Galactic Observer

John J. McCarthy Observatory

Volume 16, No. 6 June 2023

Life Extension

The International Space Station (ISS) partners have committed to extending the operations of the station. The orbiting laboratory has been continuously occupied for more than 22 years. The United States, Japan, Canada, and the participating countries of the European Space Agency (ESA), have confirmed they will support continued space station operations through 2030 and Russia has confirmed it will support continued station operations through 2028.

Photo: NASA

June Astronomy Calendar and Space Exploration Almanac

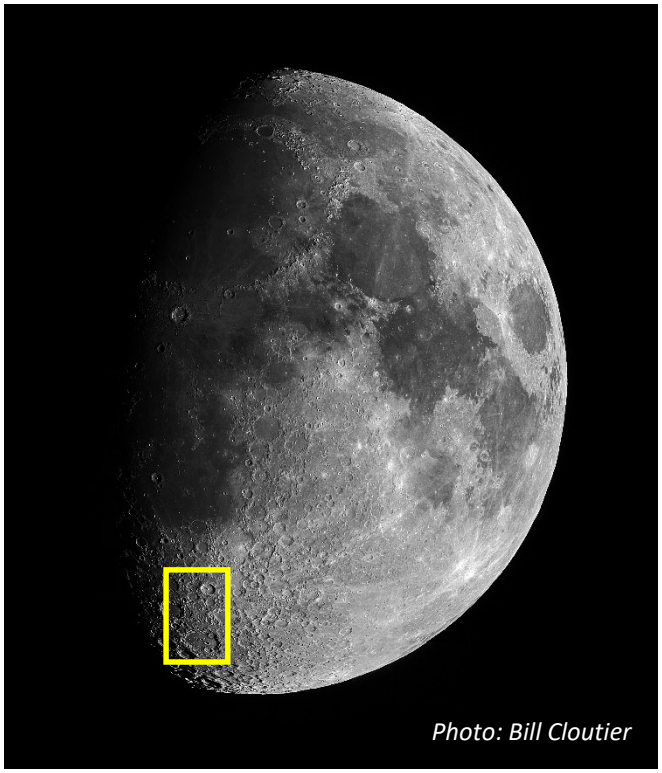
Photo: Bill Cloutier

Earthlight is the illumination of the unlit portion of the Moon by sunlight reflected off the Earth. First explained by Leonardo da Vinci, NASA's new Shadowcam uses Earthlight to illuminate areas within craters that never see the Sun.

In This Issue

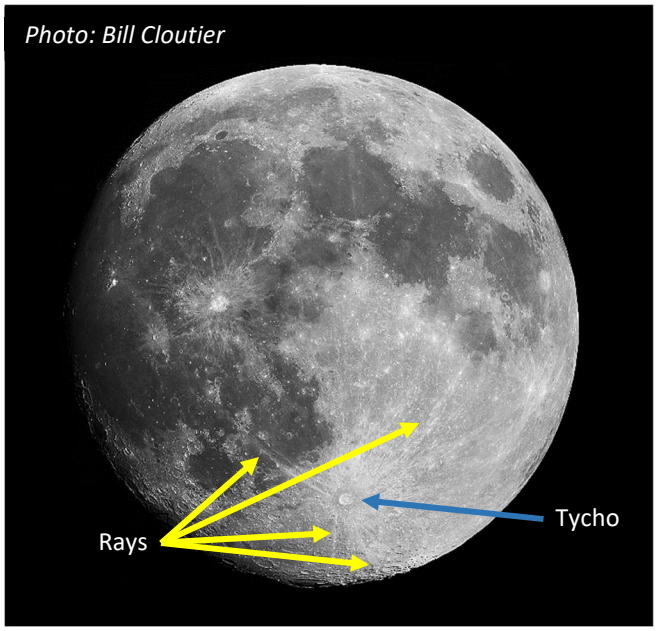
"Out the Window on Your Left"

It's been almost 54 years since Neil Armstrong first stepped onto the Moon's surface and more than 50 years since Gene Cernan left the last footprint. 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).



Southern Lunar Highlands

The lunar geological timescale (or selenological timescale) divides the history of the Moon into five generally recognized periods, starting about 4.5 billion years ago with the Pre-Nectarian epoch. The timescale is used by geologist to describe the timing of events as they relate to other happening on the lunar surface (i.e., stratigraphy or the analysis of order and position of layered events)

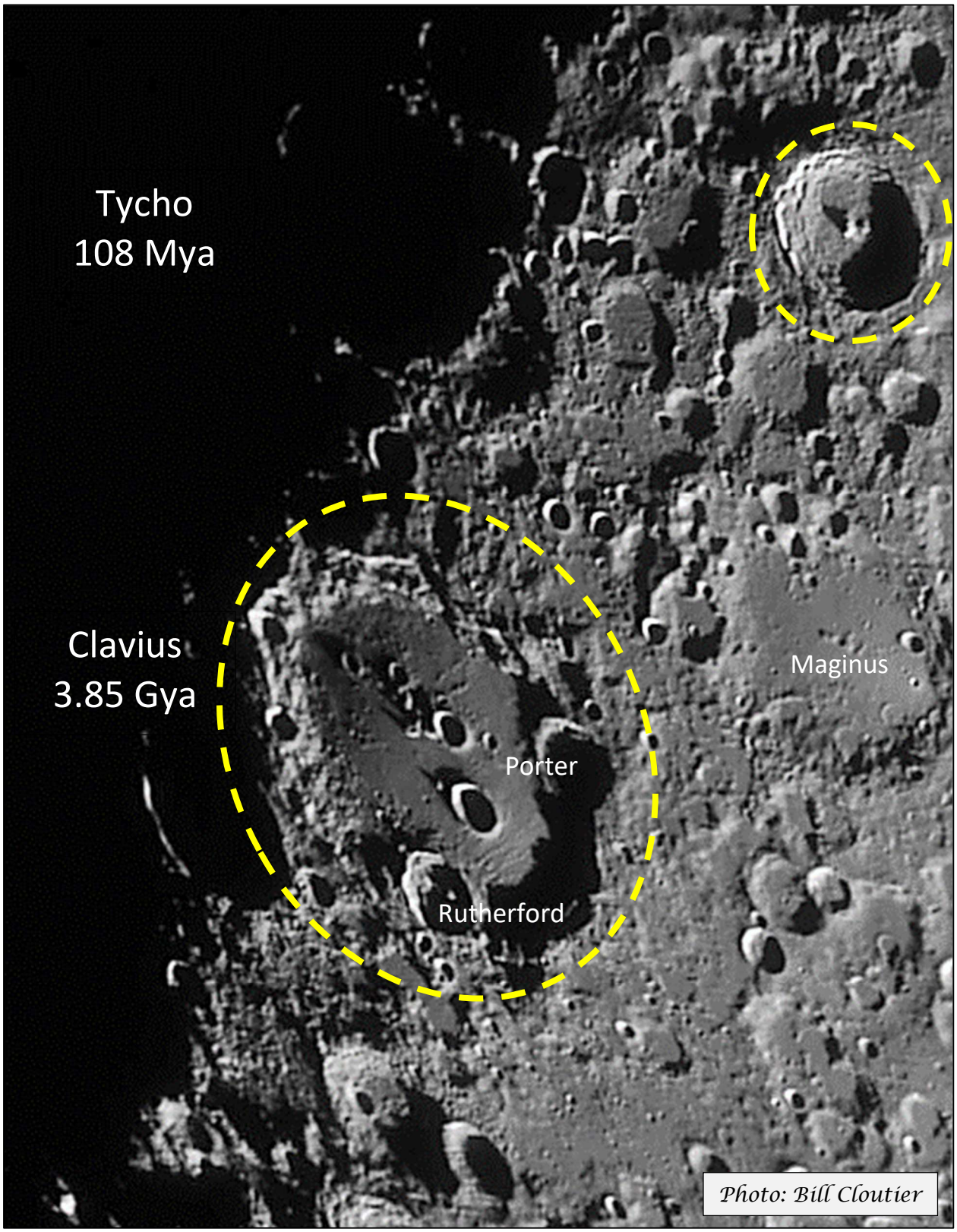


Rays from Tycho Crater

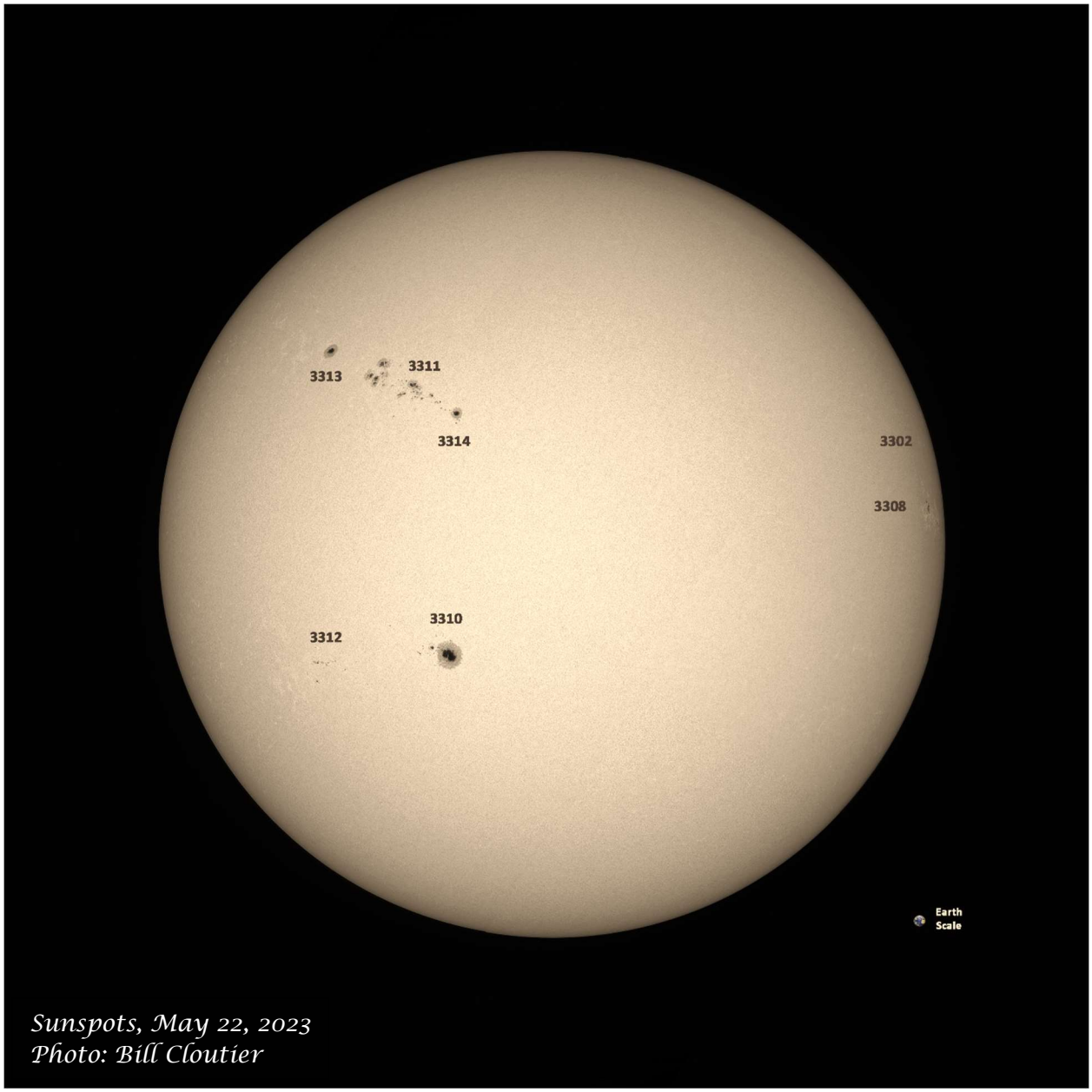
Located in the crater-filled southern highlands are two craters from vastly different geological eras – Clavius and Tycho. Clavius, one of the largest craters on the near side, formed at the end of the lunar Nectarian period, approximately 3.85 billion years ago. This large "walled plain" spans more than 143 miles (231 km) with its rim eroded and broken by two large superimposing craters (Porter to the north and Rutherford to the south) and countless smaller impact features.

Tycho, by comparison, is much smaller (at 53 miles or 85 km in diameter) and much younger, with an age estimated at only 108 million years, having formed during the current Copernican period. Its youth is revealed by an extensive bright ray system, prominent central peak and unbroken, terraced walls. In the chaotic moonscape, Tycho becomes easier to locate as the Sun becomes higher in the lunar sky and the radial streaks of pulverized rock (rays) become more noticeable.

Tycho and Clavius



Solar Storm Warning System



Sunspots, May 22, 2023
Photo: Bill Cloutier

NASA has developed a computer model called "DAGGER" that uses artificial intelligence (AI) to assess satellite data and accurately predict dangerous space weather. The model uses AI to analyze spacecraft measurements of the solar wind (a continuous stream of charged particles flowing from the Sun) and predict where and when an impending solar storm will strike.

The DAGGER team tested the model against two geomagnetic storms that occurred in August 2011 and March 2015. In each instance, the model was able to quickly and accurately assess the storm's impacts across the world. According to the team, predictions can be generated in less than a second. Updated by the minute, DAGGER is able to give forecasters 30 minutes of advanced warning of an imminent storm. With advanced knowledge of such an event, power grids and other critical assets can be secured, aircraft moved to lower and less exposed altitudes, and satellites' sensitive electronics placed in a safe mode until the storm surge of charged particles passes.

NASA Selects Second Lunar Lander Provider

Concept of the Blue Moon lunar Human Landing System
Credit: Blue Origin

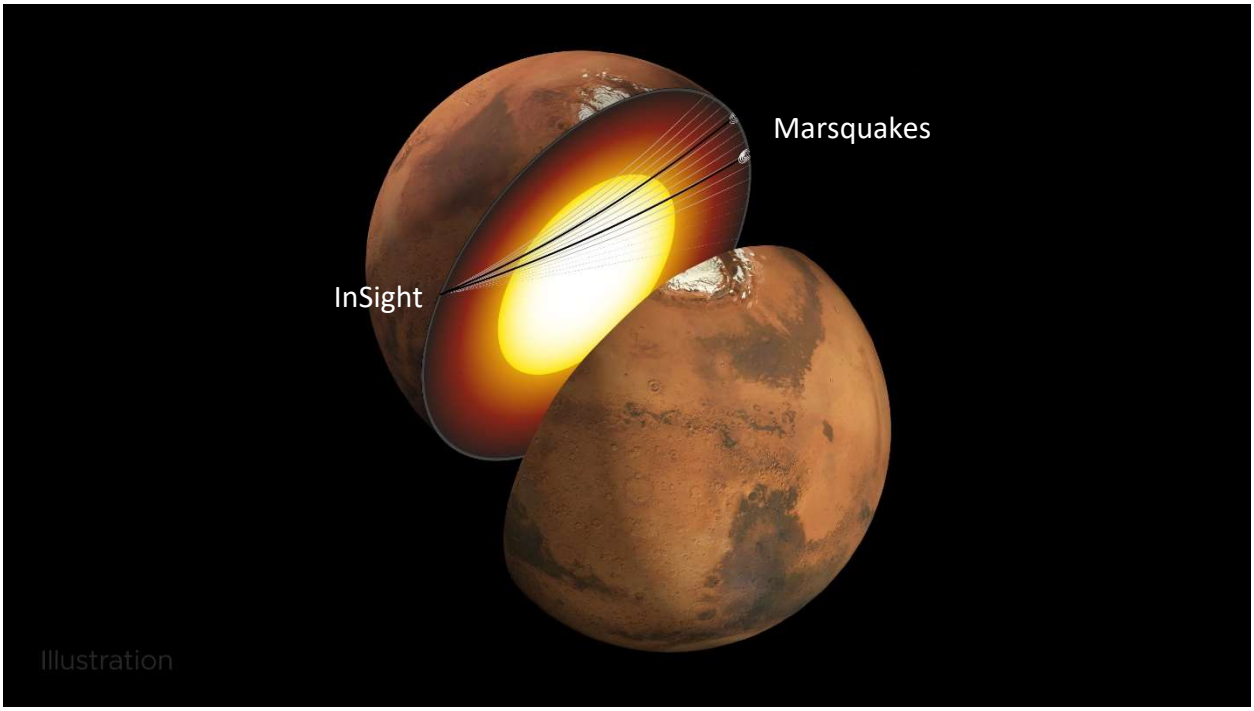
NASA's Artemis program is designed to return humans to the Moon and beyond. Unlike the Apollo program, the Artemis program's architecture includes a small space station, in a halo orbit around the Moon, which will serve as a transfer hub for astronauts traveling to and from the Moon. At the space station, called "Gateway," crews launched in the Orion spacecraft will dock before transferring to a "Human Landing System" (HLS) for the descent to the lunar surface. The astronauts would pass through Gateway again on their return to Earth in the Orion spacecraft.

NASA contracted with SpaceX for the initial HLS for the Artemis III mission (based on their Starship project) and a more evolved design for a more aggressive Artemis IV mission. The space agency has now selected a second company, Blue Origin, of Kent, Washington, to develop an HLS for the Artemis V mission, which is expected to launch in 2029 and support two astronauts for a weeklong exploration of the Moon's south polar region.

The firm-fixed price contract of $3.4 billion includes one uncrewed demonstration mission, as well as the Artemis V undertaking. NASA believes that a second provider increases competition, thereby reducing costs, and supports the long-term goal of a permanent presence on our celestial neighbor. The development of multiple landing options also supports the agency's ambitions for missions to Mars and beyond.

Mars Core Revealed

While NASA's Mars InSight lander was retired last December, the data collected by its seismometer over the four years on the surface is still being reviewed and producing new science. A pair of farside Marsquakes in 2021 generated seismic waves that traveled through the planet. They gave scientists a rare opportunity to assess size and composition of the Red Planet's core.



Cutaway of Mars showing the paths of seismic waves from two separate quakes in 2021
Credit: NASA/JPL-Caltech/University of Maryland

The two seismic waves were the first to enter another planet's core, and, while not robust by Earth standards, proved challenging to tease their signatures from the complex seismograms recorded by the lander. The quakes were also in the "shadow zone," part of the planet from which seismic waves tend to be refracted away from InSight. Fortunately, the quakes were just large enough that they could be detected by InSight's solitary seismometer.

It also helped that a meteoroid impact produced one of the two quakes. This provided scientists with a precise location for the source of the seismic waves to work with (images taken by the Mars Reconnaissance Orbiter in late December 2021 revealed a new, large impact crater about 2,200 miles (3,500 km) from InSight). The greater the distance the event occurs, the deeper into the planet its seismic waves can travel before being detected.

The InSight data indicates that Mars' liquid iron-nickel core is smaller and denser than previously thought, with a mean radius of 1,100 to 1,125 miles (1,780 to 1,810 km). It is likely rich in lighter elements such as sulfur, with smaller fractions of oxygen, carbon and hydrogen.

The planet's core is surrounded by a rocky mantle between 770 and 1,170 miles (1,240 to 1,880 km) thick, and above that, a crust made of iron, magnesium, aluminum, calcium, and potassium. The crust is between 6 and 30 miles (10 to 50 km) in depth.

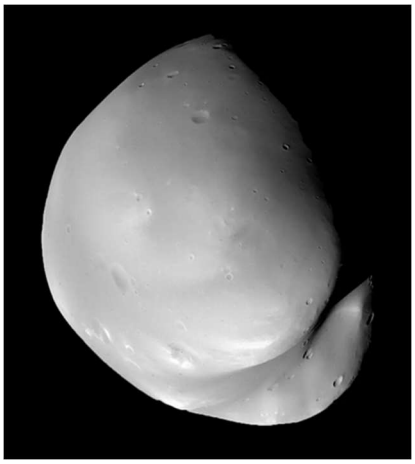
The Far Side of Deimos

Image credit: Emirates Mars Mission

The United Arab Emirates' Martian orbiter Hope captured a new view of Deimos, the smaller of Mars' two moons. The observations from a March 10th flyby, which came as close as 60 miles (96 km), suggests that the moon is made of the same material as Mars itself.

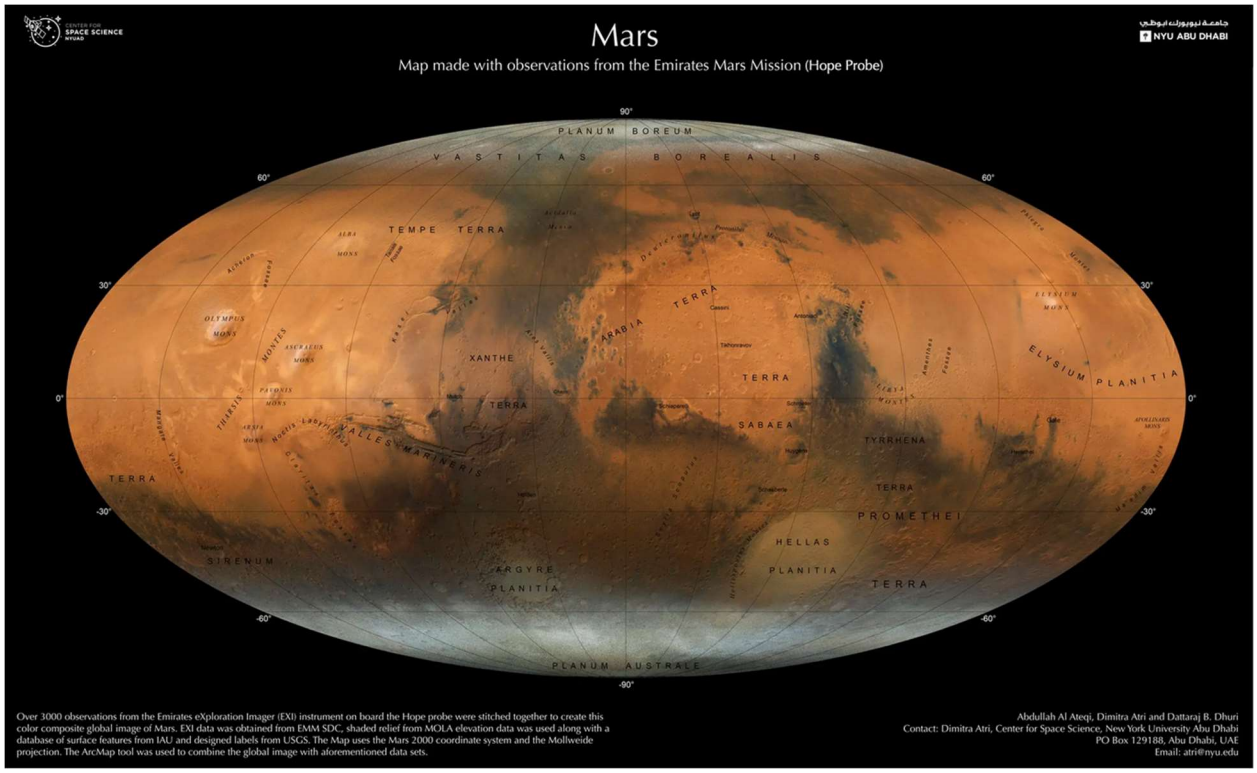
Deimos is only 7.7 miles (12.4 km) wide and orbits the planet at a distance of 14,580 miles (23,460 km). The moon is tidally locked with Mars, meaning the same side always faces the planet. Thus, orbiters studying the Red Planet from lower orbits only see the near side of Deimos. With Hope's primary mission completed, the science team decided to use the remaining propellant to boost the spacecraft into a higher orbit, above Deimos. This allowed them to image the far side of the moon for the first time.

Deimos' origin had been widely theorized as a captured asteroid; however, Hope didn't detect any carbon-rich elements indicative of that type of body. With a profile similar to the planet around which it orbits, Deimos may be a piece of Mars, blasted off by an ancient impact.



Mars facing side of Deimos as captured by the Mars Reconnaissance Orbiter (L) and the far side as captured by the Hope orbiter (R)

UAE Map of Mars



Credit: Abdullah Al Ateqi, Dimitra Atri and Dattaraj B. Dhuri

The United Arab Emirates Hope probe was launched from Japan in July 2020, and went into orbit around Mars in February 2021. The science team from the Dimitra Atri Center for Space Science have just released a high-resolution map of the Red Planet, from the perspective of the Hope orbiter.

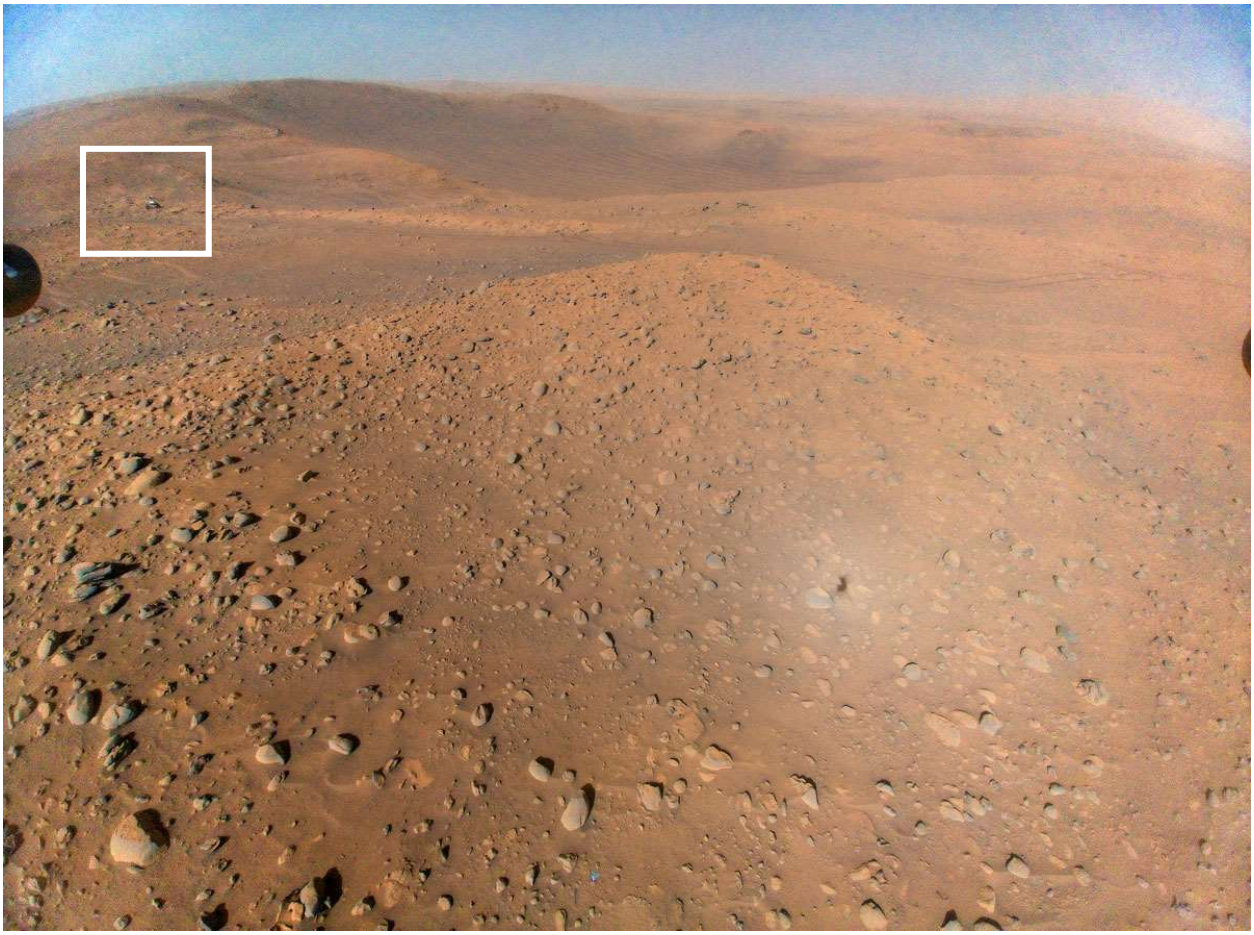
The Mars Map was created by stitching together thousands of observations captured by Hope's onboard Emirates Exploration Imager EXI instrument over the course of two Earth years (approximately one Mars' year). The map highlights many of the planet's geological features such as the polar ice caps, mountains, volcanoes, vestiges of ancient rivers, lakes, valleys, and impact craters and is part of a more extensive effort to complete a global picture of the Martian climate.

The spacecraft's elliptical orbit provided a unique prospective that facilitated the construction of the global map. Hope circles Mars every 54.5 hours. It has a periapsis (point nearest to the planet in its orbit) of 12,400 miles (19,970 km) and an apoapsis (further distance) of 26,500 miles (42,650 km), with a 25° inclination.

The spacecraft's three science instruments (the Emirates eXploration Imager, Emirates Mars InfraRed Spectrometer, and Emirates Mars Ultraviolet Spectrometer) enable scientists to: study the dynamics of the Martian atmosphere and characterize the state of the lower atmosphere on global scales and its geographic, diurnal, and seasonal variability, correlate rates of thermal and photochemical atmospheric escape with conditions in the collisional Martian atmosphere, and characterize the spatial structure and variability of key constituents in the Martian exosphere.

Ingenuity Perseverance

NASA's Mars Perseverance rover has been working its way up the delta in Jezero crater, stopping along the way to examine geologic features that suggest that the area was once the site of a raging river. The rover has been accompanied by the Mars Ingenuity helicopter, which has been scouting the local terrain for areas of interest and provide a birds-eye view of the approach to the upper delta and the breach in the crater wall.



On Ingenuity's 51st flight (April 22, 2023), the rotorcraft's color camera captured the rover in the distance as Perseverance was exploring the rim of the Belva impact crater. The helicopter was at an altitude of 40 feet (12 meters) when it snapped the photo.

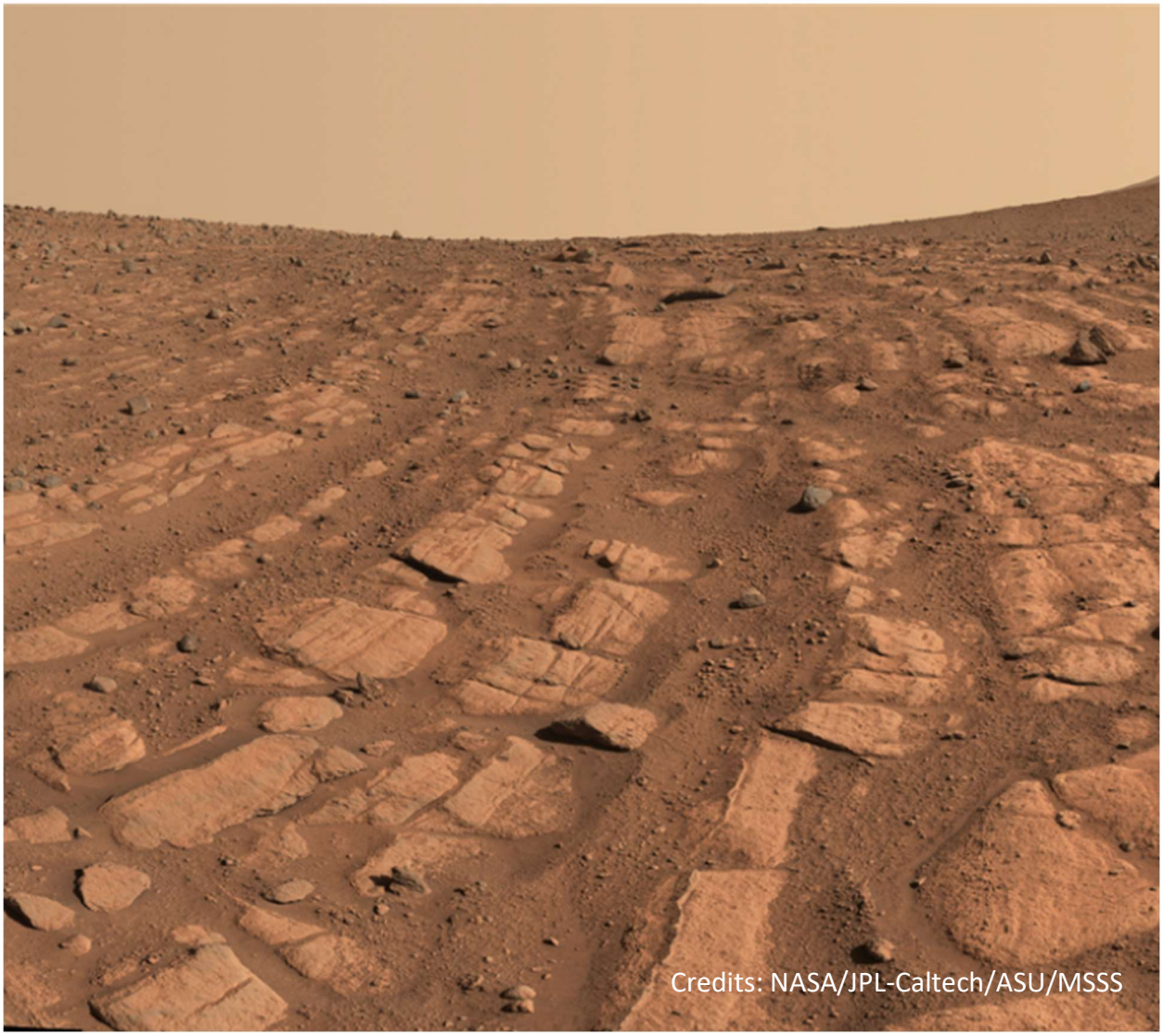
Image Credit: NASA/JPL-Caltech

Ingenuity's flight lasted just under 137 seconds. with the diminutive helicopter traveling a total of 617 feet (188 m). Since its first flight on April 19, 2021, Ingenuity has flown a total distance of 38,499 feet (11,734 meters) with a cumulative flight time of 91.4 minutes.

The sky appears blue in the photo because the camera is a commercial, off-the-shelf camera which automatically applies a "white balance."

Evidence of An Ancient River

NASA's Mars Perseverance is exploring the top of a fan-shaped delta of sedimentary rock on the western rim of Jezero crater. The delta stands 820 feet (250 meters) high and is located near a breach of the crater wall from where it transitioned to an ancient, meandering river channel. While the geological feature is indicative of flowing water, until recently, scientists were unsure whether the water flowed in relatively shallow streams or as a fast-moving river.



The latest images from rover show features that, on Earth, are typically created by a high-energy river, one that would be capable of carrying a lot of debris.

According to project geologists, the curved layers could be the remnants of a river's banks that shifted over time – or the remnants of sandbars that formed in the river. Over eons, after these piles of sediment turned to rock, the layers were sandblasted by the Martian winds. The winds removed the tops of the deposits and carved the remaining material to their present size and shape.

While scientists have seen similar features on Earth, they are never as exposed as those in Jezero crater, being covered in vegetation.

Europa Reimagined

With one spacecraft currently in orbit around Jupiter (Juno), another on its way (ESA's JUICE mission) and a third (Europa Clipper) scheduled for launch next year, information from past Jovian missions, including Galileo, is being revisited so as to maximize the science return of future exploration.

Europa's icy and disrupted terrain. Area spans about 180 miles (300 km) across with image resolution of 247 yards (226 meters) per pixel. Credit: Mario Valenti at the SETI Institute in Mountain View, Calif.

The Galileo spacecraft entered orbit around Jupiter in December 1995. It orbited the gas giant for almost eight years, and made close passes by all its major moons. One of the key science discoveries was the detection of a global ocean of liquid water under the icy surface of Jupiter's moon Europa. Galileo made 11 targeted flybys of Europa, mapping the moon's disrupted "chaos terrain," domes and ridges. Images from those flybys are being reprocessed and enhanced to highlight the chemical composition and non-ice materials for use in targeting areas of additional study for arriving spacecraft.

Closing in on Io

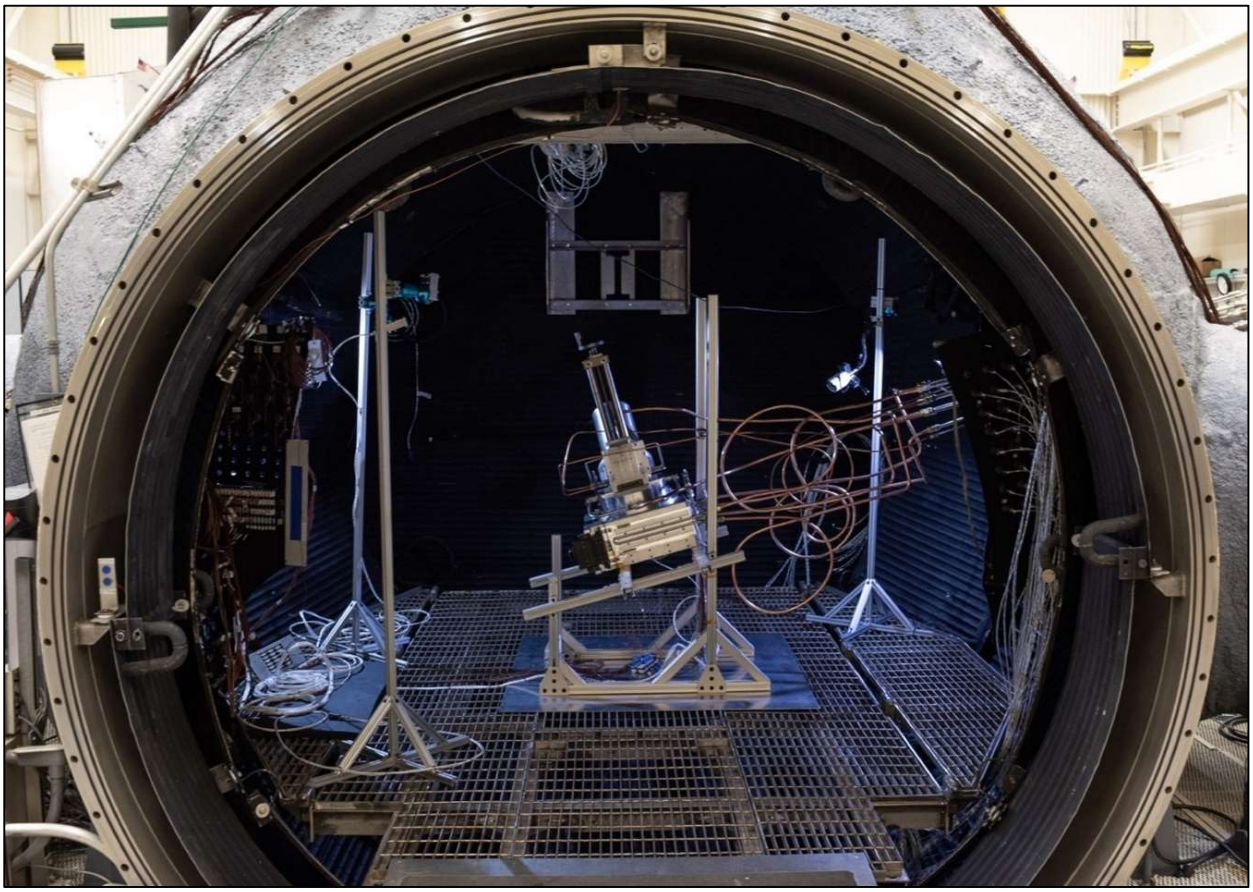
Jupiter and Io during Perijove 51
Credit : NASA/JPL-Caltech/SwRI/MSSS/Kevin M. Gill

NASA's Juno spacecraft has been orbiting Jupiter 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 51, on May 16th, Juno flew by the moon Io, at a distance of 22,060 miles (35,500 km). Future flybys in December of this year and February of next year will take the spacecraft as close as 1,000 miles (1,600 km) to the most volcanically active world in the solar system.

Oxygen Extracted from Lunar Soil



A high-powered laser and carbothermal reactor located inside the testing chamber of NASA's Carbothermal Reduction Demonstration (CaRD) at NASA's Johnson Space Center
Credits: NASA/Brian Sacco

Scientists at NASA's Johnson Space Center have successfully extracted oxygen from simulated lunar soil. The demonstration was conducted inside a special spherical vacuum chamber, using a high-powered laser to replicate the heat from a solar energy concentrator. After the soil was heated, a mass spectrometer was able to detect the emission of carbon monoxide.

Sierra Space Corporation of Broomfield, Colorado, developed the carbothermal reactor for NASA. Carbothermal reduction is a commonly used on Earth in industrial applications, including in the production of solar panels and steel, however, this was the first time it has been performed in simulated lunar conditions, where the feed material needs to transit the reaction zone while the reactor maintains pressure to keep gases from escaping to "space."

Oxygen extraction has been identified by NASA as a critical technology gap if human are to establish a permanent presence on the Moon and/or Mars. Oxygen can be used for breathing air, recombined with hydrogen for drinking water, as well as used as an oxidizer for rocket fuel.

The successful demonstration of the reactor increased its technical readiness level to that of a fully functional prototype, one that is able to survive on the lunar surface and function as intended.

Lunar Impact Detected

Daichi Fujii, the curator of the Hiratsuka City Museum, recorded a brilliant flash on the unlit portion of the Moon on February 23rd. The flash was likely from a meteoroid impact and appears to have struck near Ideler L crater, slightly northwest of Pitiscus crater.

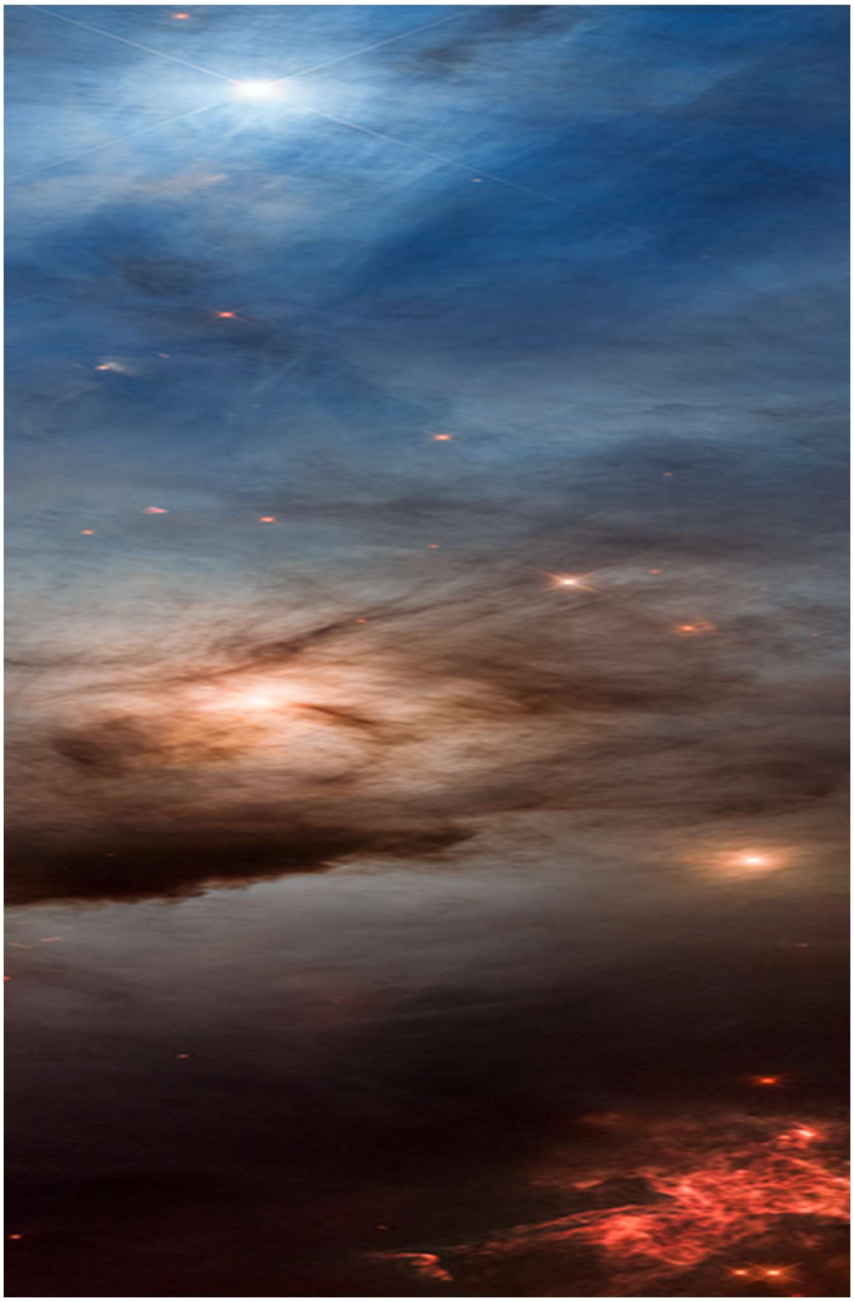
Meteors travel on average at around 30,000 mph (48,280 kph), or 8.3 miles per second (13.4 km/s). While a common occurrence, the vast majority that encounter Earth burn up completely on contact with the atmosphere. The Moon has almost no atmosphere, so any space rock will impact the surface and create a crater-like feature. High-velocity impacts not only create craters but generate enough heat so as to be detectable as a brilliant flash of visible light.

The newly created crater may eventually be located and imaged by NASA's Lunar Reconnaissance Orbiter or India's Chandrayaan 2 lunar probe. Capturing lunar impact events has significant scientific value for those countries that plan to return and establish a permanent presence on the Moon and in assessing the potential threat to spacecraft, space station modules or any other pressurized structure in cis-lunar space.

NASA's Meteoroid Environment Office and the Marshall Space Flight Center's Space Environments Team developed a comprehensive strategy for understanding the meteoroid environment around the Moon, including the flux of meteoroids across a range of sizes. Observations are taken between the New and First Quarter Moon and between Last Quarter and New Moon, when the solar illumination is between 10 and 55 percent. These conditions yield 10-12 observing nights per month.

Hubble Birthday Portrait

Astronomers are celebrating the 33rd anniversary of the launch of NASA's Hubble Space Telescope with the release of an image of a nearby star-forming region, NGC 1333. The nebula is in the Perseus molecular cloud, located approximately 960 light-years from Earth.



SCIENCE: NASA, ESA, STScI
IMAGE PROCESSING: Varun Bajaj (STScI), Joseph DePasquale (STScI), Jennifer Mack (STScI)

The telescope was deployed into orbit around Earth on April 25, 1990, by NASA astronauts aboard the Space Shuttle Discovery. To date, Hubble's cameras have taken approximately 1.6 million images of nearly 52,000 celestial targets.

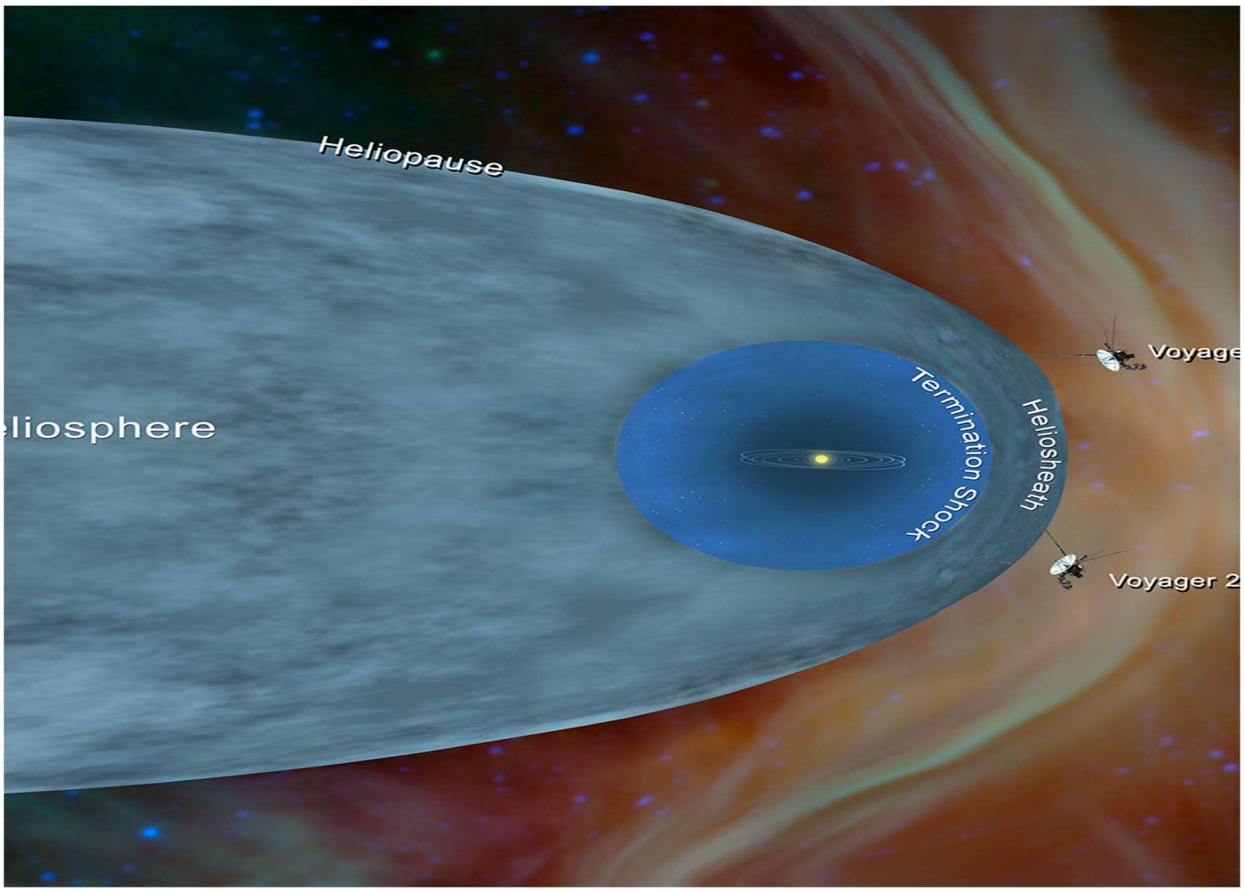
The image of NGC 1333 showcases Hubble's unique capability to obtain images over a range of wavelengths, from ultraviolet to near-infrared light.

At the top of the image, intense stellar winds, likely from the bright blue star, are blowing through a curtain of fine dust. The dust scatters starlight at blue wavelengths.

Near the center, another bright super-hot star is partially obscured by the dust cloud. It is accompanied by a string of reddish-looking stars, whose true color is filtered by the nebula.

The lower portion of the image includes the darker region of the nebula, as well as the reddish glow of ionized hydrogen. The cosmic fireworks display (the bright red streams of material) is being fashioned by the powerful magnetic fields of newly formed stars located just outside the field of view.

Power Boost



Locations of NASA's Voyager 1 and Voyager 2 spacecraft. Both probes are currently outside of the heliosphere and in the region where interstellar space begins
Credit: NASA/JPL-Caltech

The Voyager probes were launched in 1977 and conducted a grand tour of the outer planets in our solar system before heading out into interstellar space. The spacecraft are each powered by three radioisotope thermoelectric generators (RTGs), which convert heat from the decay of plutonium-238 into electricity. The decay process yields slightly less power each passing year and, to compensate, engineers have turned off heaters and other non-essential systems to keep the science instruments powered on.

Voyager 2 is now more than 12 billion miles (20 billion km) from Earth, and currently using its five science instruments to study interstellar space. (Voyager 1 has four operating instruments as one failed earlier in the mission). Continued spacecraft operations would have required the deactivation one of Voyager's science instruments this year, without a new and novel power strategy.

Engineers found a way to access a small amount of power from the RTGs that had been set aside to protect the spacecraft's instruments in case of voltage fluctuation. The mission will now be using this reserve to keep all the science instruments on line at least until 2026, a three-year reprieve. A decision on whether to turn off instruments on Voyager 1 will come next year.

Shades of Galileo

The European Space Agency's (ESA) interplanetary mission to explore Jupiter and three of its largest moons (the Jupiter Icy Moons Explorer or JUICE), was successfully launched on Friday, April 14th. Over the following weeks, JUICE deployed its massive solar panels (covering 915 square feet or 85 square meters), a radio antenna, and a 35-foot (10.6-meter) boom for measuring Jupiter's magnetic field.

Unfortunately, initial efforts to deploy the 52-foot-long (16-meter) Radar for Icy Moons Exploration (RIME) antenna were not successful. Engineers suspected that a tiny stuck pin was holding the antenna in its mounting bracket. The antenna is designed to penetrate more than 5 miles (9 km) beneath the icy surfaces of Jupiter's moons in a search for habitable conditions. The other ten instruments on the spacecraft are in the proper configuration and operating as expected.

JUICE won't reach Jupiter until 2031, taking a circuitous route that includes gravity-assist flybys of Earth and our moon, and Venus, so time was on ESA's side for freeing up the jammed antenna. After several attempts, using the spacecraft's thrusters and firing a mechanical device called a "non-explosive" actuator as well as a second actuator, the pin holding the antenna shifted just enough to release the device. Flight controllers have now confirmed full deployment.

In April 1991, NASA's Galileo spacecraft, on route to Jupiter, executed a deployment sequence to open the spacecraft's 16-foot (4.8-meter) wide, umbrella-like high-gain antenna. Unfortunately, attempts to free the antenna were not successful and it never reached its fully deployed position. The subsequent investigation attributed the failure to the design of the rib retention mechanism. The mission team, however, was able to repurpose the low gain antenna, along with new data compression techniques and customized receiving hardware, to achieve most of the mission objectives. Fortunately, ESA's team now has a fully functional spacecraft.

New Ocean Worlds

A new study, based on the re-analysis of data from NASA's Voyager 2 spacecraft, strongly suggests that four of Uranus' largest moons contain an ocean layer between their cores and icy crusts. Voyager 2 was launched in August 1977 and flew by Uranus in January 1986 after earlier encounters with Jupiter and Saturn. During its closest approach, the spacecraft discovered 11 new moons, dark rings, and a planetary magnetic field that is tilted such that the poles of the field are closer to the equator rather than the planet's rotational poles like on Earth.

Major Moons of Uranus
Credits: NASA/JPL-Caltech

Scientists have long thought that Uranus' largest moon, Titania, at 980 miles (1,580 km) in diameter, could have retained enough internal heat, produced by the decay of radioactive elements, to support a liquid layer.

The new computer modeling analyzed the interior makeup and structure of the planet's largest moons from the Voyager 2 data, with consideration of the science returned from NASA's Galileo, Cassini, Dawn, and New Horizons and their discoveries of ocean worlds. The results suggest that there likely is a brackish ocean layer within four of Uranus' major moons: Ariel, Umbriel, Titania, and Oberon. The oceans, lying beneath the moon's icy crusts and atop layers of water-rich rock and dry rock could be dozens of miles deep. The fifth moon analyzed, Miranda, was deemed too small to retain enough heat to keep a liquid layer from freezing, even with the contribution from tidal heating (from the gravitational pull from Uranus). The thermal modeling of each moon's surface as an insulating layer, also hints that the oceans within Titania and Oberon may be warm enough to support life.

The National Academies' 2023 Planetary Science and Astrobiology Decadal Survey has prioritized the exploration of Uranus.

Remembering "Oppy"

NASA's Mars Exploration Rover named Opportunity (or "Oppy") spent more than 14 years exploring Meridiani Planum. Oppy was the second of the two rovers launched in 2003 (Spirit was the other). Her planned 90-day mission began on January 24, 2004 when the rover, sheathed inside an airbag cocoon, bounced into a small crater. Once settled, the airbags deflated and the rover drove off the landing craft. The mission had an auspicious start when hematite nodules were spotted lodged in the landing crater wall, a mineral that typically forms in water.

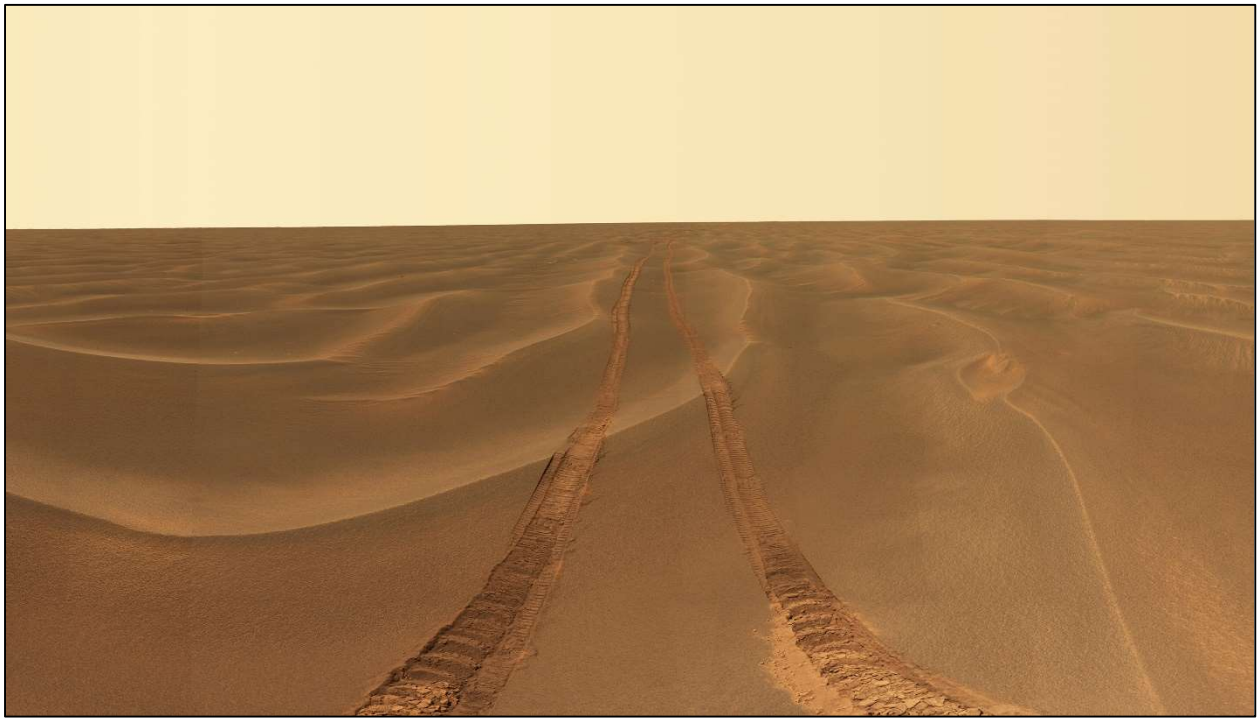
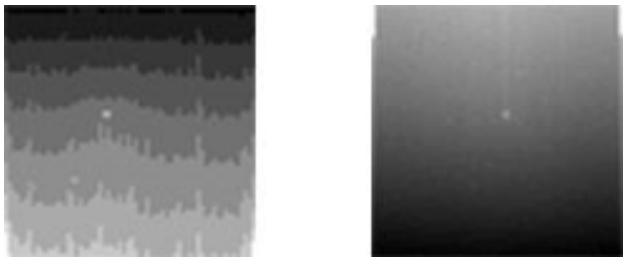


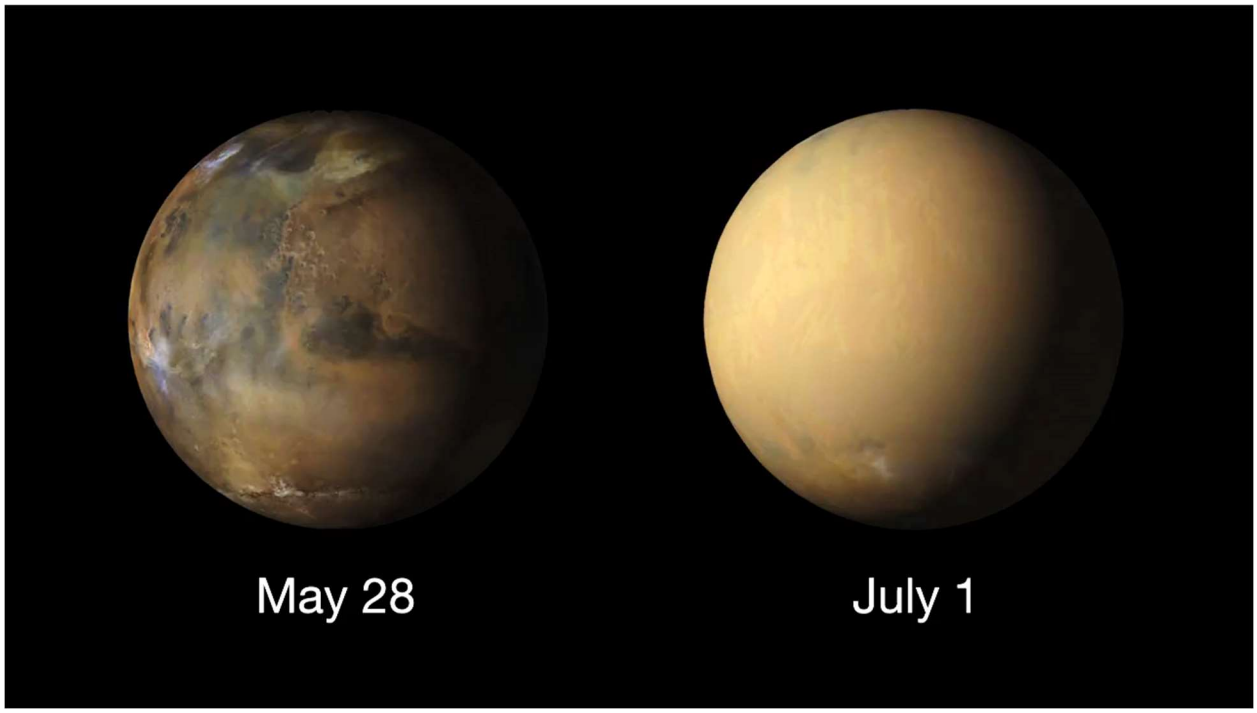
Image Credit: NASA/JPL-Caltech/Cornell Univ./Arizona State Univ.

Oppy visited and studied the geology in over 100 impact craters of all sizes (Endeavour being the largest at 14 miles or 22 km in diameter). The solar-powered rover still holds the off-Earth roving distance record with an odometer reading 28.06 miles (45.16 km) at mission end. In her trek, Oppy found signs of a more hospitable past (for microbial life), including deposits of gypsum in the rocks, likely formed when water flowed through underground fractures, leaving calcium behind, and clay minerals that formed in neutral-pH water.

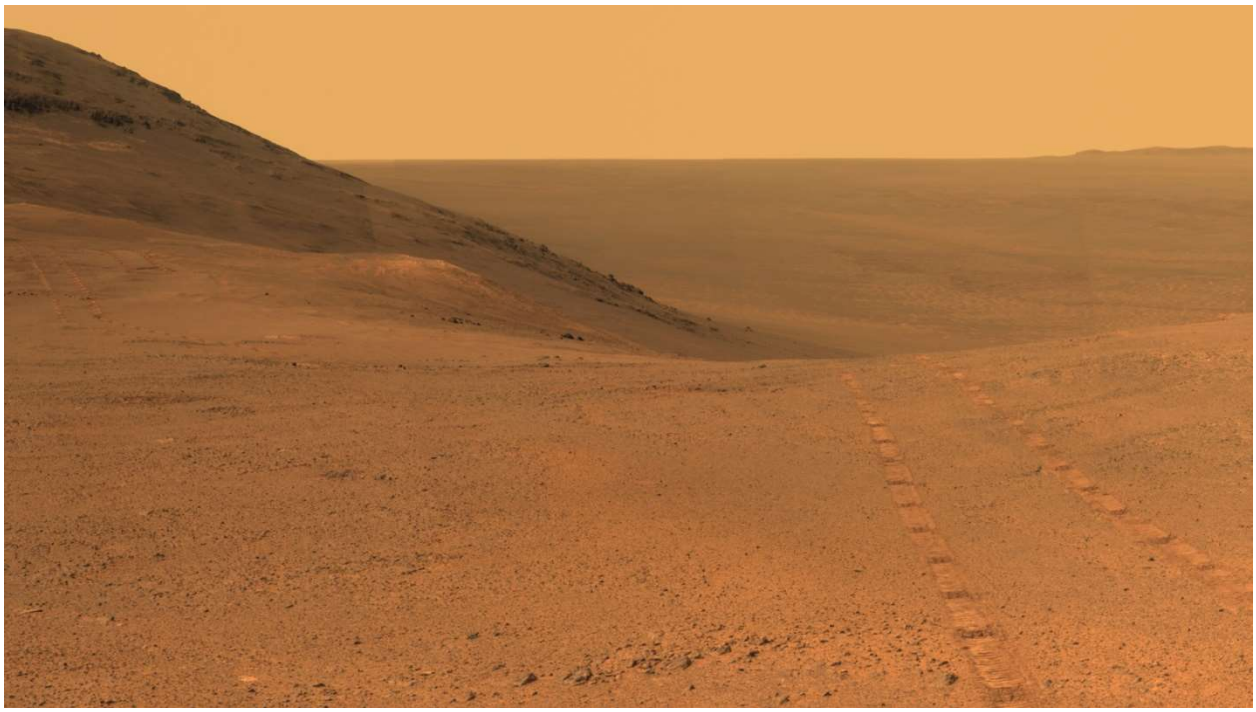


Credit: NASA/JPL-Caltech/Cornell/ASU

In 2018, Oppy became the victim of a global dust storm. With day turned into night, the rover's solar panels were unable to generate enough power to keep its batteries charged and critical systems on-line. On June 10, 2018 (sol 5111), Oppy sent her final message from Perseverance Valley on the rim of Endeavour crater. The short communication reported a solar array energy production of 22 Watt-hours for the sol and the highest atmospheric opacity (tau) ever measured on Mars - 10.8. The final images were thumbnails from the Pancam (above), showing the Sun as a ghostly dot in the dust laden sky. Full-frame versions were never transmitted.



Development of the 2018 global dust storm, courtesy of the Mars Color Imager (MARCI) camera onboard NASA's Mars Reconnaissance Orbiter (MRO).
Image Credit: NASA/JPL-Caltech/MSSS



Panoramic view of the upper Perseverance Valley, a broad notch in Endeavour's Crater's rim, which may have been a spillway where water, ice or wind flowed over the rim and into the crater.
Credits: NASA/JPL-Caltech

Milky Way Season

The core of the Milky Way rises around 10 pm (EDT) in the days round the New Moon on June 18th. Look to the southeast with the brightest star clouds appearing between the constellations Sagittarius and Scorpius. The faint stream of stars, that defines our galaxy seen edge-on, can be traced from Sagittarius, though Cygnus and beyond to Cassiopeia in the north.

June History

Women in Space

On June 16, 1963, Valentina Tereshkova became the first woman in space. Shortly after Yuri Gagarin's flight, the Soviets began a search for suitable female candidates for spaceflight. With few female pilots, the majority of the candidates were women parachutists (Valentina had joined an amateur parachuting club at the age of 18). Control of the Vostok spacecraft was completely automatic, so piloting experience was not required. However, since the Vostok was not designed to return its occupant safely to Earth, the cosmonaut was required to eject from the spacecraft after re-entry and parachute to the landing site.

The selection of Valentina Tereshkova for the flight was made by Premier Khrushchev. In addition to experience and fitness, qualifications included being an ideal Soviet citizen and model Communist Party member. On June 16, Valentina rode Vostok 6 into orbit with the call sign "Chaika" (Seagull). The mission was not without incident and included space-sickness, leg cramps and other discomforts from being strapped into the capsule for three days. More importantly, the capsule ended up in the wrong orientation and, had it not been corrected, would not have allowed her to return to Earth.

Valentina's three days in space was more flight time than all the American astronauts combined (at that time). After fulfilling her duties to her country, Tereshkova retired to a small house on the outskirts of Star City. The house is topped with a seagull weathervane, the call sign of her flight.

Twenty years later on June 18, Sally Ride became the first American woman in space. Launched aboard the space shuttle Challenger, Sally served as the mission specialist on the five-person crew.

An Extraordinary Feat

If you have ever seen a Gemini space capsule (there is one on display at the Air and Space Museum in Washington, D.C.) it is difficult to comprehend how two people could have spent any length of time inside its cramped interior (Frank Borman and Jim Lovell spent

14 days orbiting the Earth in Gemini 7). The reentry module, where the two astronauts sat, is approximately 11 feet long with a maximum diameter of 7½ feet and filled with instrumentation, life support systems and controls.

On June 3, 1965, Gemini 4 lifted off on a four-day mission. The highlight of the mission was to be a spacewalk by Ed White. NASA was very concerned with "putting guys in vacuums with nothing between them but that little old lady from Worcester, Massachusetts [the seamstress at the David Clark Company], and her glue pot and that suit." However, the Soviets had challenged the United States with a spacewalk by Cosmonaut Alexei Leonov in March during a Voskhod II mission, and the United States did not want to appear to be falling behind its adversary.
After struggling with a faulty hatch, Ed White finally exited the spacecraft as it passed over the Pacific Ocean. Using a gun powered by compressed oxygen, he was able to maneuver outside the capsule, just avoiding the flaming thrusters of the Gemini capsule. After a 23-minute spacewalk, Jim McDivitt struggled to get the six-foot-tall Ed White back inside the capsule and close the balky door.

Sadly, after making history as the first American to walk in space, Ed White died during a launch pad test of the Apollo 1 spacecraft when the pure oxygen atmosphere exploded, killing all three astronauts inside.

Sunrise and Sunset (from New Milford, CT)

Sun	Sunrise	Sunset
June 1st (EDT)	05:21	20:21
June 15th	05:18	20:29
June 30th	05:22	20:31

Astronomical and Historical Events

1st History: final landing of Space Shuttle Endeavour (STS-134) (2011)
1st History: launch of the ROSAT (Röntgen) X-ray observatory; cooperative program between Germany, the United States, and United Kingdom; among its many discoveries was the detection of X-ray emissions from Comet Hyakutake (1990)
1st History: Founding of the Caltech Rocket Research Group (precursor to the Jet Propulsion Laboratory) (1936),
2nd Full Moon (Strawberry Moon)
2nd History: founding of the Baikonur Cosmodrome, Kazakhstan (Soviet and Russian launch complex) (1955)
2nd History: launch of the Mars Express spacecraft and ill-fated Beagle 2 lander (2003)
2nd History: launch of the Space Shuttle Discovery (STS-91); ninth and final Mir docking (1998)
2nd History: launch of Soviet Venus orbiter Venera 15; side-looking radar provided high resolution mapping of surface in tandem with Venera 16 (1983)
2nd History: Surveyor 1 lands on the Moon (1966)
2nd History: Gemini 5, Gemini 11, Apollo 12 and Skylab 2 astronaut Pete Conrad born (1930)

Astronomical and Historical Events (continued)

2nd History: discovery of Comet Donati by Italian astronomer Giovanni Battista Donati; brightest comet of the 19th century and first comet to be photographed (1858)
3rd History: discovery of two rings around the centaur asteroid 10199 *Chariklo*, the smallest known object to have rings (2013)
3rd History: discovery of Jupiter impact event by Anthony Wesley (2010)
3rd History: launch of Gemini 9 with astronauts Thomas Stafford and Eugene Cernan (1966)
3rd History: launch of Gemini 4; Ed White becomes first American to walk in space (1965)
3rd History: dedication of the 200-inch Hale Telescope at Palomar Mountain (1948)
4th Venus at Greatest Eastern Elongation
4th History: maiden flight of SpaceX's Falcon 9 rocket; launched from Cape Canaveral, Florida (2010)
4th History: discovery of Classical Kuiper Belt Object 50000 *Quaoar* by Mike Brown and Chad Trujillo from images acquired at the Samuel Oschin Telescope at Palomar Observatory (2002)
6th Moon at perigee (furthest distance from Earth)
6th History: launch of Soviet Venus orbiter Venera 16; side-looking radar provided high resolution mapping of surface in tandem with Venera 15 (1983)
8th History: New Horizons spacecraft, on its way to Pluto, crosses the orbit of Saturn (2008)
8th History: discovery of Nova Aquila; a supernova explosion from the collapse of a white dwarf (1918)
8th History: launch of Soviet Venus orbiter/lander Venera 9; transmitted the first black and white images of the surface of Venus (1975)
8th History: Giovanni Cassini born, observer of Mars, Jupiter and Saturn (1625)
9th History: Abee meteorite fall in Canada (1952)
9th History: dedication of the Kathleen Fischer Sundial at the McCarthy Observatory (2012)
10th Last Quarter Moon
10th History: launch of Mars Exploration Rover A (Spirit) in 2003
10th History: launch of Explorer 49, Moon orbiter and radio astronomy explorer (1973)
11th History: flyby of Venus by Soviet spacecraft Vega 1 on its way to Comet Halley; dropped off lander and a balloon to study middle cloud layers (1985)
12th History: launch of Venera 4, Soviet Venus lander; first to enter atmosphere of another planet (1967)
13th History: return of the sample capsule from the Hayabusa (MUSES-C) spacecraft (2010)
14th History: launch of a V-2 rocket carrying a rhesus monkey (Albert II) – monkey survived flight and successfully transmitted biomedical data, but died on impact when parachutes failed to open (1949)
14th History: first radar astrometry for an asteroid from Goldstone and Haystack antennae observations of the asteroid 1566 *Icarus* (1968)
14th History: launch of Mariner 5; Venus flyby mission (1967)
14th History: launch of Venera 10; Soviet Venus orbiter/lander (1975)
15th History: flyby of Venus by Soviet spacecraft Vega 2 on its way to Comet Halley; dropped off lander and a balloon to study middle cloud layers (1985)
16th History: Liu Yang becomes the first Chinese woman in space aboard a Shenzhou-9 spacecraft, joining two other crew members on a thirteen-day mission to the orbiting Tiangong 1 laboratory module (2012)
16th History: Valentina Tereshkova; first woman in space aboard Soviet Vostok 6 (1963)

Astronomical and Historical Events (continued)

18th New Moon
18th History: launch of the Lunar Reconnaissance Orbiter (LRO) and Lunar CRater Observation and Sensing Satellite (LCROSS) to the Moon (2009)
18th History: Sally Ride becomes the first American woman in space aboard the Space Shuttle Challenger (1983)
19th History: discovery of the potentially hazardous asteroid (PHA) 99942 *Apophis* – on April 13, 2029, the asteroid will pass within 19,000 miles (31,000 km) of the Earth (2004)
19th History: flyby of Earth by the ill-fated Nozomi spacecraft on its way to Mars (2003)
20th History: successful landing of the Viking 1 spacecraft on Mars' Chryse Planitia (Plains of Gold) (1976)
20th History: discovery of Nova 1670 in Vulpeculae (1670)
21st Summer Solstice at 10:58 a.m. EDT (14:58 UT)
21st History: SpaceShipOne makes first privately funded human spaceflight (2004)
22nd Moon at apogee (furthest distance from Earth)
22nd History: launch of Soviet space station Salyut 5 (1976)
22nd History: founding of the Royal Greenwich Observatory (1675)
22nd History: discovery of Pluto's largest moon *Charon* by Jim Christy (1978)
24th History: launch of the Salyut 3 Soviet space station (1974)
24th History: Fred Hoyle born; British astronomer and proponent of nucleosynthesis (1915)
24th History: Sir William Huggins makes first photographic spectrum of a comet (1881)
25th History: Rupert Wildt born, German-American astronomer and first to hypothesize that the CO_2 in the Venusian atmosphere was responsible for the trapped heat (1905)
25th History: Hermann Oberth born, father of modern rocketry and space travel (1894)
26th First Quarter Moon
26th History: Discovery of Saturn's moons Surtur, Jarnsaxa, Greip and Loge (2006)
26th History: Charles Messier born, famed comet hunter (1730)
27th History: discovery of the Mars meteorite SAU 060, a small 42.28 g partially crusted grey-greenish stone found near Sayh al Uhaymir in Oman (2001)
27th History: flyby of the asteroid *Mathilde* by the NEAR spacecraft (1997)
27th History: Space Shuttle Atlantis (STS-71) first docking with the Russian space station Mir (1995)
27th History: launch of SEASAT, the first Earth-orbiting satellite designed for remote sensing of the Earth's oceans (1978)
27th History: Alexis Bouvard born, French astronomer, director of Paris Observatory, postulated existence of eighth planet from discrepancies in his astronomical tables for Saturn and Uranus. Neptune was subsequently discovered by John Couch Adams and Urbain Le Verrier after his death where he had predicted (1767)
28th History: discovery of Pluto's moon *Kerberos* by Mark Showalter, et al., using the Hubble Space Telescope (2011)
28th History: Nakhla meteorite fall in Egypt (Mars meteorite), a piece of which was claimed to have vaporized a dog; first direct evidence of aqueous processes on Mars (1911)
29th History: George Ellery Hale born, founding father of the Mt. Wilson Observatory (1868)
30th History: the Cassini-Huygens spacecraft enters orbit around Saturn (2004)
30th History: discovery of *Haume*a's moon *Namaka*, the smaller, inner moon of the dwarf planet, by Mike Brown, Chad Trujillo, David Rabinowitz, et al. (2005)

Astronomical and Historical Events (continued)

30th History: crew of Soyuz 11 dies upon return from the Salyut space station when capsule depressurizes (1971)
30th History: Tunguska Explosion Event (1908)

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
- 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

International Space Station and Artificial Satellites

- www.heavens-above.com for the times of visibility and detailed star charts for viewing the International Space Station and other manmade objects.

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

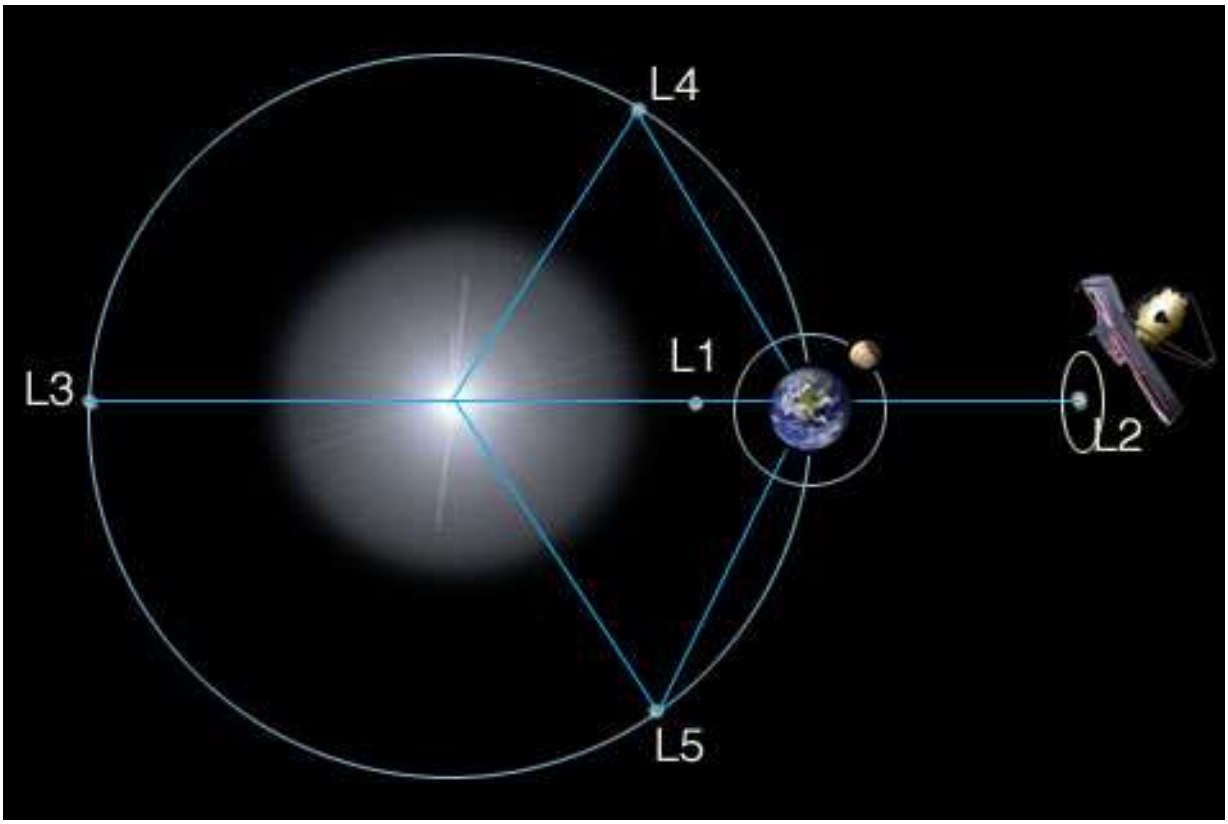
- Vital Signs of the Planet: https://climate.nasa.gov/

Mars – Mission Websites

- Mars 2020 (Perseverance rover): https://mars.nasa.gov/mars2020/
- Mars Helicopter (Ingenuity): https://mars.nasa.gov/technology/helicopter/
- Jezero Crater map: https://mars.nasa.gov/mars2020/mission/where-is-the-rover/
- Mars Science Laboratory (Curiosity rover): https://mars.nasa.gov/msl/home/
- Mars InSight (lander): https://mars.nasa.gov/insight/

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 (and location of the Webb telescope) is located 1 million miles (1.5 million km) beyond the Earth (as viewed from the Sun).



James Webb Space Telescope

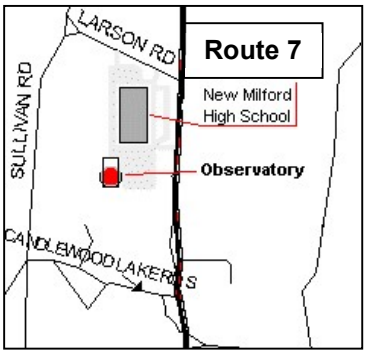
- https://webb.nasa.gov/index.html

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