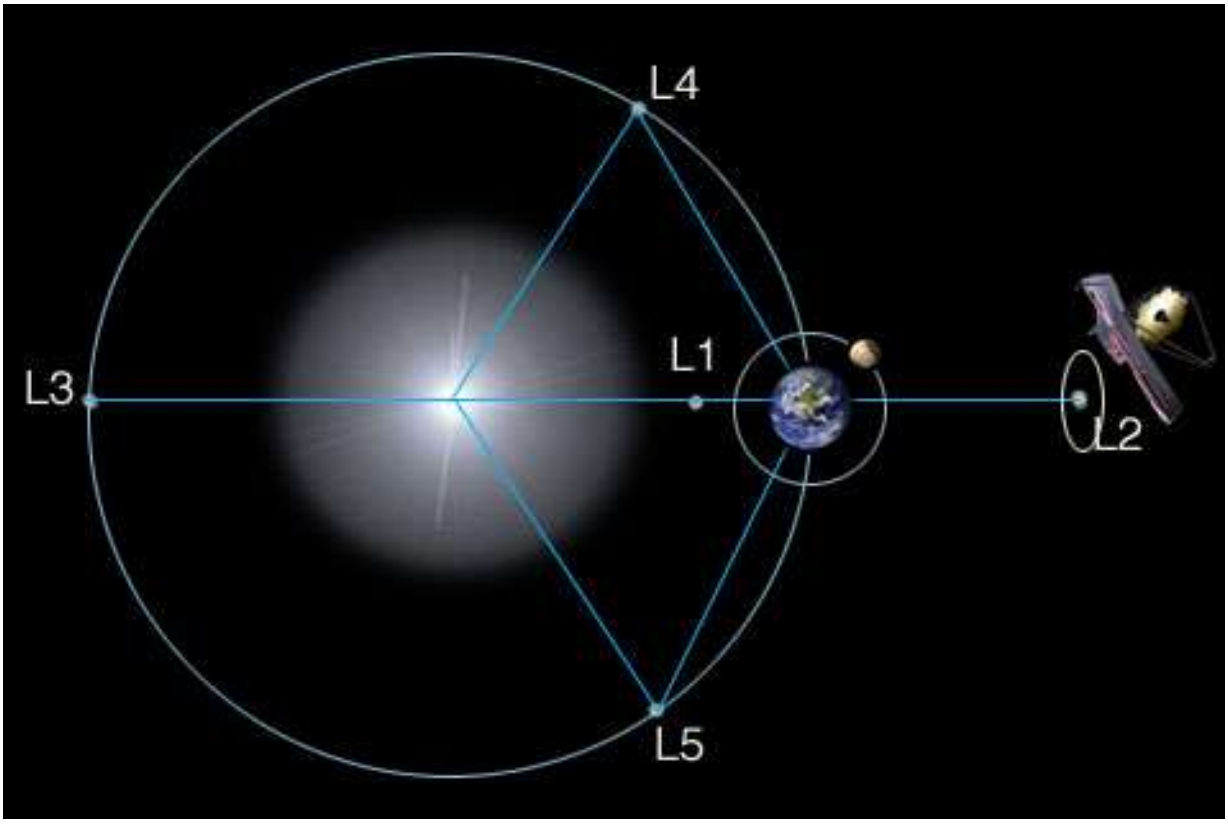
Commonly Used Terms

- Centaur: icy planetesimals with characteristics of both asteroids and comets
- Kuiper Belt: region of the solar system beyond the orbit of Neptune (30 AUs to 50 AUs) with a vast population of small bodies orbiting the Sun
- Opposition: celestial bodies on opposite sides of the sky, typically as viewed from Earth
- Plutino: an asteroid-sized body that orbits the Sun in a 2:3 resonance with Neptune
- Trojan: asteroids orbiting in the 4th and 5th Lagrange points (leading and trailing) of major planets in the Solar System

References on Distances

- the apparent width of the Moon (and Sun) is approximately one-half a degree (½°), less than the width of your little finger at arm's length which covers approximately one degree (1°); three fingers span approximately five degrees (5°)
- 1 astronomical unit (AU) is the distance from the Sun to the Earth or approximately 93 million miles

Lagrange Points



Five locations discovered by mathematician Joseph Lagrange where the gravitational forces of the Sun and Earth (or other large body) and the orbital motion of the spacecraft are balanced, allowing the spacecraft to hover or orbit around the point with minimal expenditure of energy. The L2 point (location of the Euclide and James Webb telescope) is situated 1.5 million kilometers beyond the Earth (as viewed from the Sun).

James Webb Space Telescope

https://webb.nasa.gov/index.html

Euclid Space Telescope

https://www.esa.int/Science_Exploration/Space_Science/Euclid

International Space Station and Starlink Satellites

Visit www.heavens-above.com for the times of visibility and detailed star charts for viewing the International Space Station and bright satellites.

Solar Activity

For the latest on what's happening on the Sun and the current forecast for flares and aurora, check out www.spaceweather.com

NASA's Global Climate Change Resource

Vital Signs of the Planet: https://climate.nasa.gov/

Mars – Mission Websites

Mars 2020 (Perseverance rover): https://mars.nasa.gov/mars2020/

Mars Helicopter (Ingenuity): https://mars.nasa.gov/technology/helicopter/

Mars Science Laboratory (Curiosity rover): https://mars.nasa.gov/msl/home/

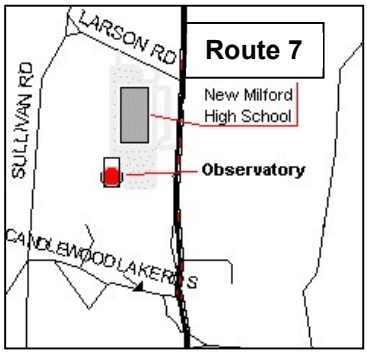
Mars Atmosphere and Volatile EvolutioN (MAVEN): https://science.nasa.gov/mission/maven/

Contact Information

The John J. McCarthy Observatory
P.O. Box 1144
New Milford, CT 06776

New Milford High School
388 Danbury Road
New Milford, CT 06776

Phone/Message: (860) 946-0312
www.mccarthyobservatory.org



	www.mccarthyobservatory.org
	@McCarthy Observatory
	@McCarthy Observatory
	mccarthy.observatory@gmail.com
	@JJMObservatory
	@mccarthy.observatory