Galactic Observer

John J. McCarthy Observatory

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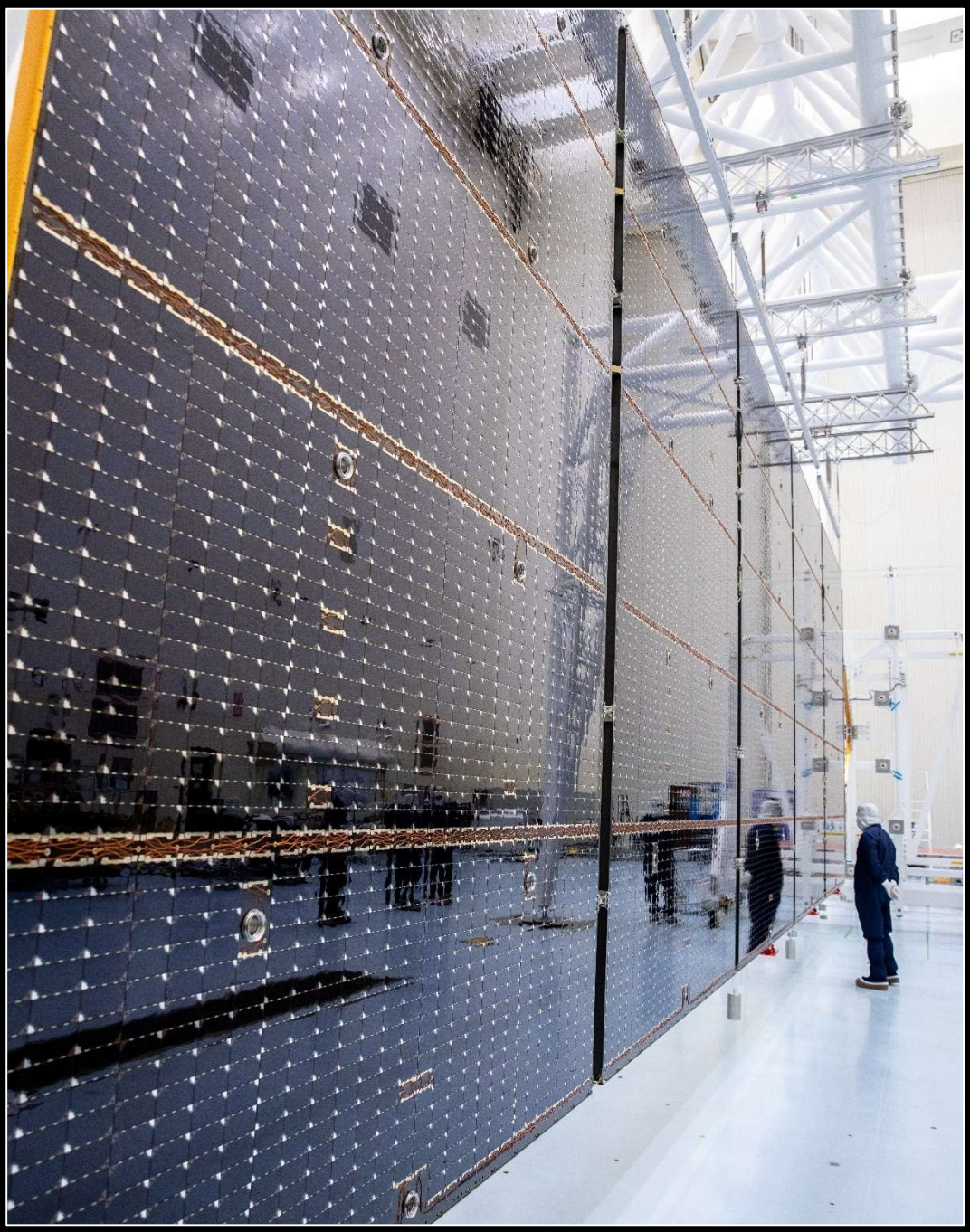
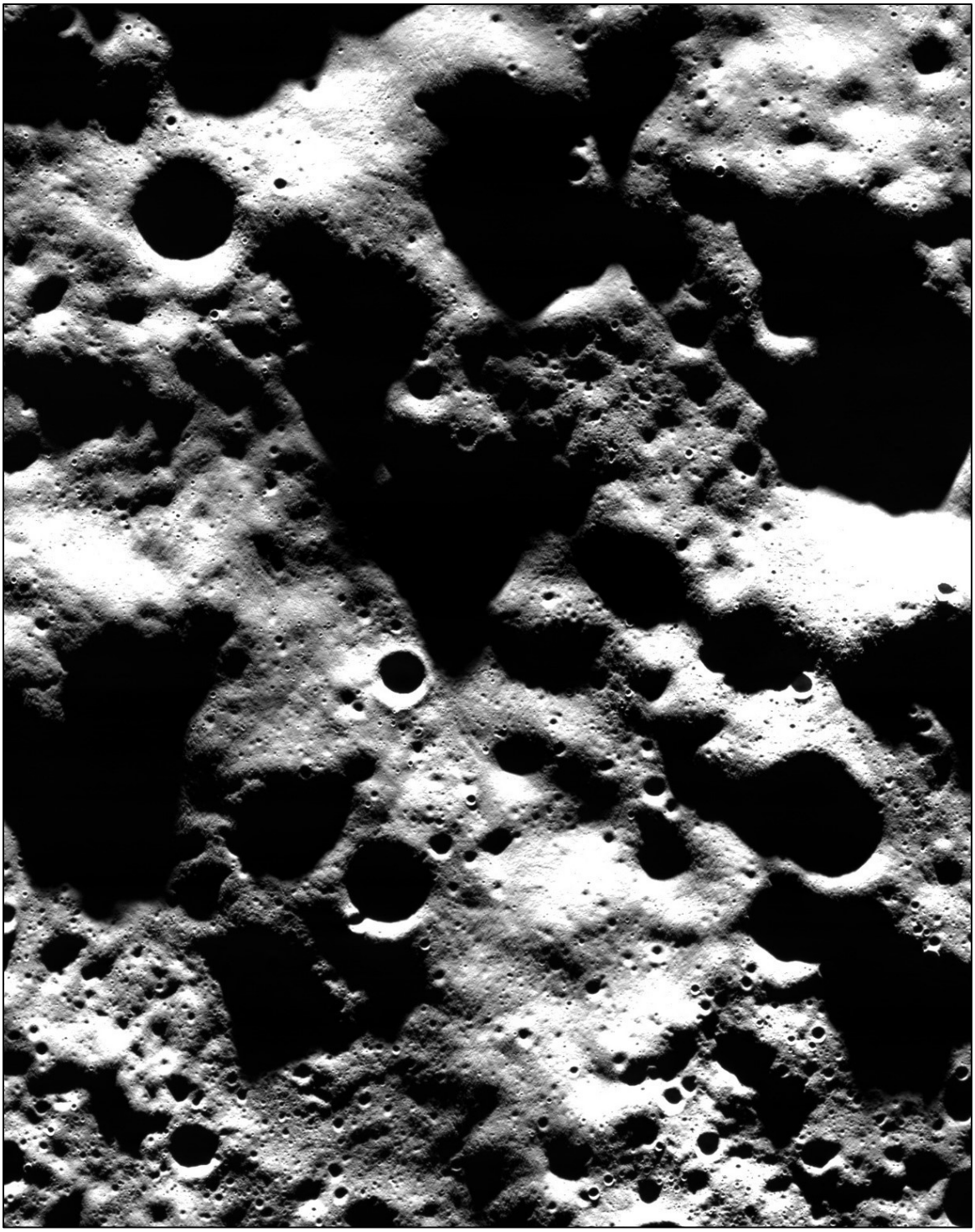


Europa Clipper's solar arrays are the largest developed for a planetary mission - each measuring about 46½ feet (14.2 meters) long and about 13½ feet (4.1 meters) high
Image Credit: NASA Kennedy Space Center

October Astronomy Calendar and Space Exploration Almanac



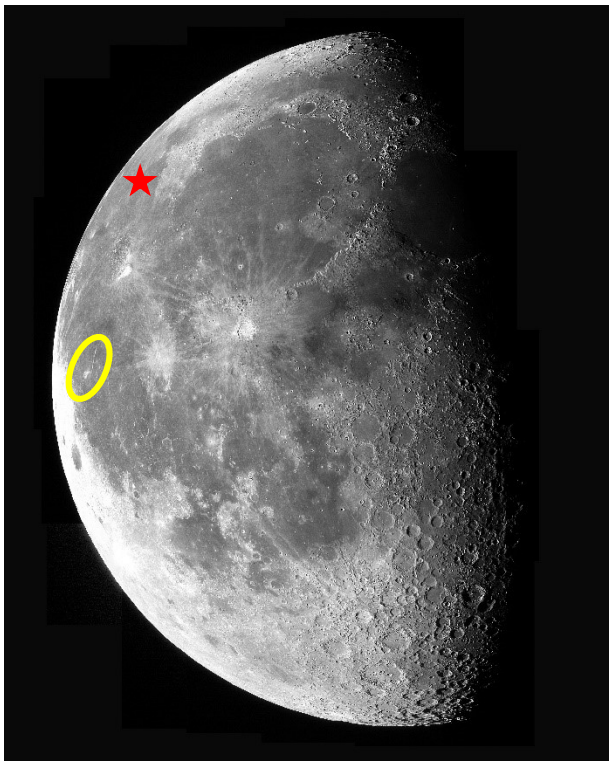
The JANUS camera onboard ESA's Jupiter Icy Moons Explorer imaged our Moon during its lunar-Earth flyby on August 19th for an evaluation of instrument performance.
Credit: ESA/Juice/JANUS

In This Issue

"Out the Window on Your Left"

It's been almost 52 years since Gene Cernan left the last bootprint 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).

Lunar swirls are patches of lighter colored regolith, the brightest of which are easily seen with a moderate size telescope. Their origin remains a mystery although they are commonly found in areas with localized magnetic fields (the Moon does not have a global magnetic field, at least at this time). If the two are related, the fields could be preventing solar radiation from darkening the surface where the fields are the strongest.



Location of the Chang'e 5 (star) and Reiner Gamma swirl (circle) in Oceanus Procellarum
Photo: Bill Cloutier

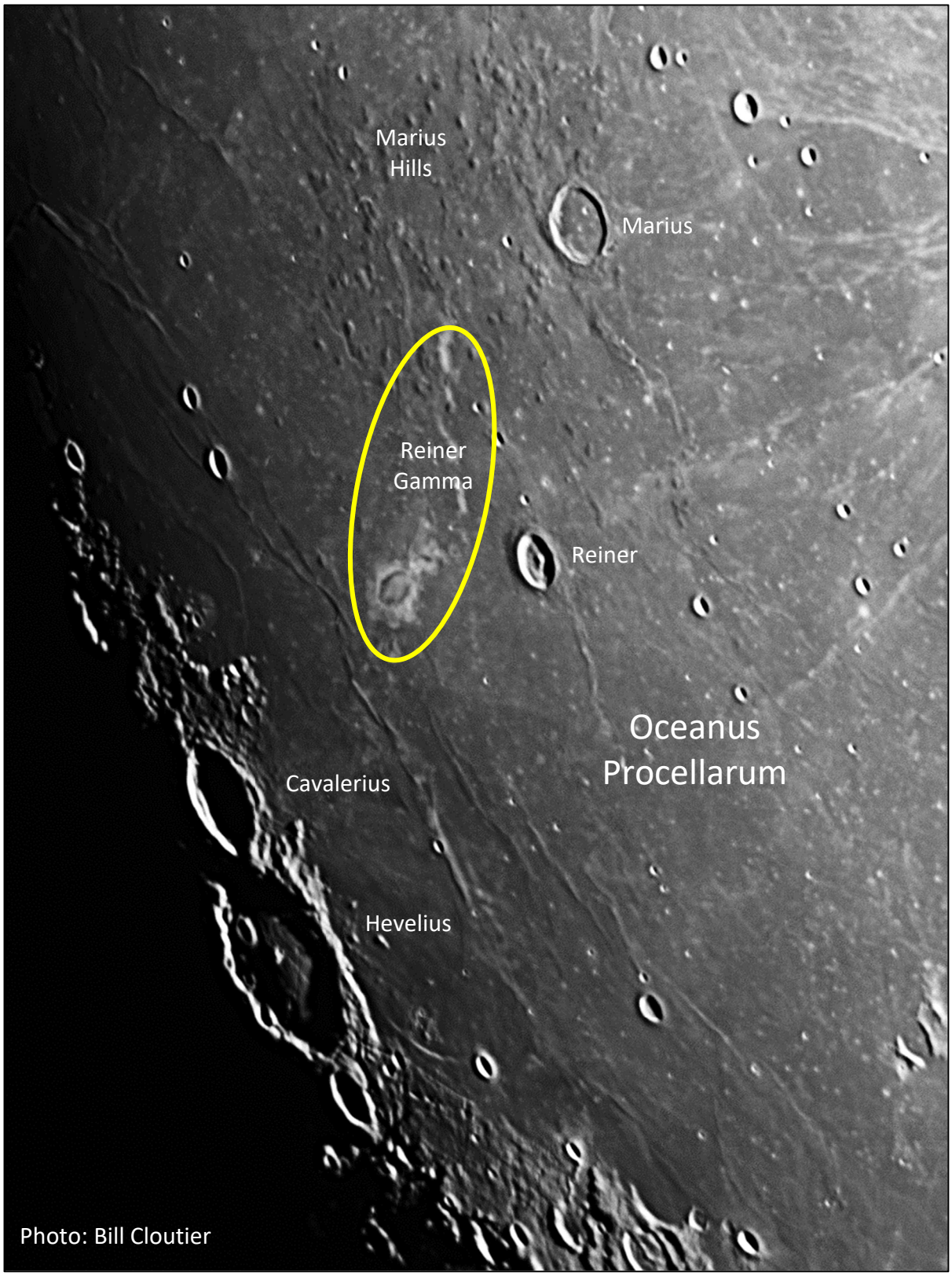
Reiner Gamma is one of the brightest and easiest swirl to locate. Located on the western edge of Oceanus Procellarum, just south of Marius Hills (a field of volcanic domes), the swirl first becomes visible two to three days before the Full Moon. The tadpole-shaped sinuous swirl is listed at 45.6 miles or 73.4 km in length.

In a recently published study, researchers presented a means by which a localized magnetic field could be created. Experiments on Earth have shown that ilmenite, which is abundant on the Moon, can react and form particles of iron metal, which can become easily magnetized by underground magma activity. However, until we are able to visit a swirl, their manifestations will remain an enigma.

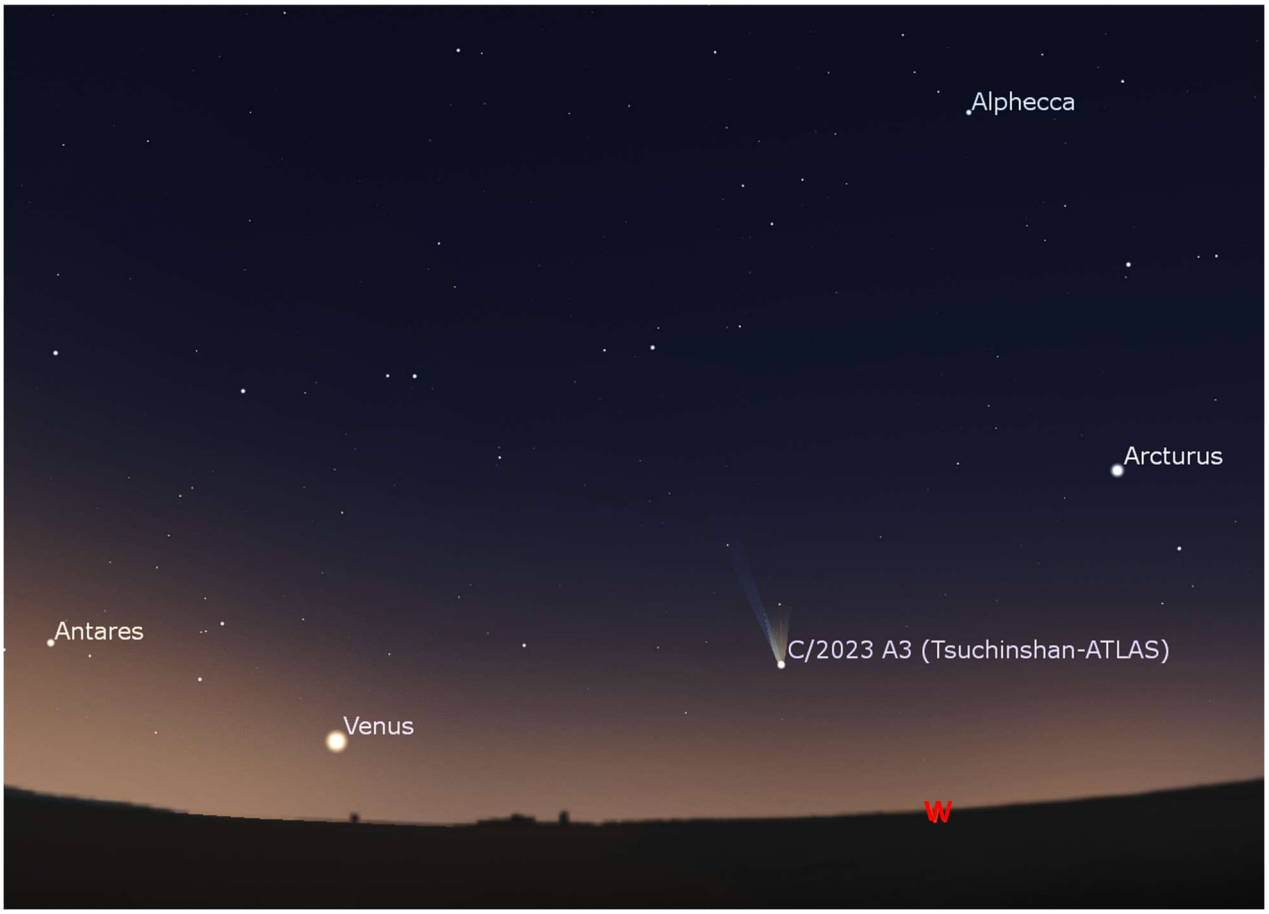
That time may be coming as NASA's Commercial Lunar Payload Services includes the Lunar Vertex, a mission specifically targeting Reiner Gamma. A lander will deliver a small rover to the surface to collect magnetic and spectral measurements over a single lunar day (about 14 Earth days), beginning at local sunrise and concluding surface operations as the sun sets (the rover is not designed to survive a lunar night). It is expected that the rover will be able to survey just over a mile (about 2 km) of the swirl in that time.

Lunar Vertex is scheduled to launch in 2025 aboard a Falcon 9 rocket. Intuitive Machines, headquartered in Houston, Texas, is under contract to provide the lander and a launch vehicle. Lunar Outpost, Inc. is supplying the rover, which will carry the survey instruments developed by the Johns Hopkins University Applied Physics Laboratory in Laurel, Maryland for in-situ analysis of the swirl.

Marius Hills and Reiner Gamma



Comet Tsuchinshan-Atlas



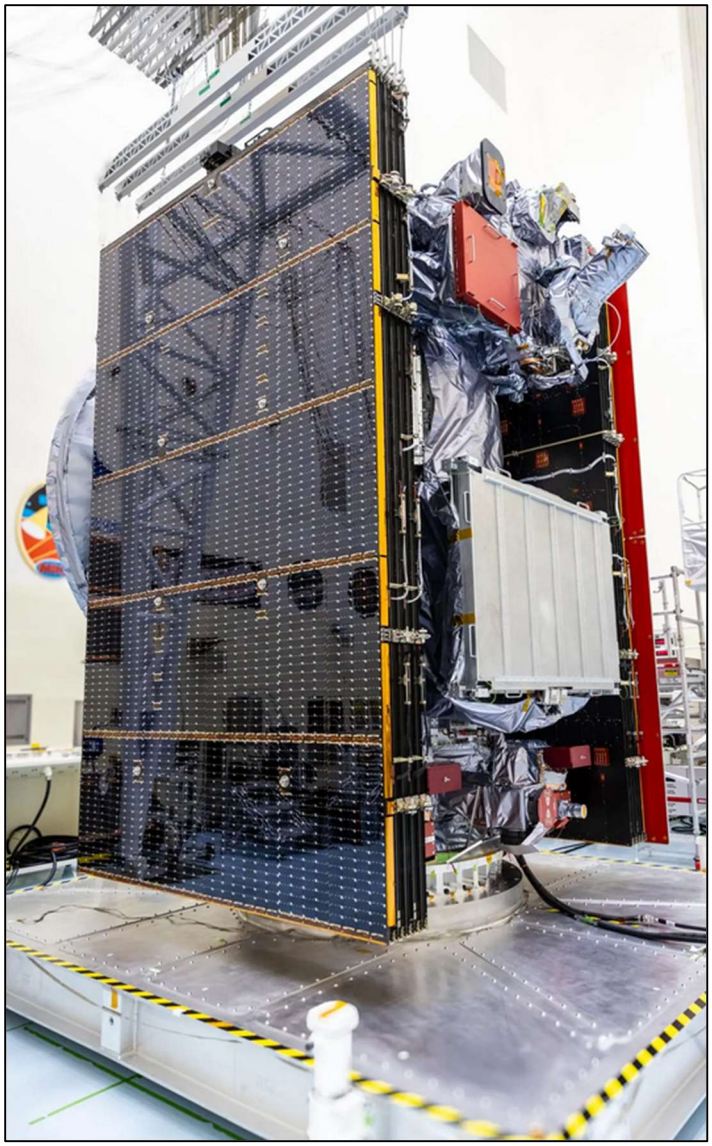
Looking west on the evening of October 13th around 7 pm EDT
Sky Simulation: Stellarium

Comet Tsuchinshan-ATLAS (C/2023) was discovered at the Purple Mountain Observatory in China on January 9, 2023 and independently by the Asteroid Terrestrial-Impact Last Alert System (ATLAS) on February 22nd. The icy visitor from the Oort cloud is currently predicted to be visible in the evening sky during the latter half of October, as long as it survives its close encounter (perihelion) with the Sun on September 27th.

Tsuchinshan-ATLAS will be closest to Earth on the 12th at a distance of 43.9 million miles (70.6 km). Current expectations are that the comet will be visible without any optical aid, rivaling some of the brightest stars in the sky. While it will be placed higher in the sky each successive night after the 12th, it will also become dimmer as it moves away from the Earth/Sun. By the end of the month, it may return to being a binocular object. Interference from a bright moon may reduce the sky contrast needed to see its dusty tail, at least until after the full moon on the 17th.

Comet Tsuchinshan-ATLAS
from the ISS
Credit: Matthew Dominick

Europa Clipper Ready for Launch



NASA's Europa Clipper in a clean room at Kennedy Space Center after the spacecraft's giant solar arrays were stowed for launch.
Photo: NASA/Frank Michaux

The launch window for the Europa Clipper, the largest spacecraft NASA has ever built for planetary exploration, opens on October 10th. Once it arrives in the Jovian system in 2030, the mission team will spend a year refining and shaping its orbit around Jupiter, using the gravity of its largest moon Ganymede, to set up a series of flybys with Europa.

Europa is one of the most promising astrobiology targets in the solar system with a global ocean beneath an icy shell containing twice the liquid water volume in Earth's oceans. The three mission objectives are to: determine the thickness of the icy shell and whether the surface interacts with the ocean; investigate the composition of the moon's ocean to determine if it has the ingredients to permit and sustain life; and characterize the geology of Europa, looking for signs of recent surface activity such as sliding crustal plates or plumes that are venting water into space.

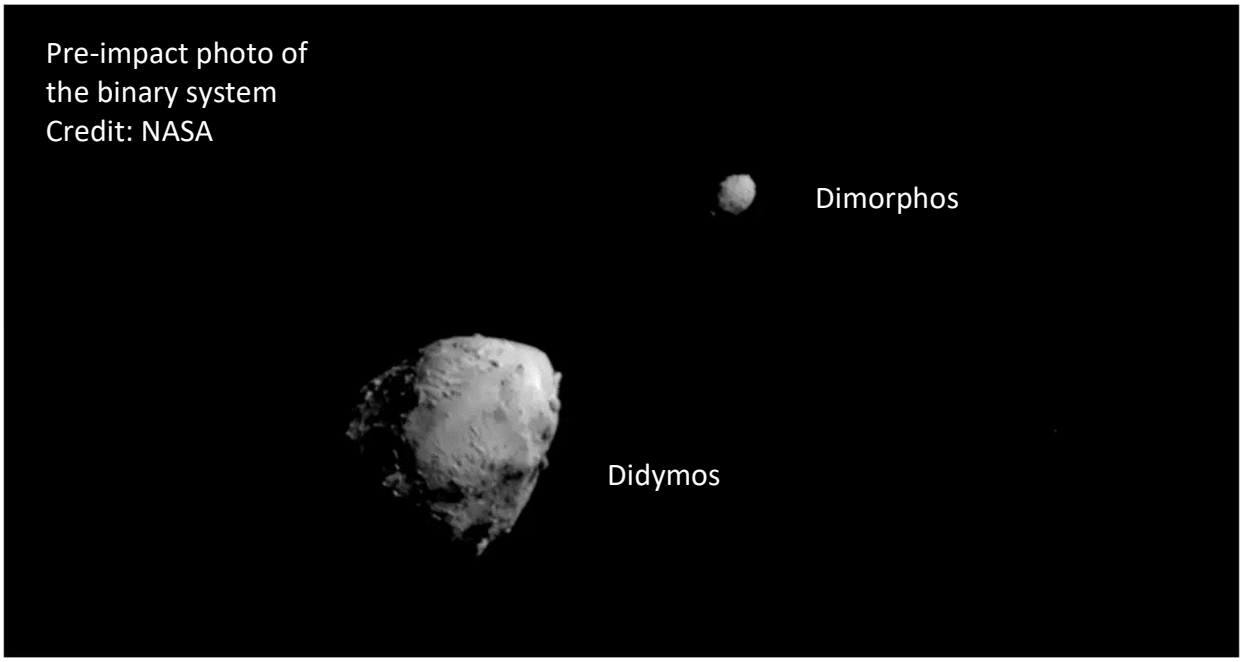
The Europa Clipper is powered by two massive solar arrays or wings, each spanning 46½ feet (14.2 meters) in length. The wings will be deployed from their folded launch position about 90 minutes after launch. With a total surface area of 1,100 square feet (102 m^2), the solar cells are designed to provide power to all of the electronics, science instruments, computer, communications equipment, and the propulsion system at Jupiter where they will receive only 3% to 4% of the sunlight that Earth receives, all while operating in temperatures as low at -400°F (-240°C).

A thermal management system will keep the spacecraft's electronics and instruments at an optimal operating temperature. The more sensitive components are also enclosed in a vault with walls made of sheets of aluminum-zinc alloy to protect them from Jupiter's intense radiation.

After nearly 50 flybys of Europa, the current plan calls for deorbiting the spacecraft into the surface of Ganymede.

Hera – Post Impact Analysis Mission

Two years ago, on September 26, 2022, NASA's DART (Double Asteroid Redirection Test) spacecraft deliberately smashed into a 560-foot-wide (170-meter-wide) asteroid. The asteroid, Dimorphos, is the smaller body in a binary system (Didymos being the larger). The collision shortened Dimorphos' orbital period around Didymos by 33 minutes and 15 seconds. It also resulted in the ejection of tons of material and modified the overall shape of the moon.



While astronomers continue to study the aftermath from afar, the European Space Agency's Hera spacecraft will perform a detailed post-impact survey of the pair, including high-resolution visual, laser and radio science mapping of the moon. Assuming an October launch, Hera will enter orbit in late January or early February 2027.

DART and Hera were conceived as part of an international 'Asteroid Impact Deflection Assessment' collaboration. Hera's orbit around the system's barycenter (the common center of gravity in the binary system) will bring the spacecraft within 12 – 18 miles (20 - 30 km) of the Dimorphos' surface.

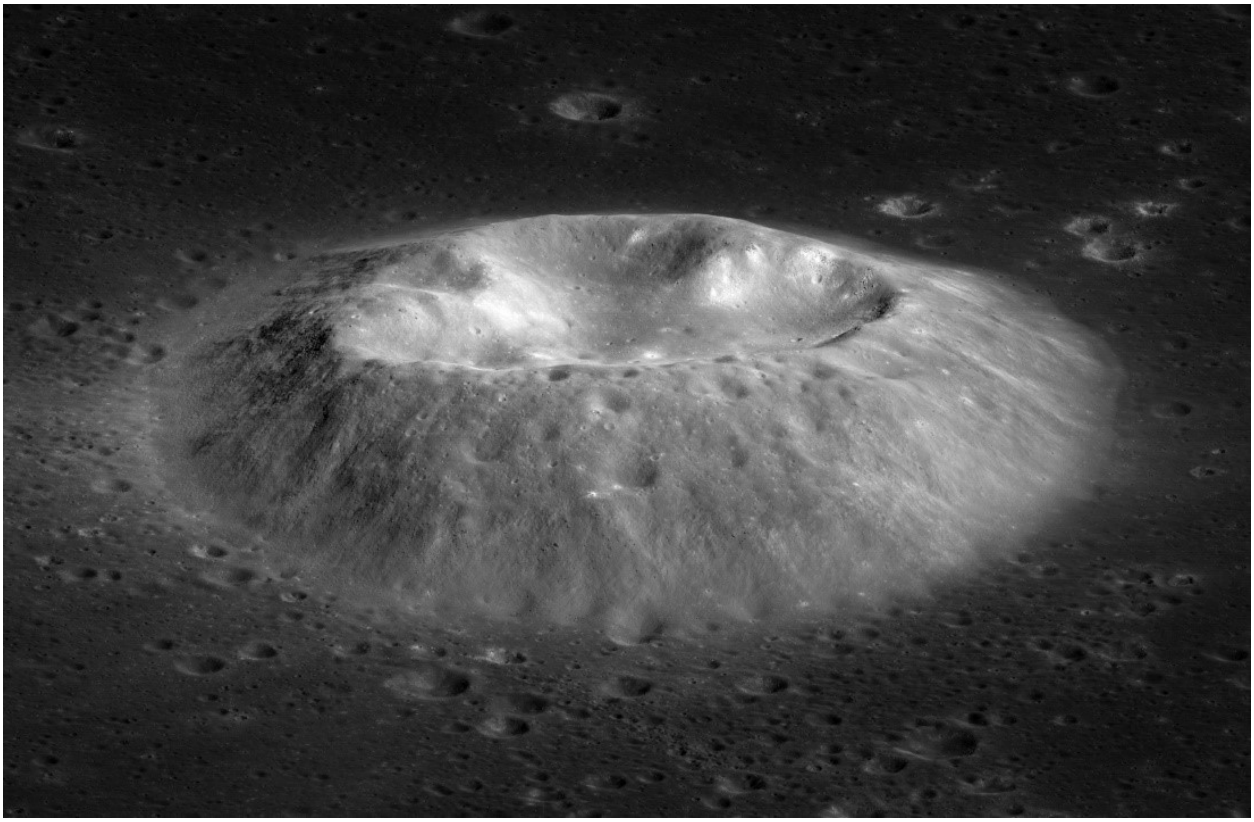
Hera is outfitted with 12 instruments and two cubesats, Juventas and Milani. The cubesat Juventas will perform radar soundings of Dimorphos before attempting to descend to its surface. If successful, it will be the first spacecraft to operate from the surface of an asteroid as it records measurements of the local gravity and changes in the gravity field as the moon orbits Didymos.

Milani will enter a low-altitude orbit around Dimorphos (coming as close as 1.25 miles or 2 km of the surface) for a detailed visual inspection and dust cloud assessment of the body before also attempting a landing. Once on the surface, the cubesat's instruments will gather data on the asteroid's surface dust.

Although the spacecraft is not designed for a landing, ESA is contemplating setting Hera down on one of Didymos' poles at the conclusion of the mission.

Lunar Volcanoes

Volcanism on the Moon had been thought to have ceased billions of year ago, yet the samples returned by China's Chang'e 5 mission suggest otherwise.



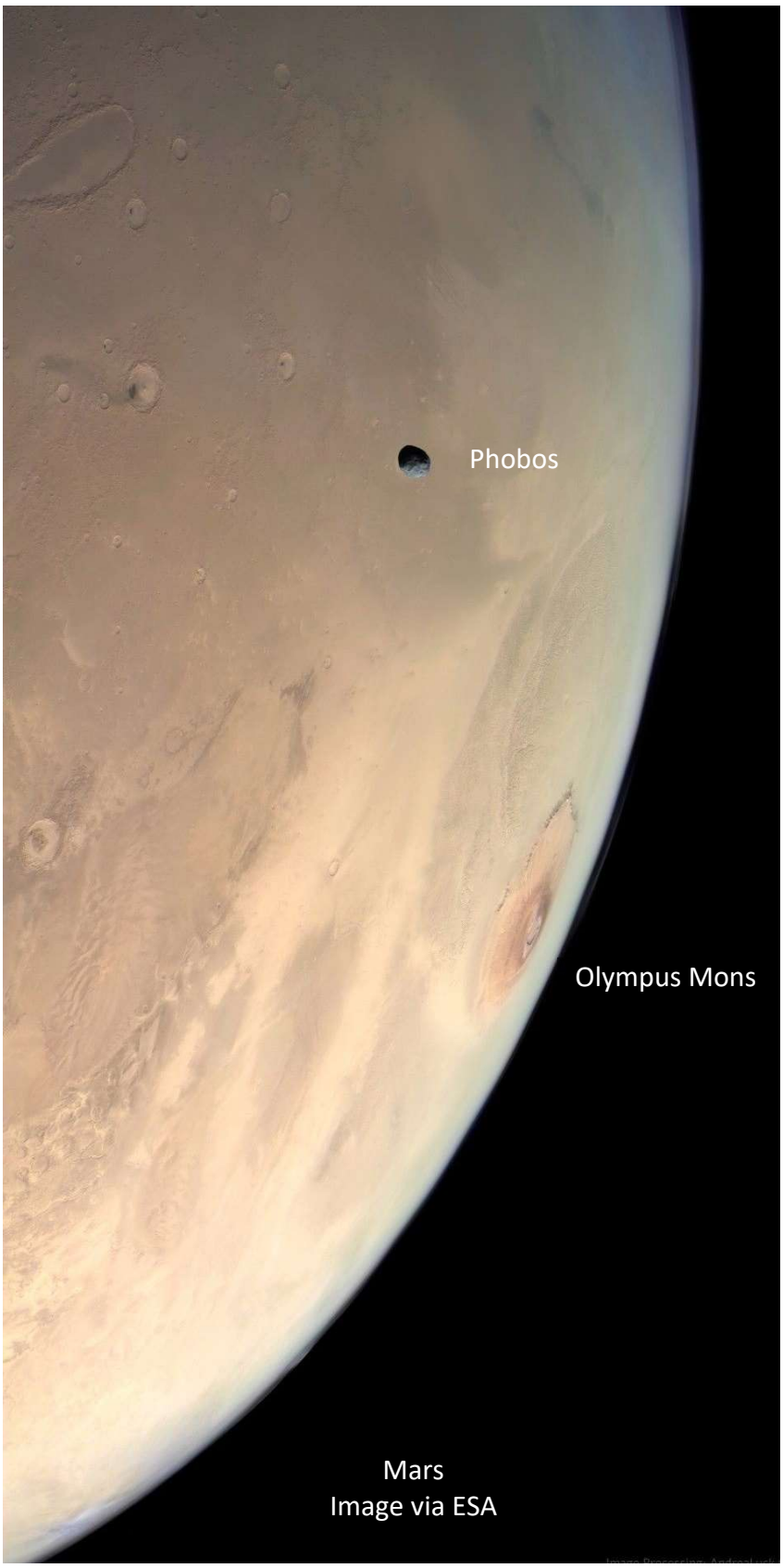
The volcano Mairan T stands over 2,000 feet (600 meters) tall above the plains of Oceanus Procellarum about 54 miles or 87 km southwest of the Chang'e 5 landing site
Credit: NASA/GSFC/Arizona State University

Chang'e 5 landed in the northern region of Oceanus Procellarum (Ocean of Storms) on December 1, 2020. The lander collected 3.82 pounds (1,731 grams) of lunar soil, including a core sample from 3 feet (1 meter) below the surface, which were returned to Earth on December 16th.

Researchers extracted about 3,000 glass beads, ranging between 20 to 400 microns in size (0.0008 to 0.016 inch), from the lunar soil and core sample. Glass beads are commonly associated with impact events and are produced from the melting of lunar regolith. Almost all of the Chang'e 5 beads were classified as impact-generated glass; however, three of the beads were identified as volcanic in origin through their chemical composition and sulfur isotopes.

What was truly extraordinary was their estimated age. The beads were dated, using the radioactive decay of uranium to lead radiometric dating technique, to a formation age of only 123 million years (± 15 million years). This suggests that the Moon was volcanically active for most of its 4.6 billion year-old history and that the recent volcanism is related to a high abundance of heat-generating elements, such as thorium and rare-Earth elements, in the lunar mantle. The finding is also consistent with the dating of irregular mare patches or IMPs and ash deposits found around volcanic vents, for example, in Alphonsus crater.

A Planet, a Moon and a Volcano



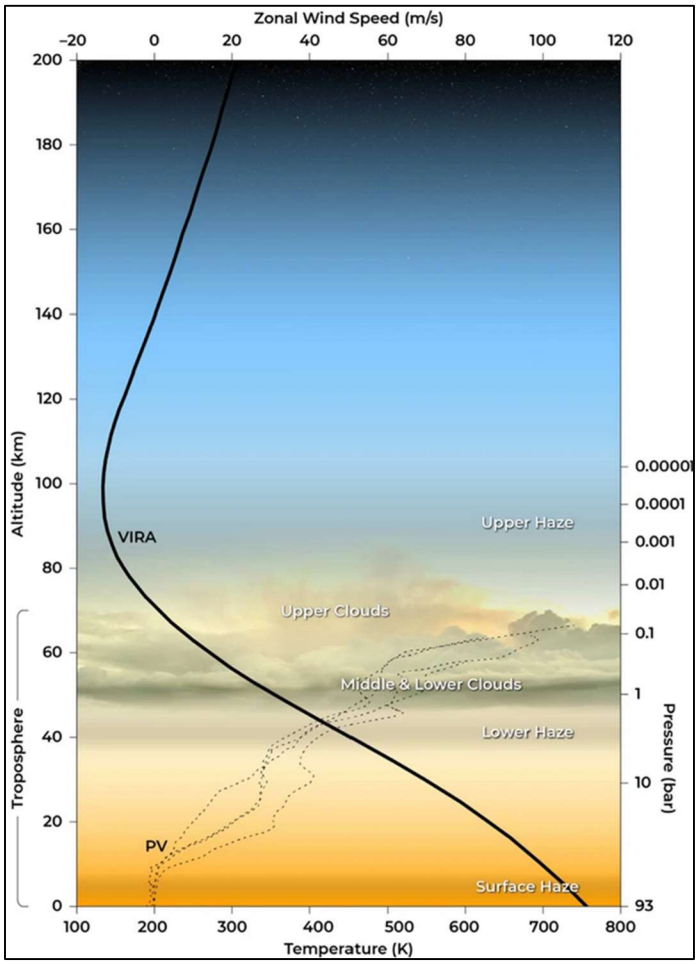
Phobos, the larger of Mars' two moons was recently captured by the European Space Agency's Mars Express spacecraft against the planet's bright limb.

Phobos was discovered on August 17, 1877 by Asaph Hall, an American astronomer at the U.S. Naval Observatory in Washington, D.C. He also discovered Mars' other moon, Deimos in the same year and named them after the mythological sons of Ares, the Greek counterpart of the Roman god, Mars. Phobos, 17 by14 by11 miles (27 by 22 by 18 km) orbits the planet three times a day and is on a collision course with the Red Planet (in 50 million years or so).

The Mars Express spacecraft began science operation in 2004 after arriving in December 2003. Over the past twenty years, the spacecraft has mapped the chemical composition of the planet's atmosphere, charted geologic activity, searched for water, volcanism and minerals.

Also visible in the image is Olympus Mons, the largest volcano in our solar system. The base of the volcano covers an area equivalent to the state of Arizona while its peak rises above the top of the Martian atmosphere. The volcano is believed to have been dormant for the past 25 million years.

Venus Cloud Life Debate Rages On



Venus from Mariner 10
Credit: NASA/JPL-Caltech

Equatorial temperature profile (black curved line)
Source: O'Rourke, J.G., Wilson, C.F., Borrelli, M.E. et al. Venus, the Planet: Introduction to the Evolution of Earth's Sister Planet. Space Sci Rev 219, 10 (2023)

The surface of Earth's "sister" planet is hellish with an average surface temperature of 870°F (465°C) and a surface pressure over 90 times that of Earth at sea-level. Forty years ago, a Soviet probe survived on the surface for 127 minutes, a record that still stands today.

Thirty miles up (about 50 km) from the surface, however, temperatures range from 86° to 158°F (30° to 70°C) and the atmospheric pressure is similar to that found on Earth's surface. In this zone, "extremophile" microbes could exist, assuming that they could tolerate the high sulfuric acid content in the clouds.

Four years ago, the discovery of phosphine in the clouds elicited excitement as well as skepticism that the compound might be an indicator of life in the carbon dioxide atmosphere of Venus. Since then, astronomers have been monitoring the atmosphere as part of the East Asian Observatory's James Clerk Maxwell-Venus program. Data gathered over multiple campaigns have not only confirmed the presence of phosphine in Venus's atmosphere once again, but also ammonia deeper down in the clouds.

The compounds identified are not only unexpected, but are short-lived, so their synthesis must be ongoing. While life may be involved in the production, researchers caution that there's also the possibility that they are being produced by a yet-unknown chemical process. Future missions being planned by NASA and ESA may provide an answer.

Morning Star

While we may have to wait until the next decade for NASA's and ESA's flagship missions to visit Venus, a private initiative may return more immediate results. The Venus Life Finder (VLF) missions are a series of Venus atmosphere probes that can be launched quickly and at relatively low cost. The astrobiology missions are designed to assess the habitability of the Venusian clouds and to search for signs of life.

The VLF concept evolved from a MIT-led study, which was partially funded by Breakthrough Initiatives. For the first mission, scheduled to launch in 2025, Rocket Lab is partnering with the MIT-led science team to deliver a small atmospheric probe (weighing about 44 pounds or 20 kg) to Venus with its Photon spacecraft. The probe will spend about 3 minutes in the Venus cloud layers at an altitude of 30-37 miles (48-60 km). It will carry an Autofluorescence Nephelometer (AFN) to search for organic material in the clouds and characterize the cloud particles.

The AutoFluorescence Nephelometer, weighing about 2.5 pounds (1 kg), is being developed by Droplet Measurement Technologies. The instrument will be able to detect and derive particle size and number density, derive complex reflective index, quantify asphericity of particles, and detect fluorescence from particles.

In 2026, the first in a series of missions to determine the ability of the Venus cloud decks to support life and search for signs of life will be launched. The first habitability mission will employ a parachute to carry an instrument suite through to cloud deck to measure particle acidity, water content, and the presence of metals and nonvolatile elements. Biosignatures, e.g., via gas detection and organic material, will also be part of the search criteria. Later missions will include balloons. Multifaceted instrumentation, including a mass spectrometer, carried by the ballon will conduct a search for complex organic molecules in the clouds.

The climax of the MIT initiative is an atmospheric sample return mission. As proposed, a balloon platform would be used to collect samples from the cloud layer. The samples would be delivered to orbit by a small rocket where they would be transferred to an Earth-return vehicle.

Evidence suggests that Venus may have been much different in the past (billions of years ago), with shallow oceans and tolerable temperatures. With a surface that's currently inhospitable, these missions may provide an answer to the question – if life did evolve on the surface, did it move to the clouds as the temperature and pressure increased?

Spacewalking History

Forty years ago, Dr. Kathryn Sullivan became the first American women to perform a spacewalk. Wearing a Shuttle-era spacesuit and Extravehicular Mobility Unit, Sullivan, a veteran of three shuttle missions, spent 3-½ hours working outside in the payload bay of the shuttle Challenger, 140 miles (225 km) above the Earth. After leaving NASA, she would go on to serve as the administrator of the National Oceanic and Atmospheric Administration, and, in 2020, became the first women to reach the deepest point on Earth, diving down to the bottom of the Mariana Trench in a submersible.

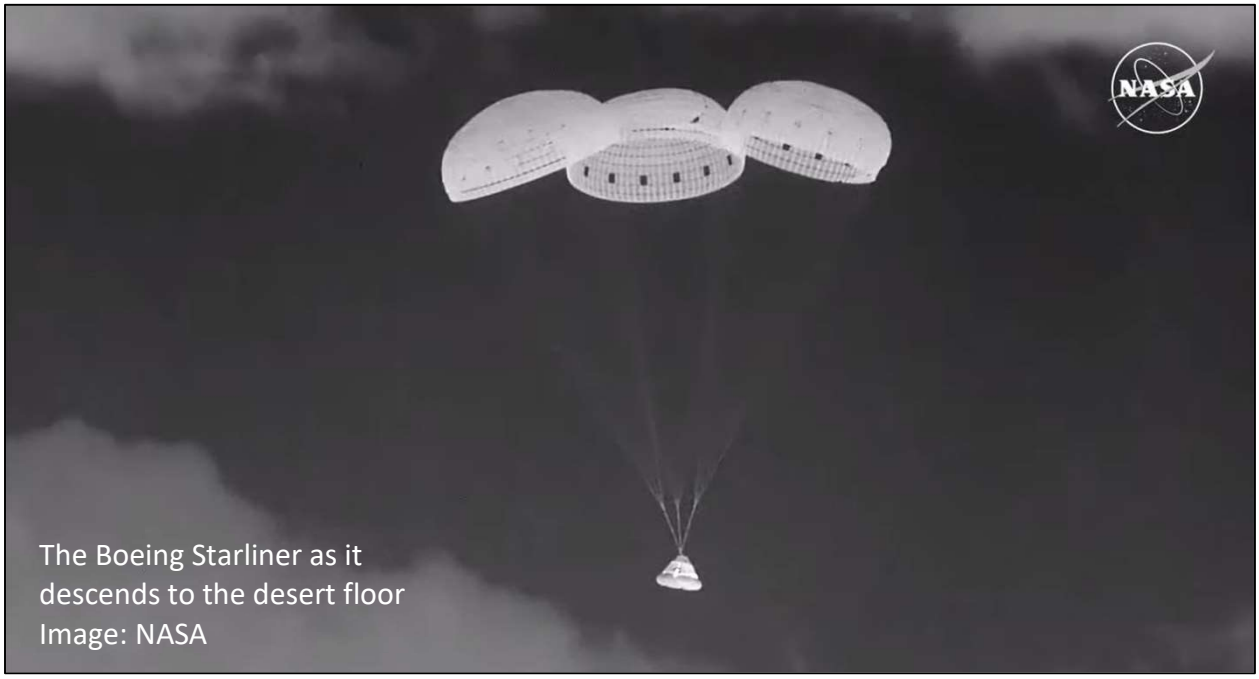
Forty years after Sullivan, Sarah Gillis participated in the first privately-financed spacewalk when she ventured outside the hatch of a SpaceX Dragon spacecraft. While she, and Jared Isaacman, remained tethered to the spacecraft and did not float free, the crew of the Polaris Dawn mission used their time in the vacuum of space to assess the performance and mobility of SpaceX's newly developed extravehicular activity spacesuit.

Polaris Dawn was the first of up to three spaceflights financed by Isaacman and are intended to demonstrate new technologies, conduct scientific research and gain additional insight into human adaptation to a microgravity environment. The first flight took the Dragon spacecraft higher than any other previous Dragon mission to date, reaching a peak altitude of 875 miles (1,408 km) above Earth and passing through portions of the inner Van Allen radiation belt. The orbit was lowered for the remainder of the five-day mission and for the spacewalk.

The second flight in the Polaris program is expected to also use a Crew Dragon spacecraft while planning for a third flight is currently considering SpaceX's Super Heavy-Starship rocket, which is still in development.

Home Alone

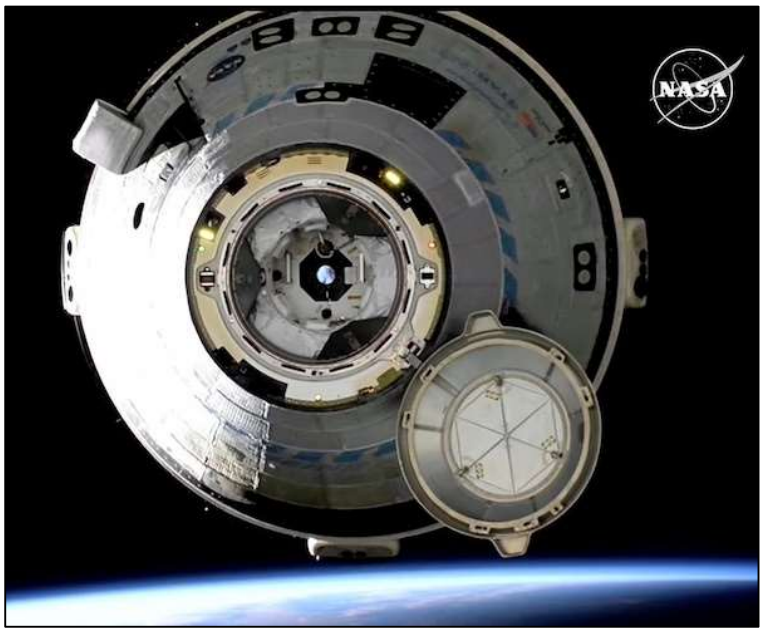
Boeing's Starliner returned to Earth on September 7 (12:01 a.m. EDT), touching down at White Sands Space Harbor in the New Mexico desert. The spacecraft had been launched from the Cape Canaveral Space Force Station on June 5th with a crew of two, Butch Wilmore and Sunita Williams, for a test flight to the International Space Station (ISS) that was originally anticipated to last about a week. However, the launch and docking sequence were encumbered by multiple helium leaks in the ship's propulsion pressurization system and overheating/premature shutdown of several control thrusters. Out of an abundance of caution, NASA elected to keep Wilmore and Williams on the ISS until another vehicle (a SpaceX Dragon) is available to bring them home, leaving the Starliner to return home empty.



The Boeing Starliner as it descends to the desert floor
Image: NASA

NASA has removed two of the crew members from the upcoming Crew 9 mission to free up seats for Wilmore and Williams to return in February 2025. The two experienced astronauts are taking the eight month delay in stride, helping out with tasks on the station.

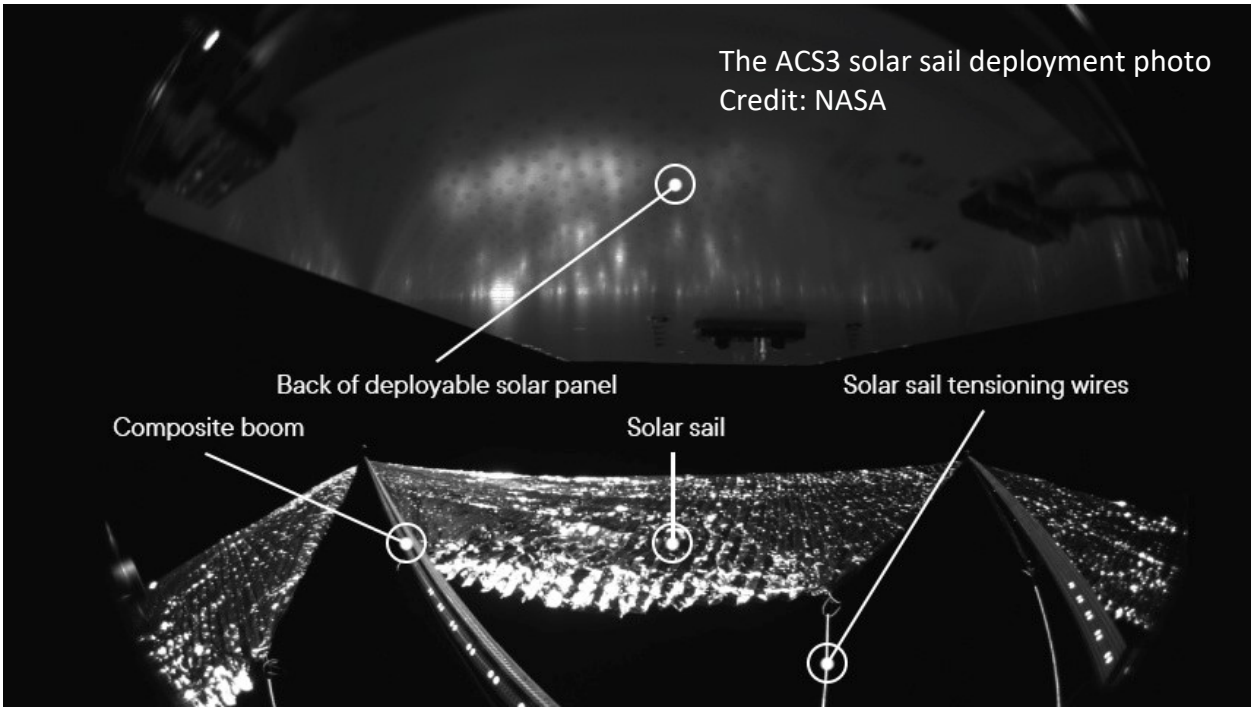
While the Starliner appeared to perform well on the return, it was not trouble-free, with a brief navigation system glitch during reentry and the failure of one of the control jets.



The Boeing Starliner moments after it undocked from the ISS
Image: NASA

Solar Sailing

NASA was finally able to unfurl its Advanced Composite Solar Sail System (ACS3) in late August. The ACS3 spacecraft had been launched earlier this year into a Sun-synchronous orbit about 600 miles (1,000 km) above Earth. The entire payload had been folded up to fit into a microwave-sized cubesat. Now fully-deployed, the sail has a surface area of about 860 square feet (80 square meters).



The sail is incredibility thin, 2.115 microns-thick (about 80 millionths of an inch), and comprised of a metallized polyethylene napthalate. Now exposed to the elements of space, NASA engineers will assess its integrity and performance as they use sunlight to perform a series of orbital maneuvers. While photons don't have mass, they do have momentum. The transfer of that momentum to the reflective side of the sail provides a small, but continuous push that can propel a spacecraft across the solar system without the traditional expenditure of chemical fuels.

Mariano Perez, quality assurance engineer at NASA Ames, inspects the ACS3 spacecraft before launch
Credit: NASA/Brandon Torres

Ring Crossing Ahead

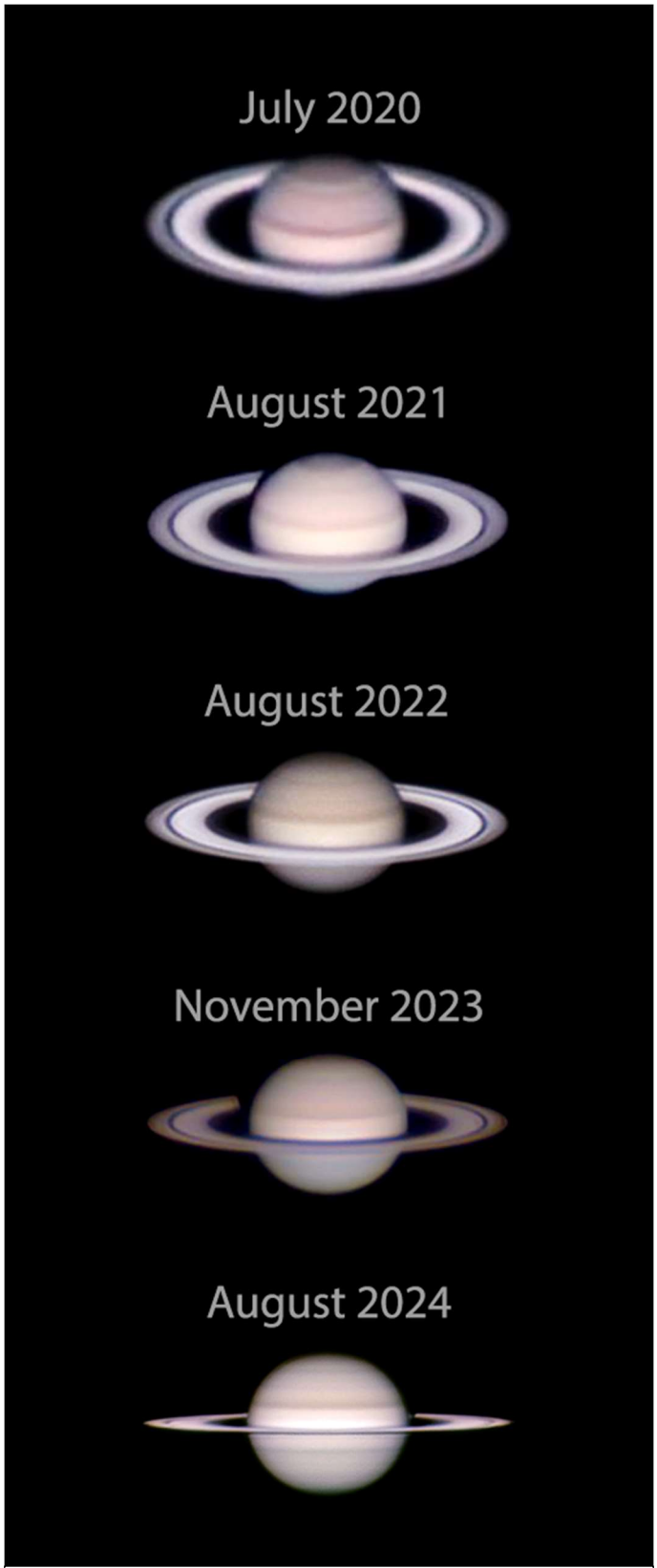
Saturn's rotation axis is tilted, much like Earth's, but with a slightly higher angle of 27° (Earth's tilt is 23.5°). Its ring system, being in the equatorial plane, is also inclined relative to the plane of the solar system and the Sun/Earth.

As Saturn move around the Sun our view of the rings change throughout the 29.5 year orbit. Summer in the northern hemisphere brings the north pole into view as well as the top side of the rings. As the autumnal equinox approaches, the rings become less visible, culminating in "ring crossing" when the Earth crosses the plane of Saturn's rings. At this time, the rings appear edge-on, effectively disappearing (since they are so thin).

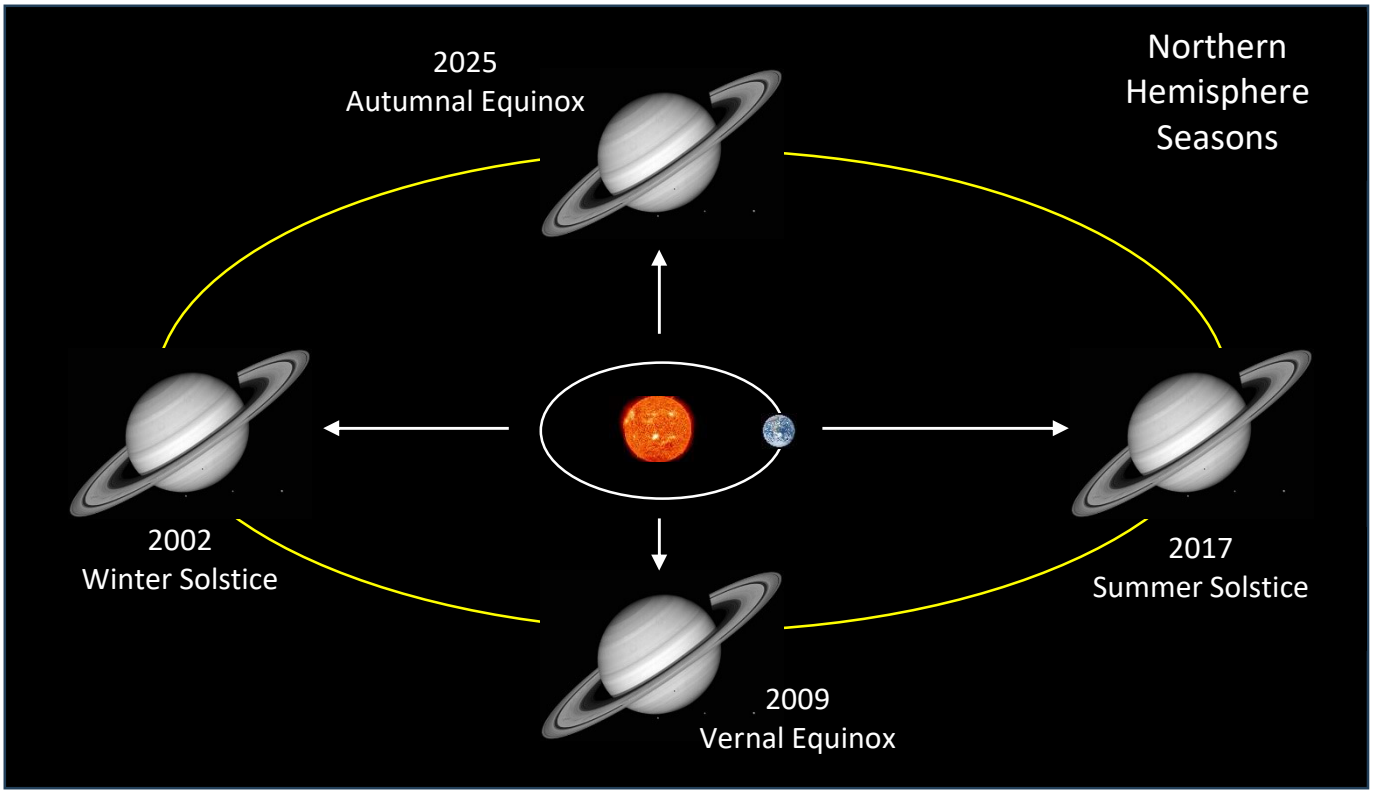
Ring plane crossings happens every 14-15 years (the last time on September 4, 2009). March 23, 2025 is the date of the next crossing, although it will not be observable from Earth (Saturn will be passing behind the Sun at that time).

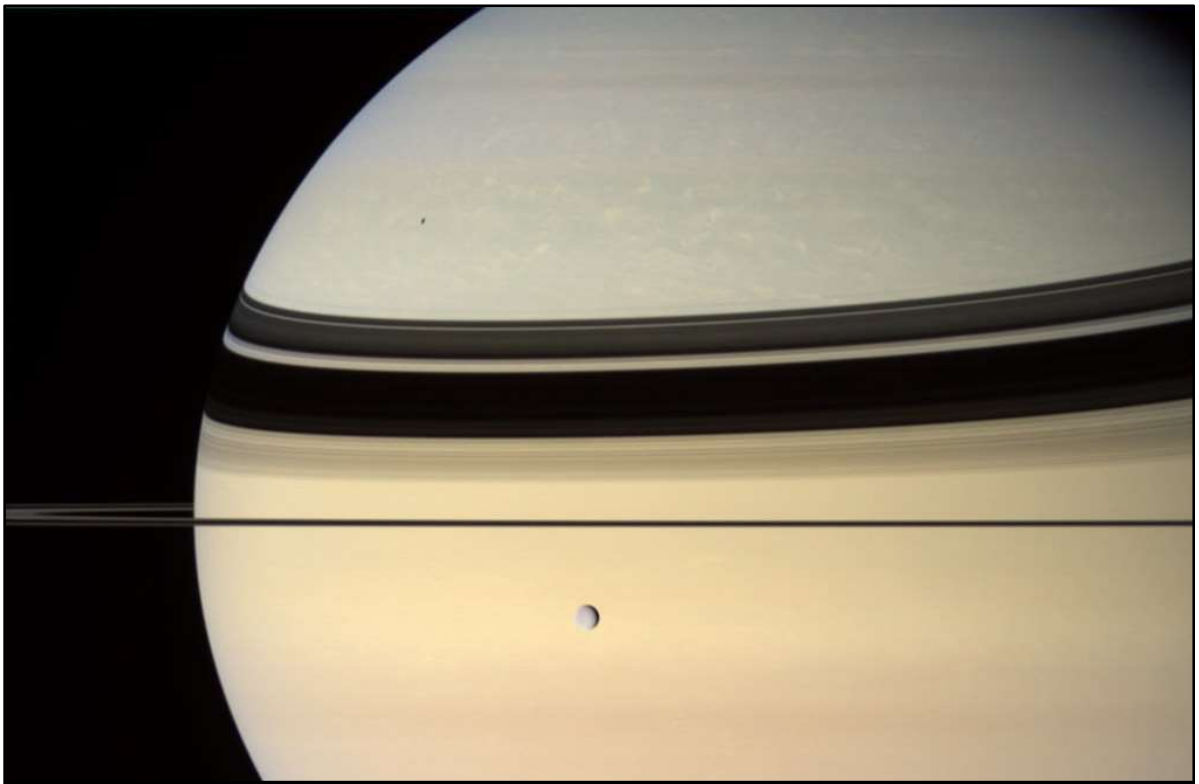
By the time Saturn reaches Opposition (closest approach) in September 2025, the rings will appear as a thin line (much like in 2024. Our view will continue to improve with each successive year revealing more of the underside to the rings and the planet's south pole. The progression will continue until 2032 when Saturn reaches its maximum tilt away from Earth.

While ring plane crossing deprives us of a view of Saturn's most majestic feature, the absence of its highly reflective, water-ice rings allows fainter objects in orbit around the planet, e.g., new moons, to be seen. Thirteen of Saturn's moons were discovered during ring-plane crossings from 1655 to 1980, including Telesto, Calypso and Helene in 1980.



Saturn's rings seen over the past five years
Photos provided by Marc Polansky





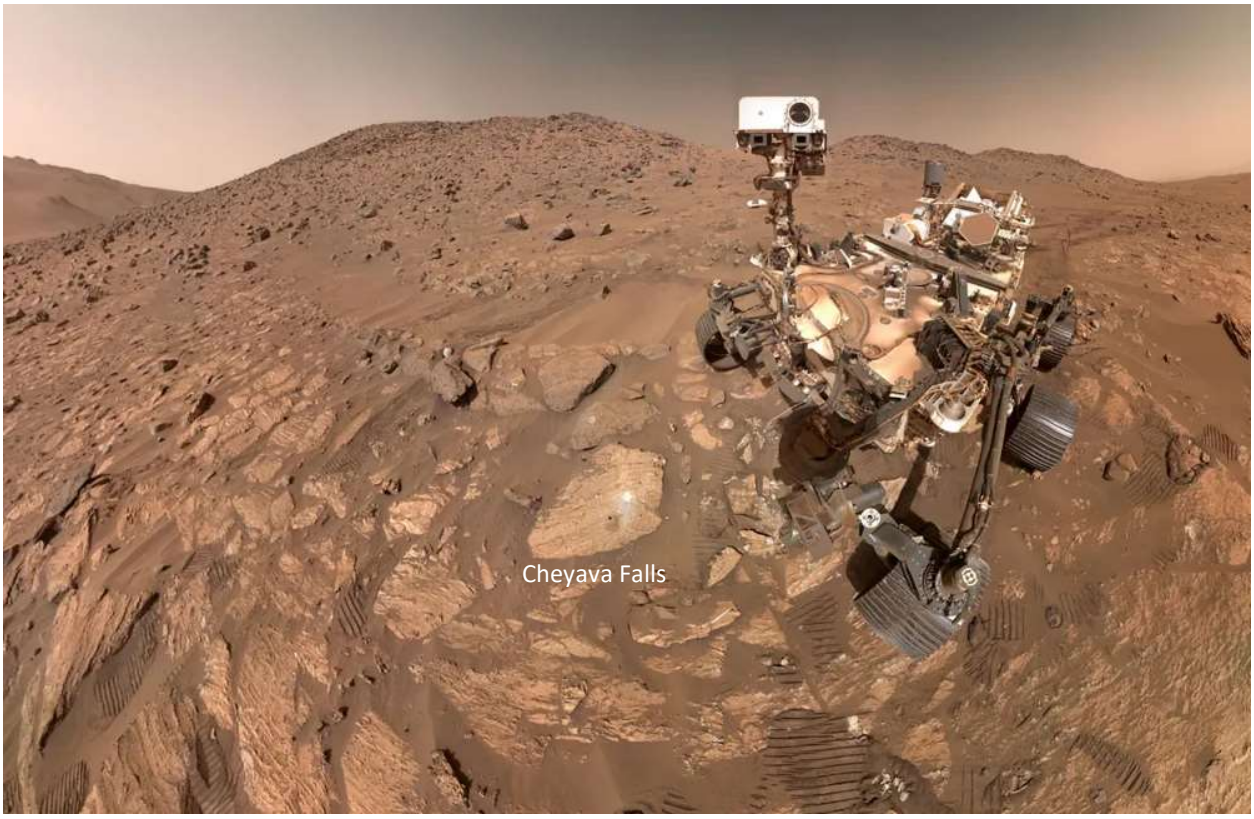
The Cassini spacecraft captured the moon Rhea, seen just below the rings (black line). The edge-on rings are casting shadows on Saturn's northern hemisphere.
Image via Cassini Imaging Team/ SSI/ ESA/ NASA-JPL

Crater Rim Campaign

NASA's Perseverance Mars rover set its wheels down in Jezero Crater in February 2021. For the past 3-½ Earth years, the highly instrumented, nuclear-powered rover has been searching, first on the floor of the crater and then up on the ancient river delta, for signs of past microbial life. Along the way it has collected 24 rock and soil samples which, someday, will be collected and returned to Earth for analysis.

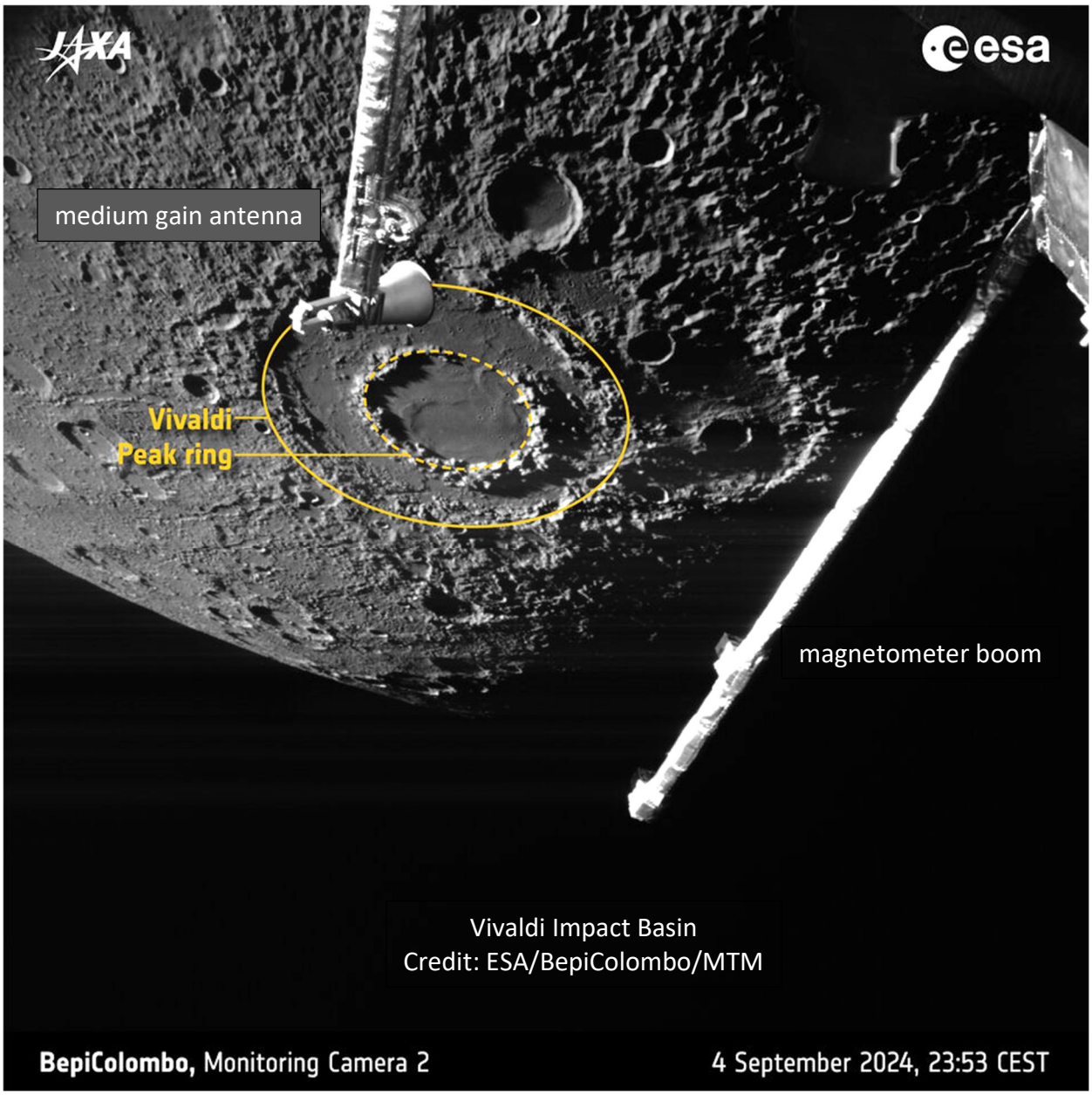
In August, Perseverance began its fifth science campaign of the mission – the "Crater Rim Campaign." The operation will take the rover, which recently completed its initial assessment of the top of the delta and ancient river bed, on its steepest climb up the western rim of the Jezero Crater. Along the route to the top of the crater rim, Perseverance will have to navigate slopes as steep as 23° and an elevation gain of almost 1,000 feet (300 meters).

The science team has already identified two areas for study on the rim, named "Pico Turquino" and "Witch Hazel Hill." The fractured surface seen from orbit suggest past hydrothermal activity at Pico Turquino while the lighter colored, layered rock at Witch Hazel Hill is likely from a different era when the climate was much different.



NASA's Perseverance rover took this selfie after collecting a rock core from a very unusual arrowhead-shaped rock nicknamed "Cheyava Falls." The rock has long, white veins of calcium sulfate, a mineral likely deposited by flowing water, ringed spots containing both iron and phosphate indicative of a chemical reaction with hematite, and the presence of organic compounds. The presence of all three features in one rock sample make a strong case for life. Credit: NASA/JPL-Caltech/MSSS

BepiColombo – A Surprisingly Close Encounter



An anomaly with the ESA/JAXA BepiColombo spacecraft's thrusters during its fourth Mercury flyby resulted in a much closer view of the planet than intended. The September 4th flyby (the 4th of 6 gravitational maneuvers at Mercury to slow the spacecraft and allow it to be captured by the planet's gravity) came within 103 miles (165 km) of the battered surface. The encounter provided an unexpected opportunity for the project team to test the spacecraft's instruments at close range. Mercury's features, like the Vivaldi impact basin, were captured by one of the Mercury Transfer Module's monitoring cameras or M-CAMSs. The black and white cameras were designed to monitor deployment of the spacecraft's solar array, antenna and magnetometer boom after launch.

The near-miss (22 miles or 35 km closer than intended) adversely altered the spacecraft trajectory, which will delay orbit insertion by 11 months. BepiColombo is now expected to enter orbit around Mercury in November 2026.

Solar Cycle 23 Revisited

Photo: Bill Cloutier

The Halloween Solar superstorms that occurred in late October and early November of 2003 were unusually energetic, especially since they occurred several years after solar maximum, when solar activity was on the decline. The storms (producing 17 major flares) affected over half of the Earth-orbiting spacecraft, destroyed the Martian Radiation Environment Experiment aboard NASA's Mars Odyssey spacecraft, and required space station astronauts to take shelter.

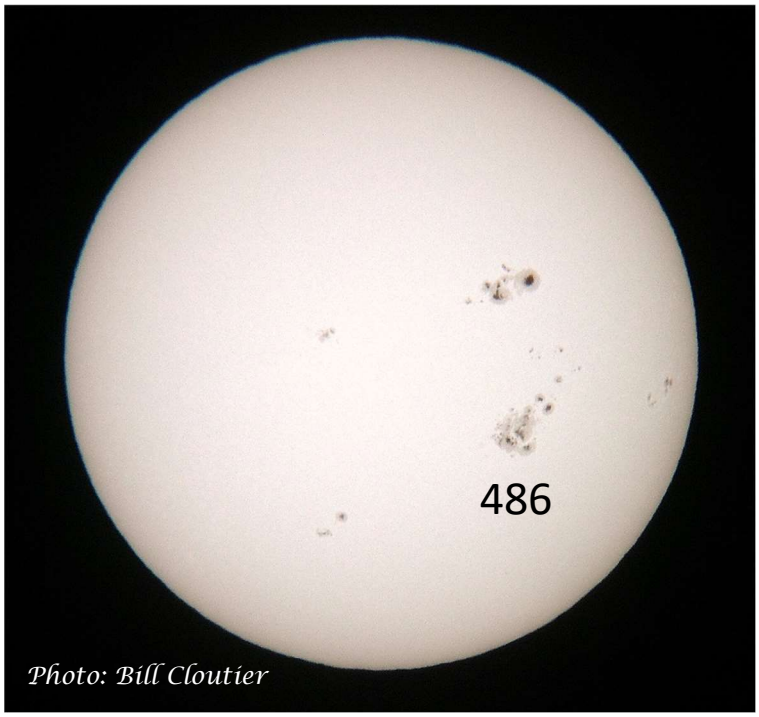
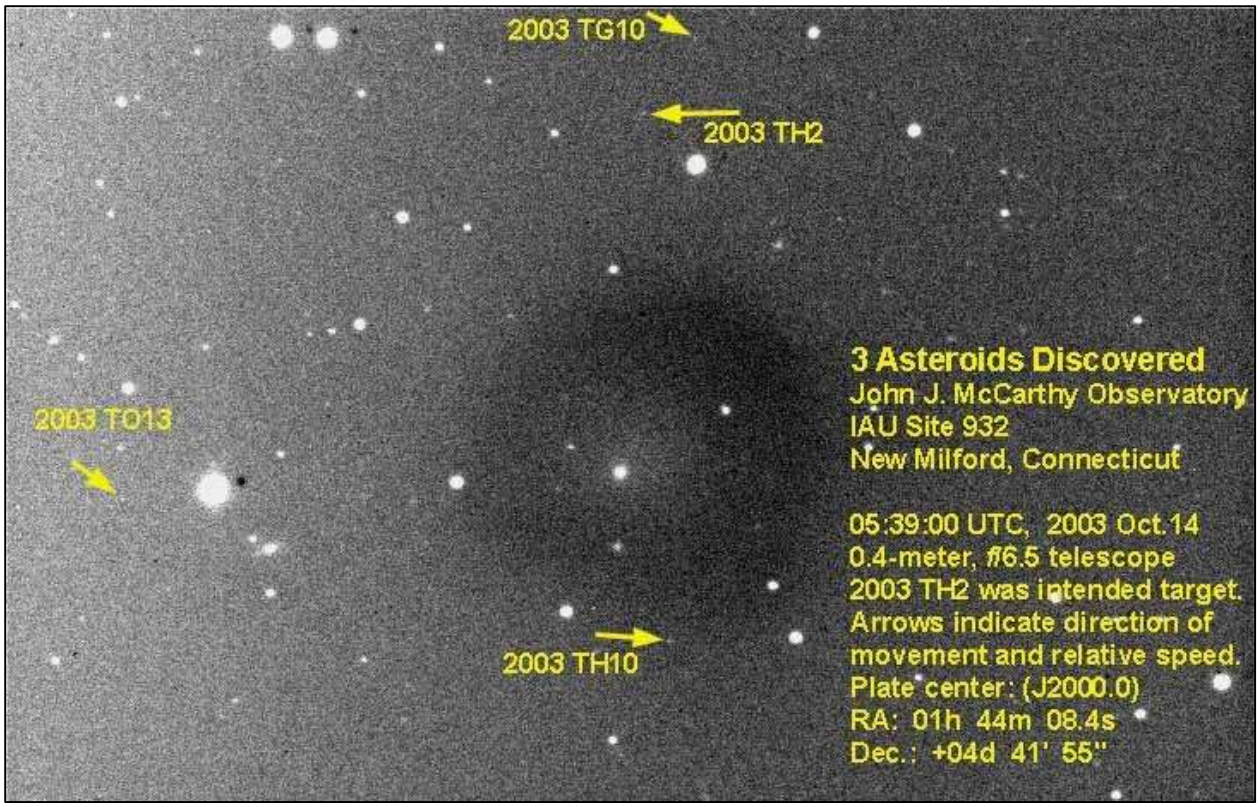


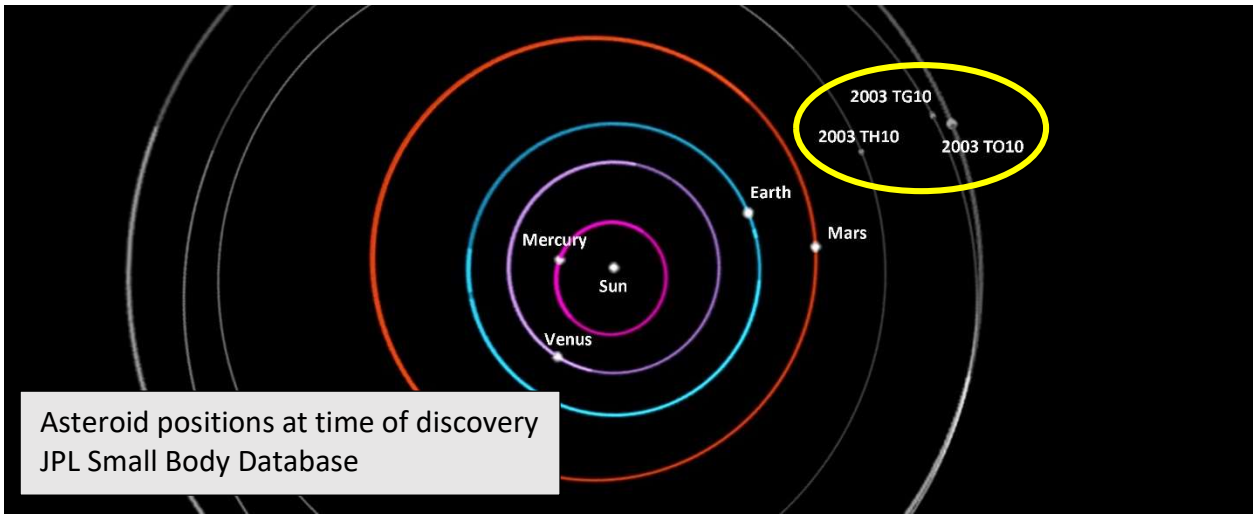
Photo: Bill Cloutier

An eruption of superheated gas (plasma) associated with sunspot complex 486 on October 29th produced spectacular aurora in the autumn sky around New Milford on the 30th. It was one of the largest flares recorded in recent history.

McCarthy Observatory History



In the early morning hours of October 14, 2003, after making urgently needed observations of a newly discovered potentially hazardous asteroid (2003 TH2), the Director of the McCarthy Observatory, Monty Robson, discovered three other asteroids in the same field of view. The asteroids were given the provisional designations of 2003 TG10, TH10 and TO13 by the International Astronomical Union's Minor Planet Center and determined to be main asteroid belt objects (located between the planets Mars and Jupiter). At the time of discovery, they had an apparent brightness of about 18th magnitude; or more than 60,000 times fainter than the dimmest object that can be seen by the unaided eye under ideal conditions. With additional observations came the right to name the space rocks – 115449 Robson (TG10), 253587 Cloutier (TH10) and 271216 Boblambert (TO13) after three members of the Observatory's founding team.



Space Race History

On October 11, 1968, a Saturn 1-B rocket carried Apollo 7, the first manned Apollo command and service module, into low-Earth orbit. The test flight would last almost 11 days and complete 163 orbits of the Earth. Walter Schirra (5th American in space when he flew the Mercury-Atlas 8 mission on October 3, 1962), commanded the crew along with command module pilot Donn Eisele and lunar module pilot Walter Cunningham.

The Block II command module was a redesigned and much improved version of the Block I model that was involved in the Apollo 1 accident. The two-piece, inward opening and bolted hatch on the Block I model was replaced with a one-piece, outward opening, quick release hatch on the Block II module. The 100% oxygen atmosphere used in the Block I module was also replaced with a less flammable 60% oxygen and 40% nitrogen mixture at launch. The air in the Block II module was purged and converted to 100% oxygen as the flight progressed.

Apollo 7 did not carry a lunar lander; however, a simulated docking with the third stage was planned (the lunar lander would be carried within the third stage in future flights). Schirra canceled the docking maneuvers when one of the adapter panels on the third stage did not fully deploy (the panels were jettisoned with explosive charges on future flights to avoid such a reoccurrence since access to the lunar module was vital to a lunar mission).

There were relatively few problems with the spacecraft and most were resolved before Apollo 8 made its historic trip to the Moon in the following December. The service module's main engine,

which was required to enter into and leave lunar orbit performed flawlessly, restarting eight times during the mission. The overall performance of the Apollo 7 command and service module was a significant factor in NASA's decision to send Apollo 8 to the Moon after only one low-Earth test flight.

October Nights

As the nights grow longer and cooler our view of the night sky begins to change. Summer evenings showcase our own galaxy, the Milky Way. The center of our spiral galaxy is in the direction of the constellation Sagittarius, which appears in the southern sky throughout the summer. In the autumn, as Sagittarius disappears into the west, the stars forming the Great Square of Pegasus rise in the east. Following Pegasus is the Andromeda Galaxy, one of the most distant objects that can be seen with the unaided eye at approximately 2.5 million light years (14.7 million trillion miles). With the rising of Andromeda, we begin to look outward to the outer arms of our own galaxy and to other galaxies far, far away.

Sunrise and Sunset (from New Milford, CT)

Sun	Sunrise	Sunset
October 1st (EDT)	06:51	18:34
October 15th	07:06	18:11
October 31st	07:24	17:48

Astronomical and Historical Events

1st Comet Tsuchinshan-ATLAS visible just above eastern horizon with crescent Moon
1st History: launch of Chang'e 2 – China's Moon Orbiter (2010)
1st History: NASA created by the National Aeronautics and Space Act (1958)
2nd New Moon
2nd Moon at apogee (furthest distance from Earth in its orbit)
2nd History: First flyby of Mercury by the BepiColombo spacecraft (2021
2nd History: opening of the Hayden Planetarium (1935)
3rd History: launch of the fifth Mercury flight, piloted by astronaut Walter Schirra (1962)
3rd History: fall of the Zagami Martian meteorite in Katsina Province, Nigeria; the meteorite is classified as a Shergottite and is the largest single individual Mars meteorite ever found at 40 pounds (1962)
3rd History: first successful test launch of the German A-4 rocket (V-2) (1942)
3rd History: fall of the Chassigny Martian meteorite in Haute-Marne province, France; the meteorite is distinctly different from other Martian meteorites (shergottites and nakhilites) and is classified as its own subgroup – "chassignites" (1815)
4th History: Japanese lunar probe "Selenological and Engineering Explorer" (SELENE) enters lunar orbit; also known as Kaguya, the spacecraft was designed to study the geologic evolution of the Moon (2007)
4th History: SpaceShipOne rockets to an altitude of almost 70 miles to win the $10 million Ansari X Prize (2004)
4th History: launch of Luna 3; Soviet spacecraft was first to photograph the far side of the Moon (1959)

Astronomical and Historical Events (continued)

4th History: launch of Sputnik 1, world's first artificial satellite (1957)
5th Closest approach of Apollo class asteroid and Near-Earth Object (NEO) 2023 GM1
5th Closest approach of Amor class asteroid and NEO 2014 VA
5th History: Edwin Hubble's discovery of Cepheid Variable Star V1, a special class of variables that can be used measure large cosmic distances (1923)
5th History: launch of the space shuttle Challenger (STS-41-G), crew included astronaut Kathryn Sullivan, first American women to walk in space (1984)
5th History: Robert Goddard born, founding father of modern rocketry (1882)
6th Closest approach of Apollo class asteroid and NEO 2022 SU21
6th Closest approach of Apollo class asteroid and NEO 671076 (2014 FP47)
6th History: Asteroid 2008 TC3 discovered by astronomers on Mt. Lemmon less than 24 hours before exploding over the Sudan. The McCarthy Observatory submitted one of the last accepted observations. Meteorites from the fall were eventually recovered. (2008)
6th History: launch of the space shuttle Discovery and the solar polar orbiter spacecraft Ulysses (1990)
8th Closest approach of Apollo class asteroid and NEO 2016 JG38
9th Closest approach of Apollo class asteroid and NEO 2018 QE
9th Draconids Meteor Shower peak (produced by debris from Comet Giacobini-Zinner)
9th History: LCROSS impacts crater Cabeus near the Moon's south pole in search of water (2009)
9th History: Peekskill meteorite fall; 27-pound meteorite hits a 1980 Chevy Malibu sitting in its driveway in Peekskill, NY (1992)
9th History: discovery of Supernova 1604 (Kepler's Nova) (1604)
10th First Quarter Moon
10th Tentative launch of NASA's Europa Clipper from the Kennedy Space Center aboard a SpaceX Falcon Heavy
10th History: inauguration of the Very Large Array, one of the world's premier astronomical radio observatories; located west of Socorro, New Mexico (1980)
10th History: enactment of the Outer Space Treaty: 1) prohibited placement of nuclear and other weapons of mass destruction in orbit, on the Moon or other celestial body and 2) limited the use of the Moon and other celestial bodies to peaceful purposes (1967)
10th History: discovery of Neptune's moon *Triton* by William Lassell (1846)
11th Closest approach of Aten class asteroid, NEO and Potentially Hazardous Asteroid (PHA) 363027 (1998 ST27)
11th History: NASA's historic 100th space shuttle flight as Discovery carries the Z1 Truss (first piece of the ISS structural backbone) into space (2000)
11th History: Magellan spacecraft burns up in the Venusian atmosphere after completing its mission to map the planet with its imaging radar (1994)
11th History: launch of first manned Apollo mission (Apollo 7) with astronauts Schirra, Eisele and Cunningham (1968)
11th History: launch of WAC Corporal, first man-made object (16-foot rocket) to escape Earth's atmosphere (1945)
12th **Second Saturday Stars at the McCarthy Observatory** (starting at 7:00 p.m.)
12th Closest approach of Apollo class asteroid and NEO 2008 UU95
12th Comet Tsuchinshan-ATLAS enters the evening sky

Astronomical and Historical Events (continued)

12th History: launch of Voskhod 1; Soviet spacecraft was first to carry multiple (3) cosmonauts (a pilot, scientist and physician) into space. Due to the cramped conditions the crew flew without spacesuits, ejection seats, or an escape tower (1964)
12th History: first Symposium on Space Flight held at the Hayden Planetarium in New York City; participants included Wernher von Braun, Willy Ley, and Fred L. Whipple; topics included an orbiting astronomical observatory, survival in space, circumlunar flight, a manned orbiting space station, and the question of sovereignty in outer space (1951)
13th History: launch of the Psyche spacecraft from the Kennedy Space Center to the metallic asteroid Psyche, where it will enter orbit in 2029 (2023)
13th History: launch of Shenzhou 6, China's second manned spacecraft (2005)
13th History: launch of Explorer 7; spacecraft measured solar X-rays, energetic particles, and cosmic rays (1959)
13th History: formation of the British Interplanetary Society by Phillip Cleator in Liverpool (1933)
14th Closest approach of Apollo class asteroid and NEO 2021 TK11
14th History: three main belt asteroids discovered by the McCarthy Observatory while searching for NEOs. 2003 TG10 (its provisional name) was subsequently named after Monty Robson (115449 Robson), the founder and director of the observatory (2003)
14th History: launch of Shenzhou 5, first Chinese manned spacecraft (2003)
14th History: Air Force Captain Chuck Yeager breaks the sound barrier in the Bell X-1 rocket plane (called "Glamorous Glennis" as a tribute to his wife). The plane reached a speed of 700 miles per hour after being launched from the bomb bay of a Boeing B-29 (1947)
15th Closest approach of Apollo class asteroid and NEO 2022 TB41
15th History: Interstellar Object 1I/2017 U1 (*'Oumuamua*) closest approach to Earth (0.162 AU) (2017)
15th History: launch of the Cassini spacecraft to the planet Saturn (1997)
16th Moon at perigee (closest distance to Earth in its orbit)
16th History: launch of the Lucy spacecraft on 12-year mission and a flyby of seven Trojan asteroids that orbit the Sun in front of and behind Jupiter (2021)
16th History: launch of GOES 1, first weather satellite placed in geosynchronous orbit (1975)
17th Full Moon (Hunter Moon)
17th Closest approach of Apollo class asteroid and NEO 2019 UH14
18th History: launch of the space shuttle Atlantis (STS-34) and Galileo spacecraft to Jupiter (1989)
18th History: discovery of *Chiron* by Charles Kowal; *Chiron* has the characteristics of both a comet and an asteroid. These types of objects are called Centaurs after a mythological being that are half human/half horse (1977)
18th History: Soviet spacecraft Venera 4 enters the atmosphere of Venus; first probe to analyze the environment (in-situ) of another planet (1967)
18th History: discovery of Asteroid *8 Flora* by John Hind (1847)
19th History: launch of the BepiColombo spacecraft (Mercury orbiters) from the Kourou launch facility in French Guiana. BepiColombo is on a seven-year journey to Mercury carrying orbiters from the European Space Agency and the Japan Aerospace Exploration Agency (2018)
19th History: launch of the IBEX (Interstellar Boundary Explorer) (2008)
19th History: flyby of the planet Venus by the Mariner 5 spacecraft (1967)

Astronomical and Historical Events (continued)

19th History: Subrahmanyan Chandrasekhar born; awarded Nobel Prize in Physics (1983) for studies of the structure and evolution of stars; NASA named its premier X-ray observatory the Chandra X-ray telescope in his honor (1910)
20th History: launch of the Soviet spacecraft Zond 8; moon flyby mission (1970)
20th History: discovery of asteroid *577 Rhea* by Max Wolf (1905)
21st Orionids Meteor Shower peak (produced by debris from Comet Halley)
21st History: NASA's Mars Atmosphere and Volatile Evolution (MAVEN) spacecraft successfully entered orbit around Mars - first spacecraft dedicated to studying the Martian atmosphere and its connection to the Red Planet's climate (2014)
21st History: dedication of the Yerkes Observatory in Williams Bay, Wisconsin; home of the world's largest refractor with its 40-inch objective lens ground and polished by Alvan Clark and Sons (1897)
22nd History: launch of Chandrayaan-1, India's first mission to the Moon (2008)
22nd History: Soviet spacecraft Venera 9 touches down on Venus and transmits first pictures (black and white) of its surface (1975)
22nd History: launch of the Soviet Moon orbiter Luna 12 to take high-resolution photos of the Moon's surface from lunar orbit (1966)
23rd History: India's Mars Orbiter Mission (MOM) entered orbit around Mars (2014)
23rd History: first time female commanders led orbital missions at the same time: Pamela Melroy commanded space shuttle Discovery (STS-120) to the ISS while Peggy Whitson led the Expedition 16 team aboard the ISS in the installation of a new orbital node (2007)
24th Last Quarter Moon
24th Closest approach of Apollo class asteroid and NEO 2015 HM1
24th Closest approach of Apollo class asteroid, NEO and PHA 363305 (2002 NV16)
24th Closest approach of Apollo class asteroid and NEO 2021 UE2
24th Closest approach of Aten class asteroid and NEO 2023 TG14
24th History: launch of Chang'e-1, Chinese lunar orbiter, from the Xichang Satellite Launch Center in the southwestern province of Sichuan (2007)
24th History: Mars Odyssey enters orbit around Mars (2001); science goals included mapping the elemental composition of the surface
24th History: launch of Deep Space 1; first of a series of technology demonstration probes developed by NASA's New Millennium Program; propulsion was provided by a xenon ion engine that operated for a total of 16,265 hours (1998)
24th History: discovery of Saturn's moon Prometheus by Stewart Collins in photos taken by the Voyager 1 probe (1980)
24th History: Over 100 people killed in a launch pad explosion when Air Marshal Mitrofan Nedelin, commander of the USSR's Strategic Rocket Forces, orders workers back to the pad to repair a defective R-16 missile without first unloading the unstable fuel (1960)
24th History: discovery of Uranus' moons *Umbriel* and *Ariel* by William Lassell (1851)
25th History: launch of the twin Solar Terrestrial Relations Observatories (STEREO A and B); 3-D studies of the Sun and coronal mass ejections (2006)
25th History: Soviet spacecraft Venera 10 touches down on Venus 2,200 km from its twin Venera 9; lands on a flat boulder that was determined to be similar in composition to basalt on Earth (1975)
25th History: discovery of Saturn's moon *Iapetus* by Giovanni Cassini (1671)
26th Closest approach of Aten class asteroid and NEO 2007 UT3

Astronomical and Historical Events (continued)

27th History: first test flight of the Saturn I rocket (1961)
28th Closest approach of Apollo class asteroid, NEO and PHA 2020 WG)
28th History: Karl Reinmuth's discovery of Apollo asteroid *69230 Hermes* (1937)
28th History: first (and last) test flight of the Ares I-X rocket; a two-minute powered suborbital flight (2009)
28th History: launch of Prospero spacecraft, Great Britain's first space launch (1971)
29th Moon at apogee (furthest distance from Earth in its orbit)
29th History: launch of the space shuttle Discovery (STS-95) with astronaut and then U.S. Senator, John Glenn (1998)
29th History: flyby of asteroid *Gaspra* by the Galileo spacecraft on mission to Jupiter (1991)
30th Closest approach of Apollo class asteroid and NEO 2021 CV1
30th History: discovery of the Los Angeles (Mars) Meteorite (1999)
30th History: launch of Venera 13, Soviet Venus lander; lander survived for 127 minutes on the surface where the temperature was recorded at 855 °F (1981)
30th History: Mercury Theatre broadcasts Orson Welles' adaptation of H.G. Wells "War of the Worlds" (1938)
31st Closest approach of Aten class asteroid and NEO 2023 KX3
31st Closest approach of Apollo class asteroid and NEO 2022 UD21
31st History: Walter Baade's discovery of the first Centaur Object, 944 Hidalgo (1920)
31st History: birthday of Apollo 11 Command Module pilot Michael Collins (1930)
31st History: first rocket engine tests by three young rocketeers that would be the beginning of what would become the Jet Propulsion Laboratory (1936)

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

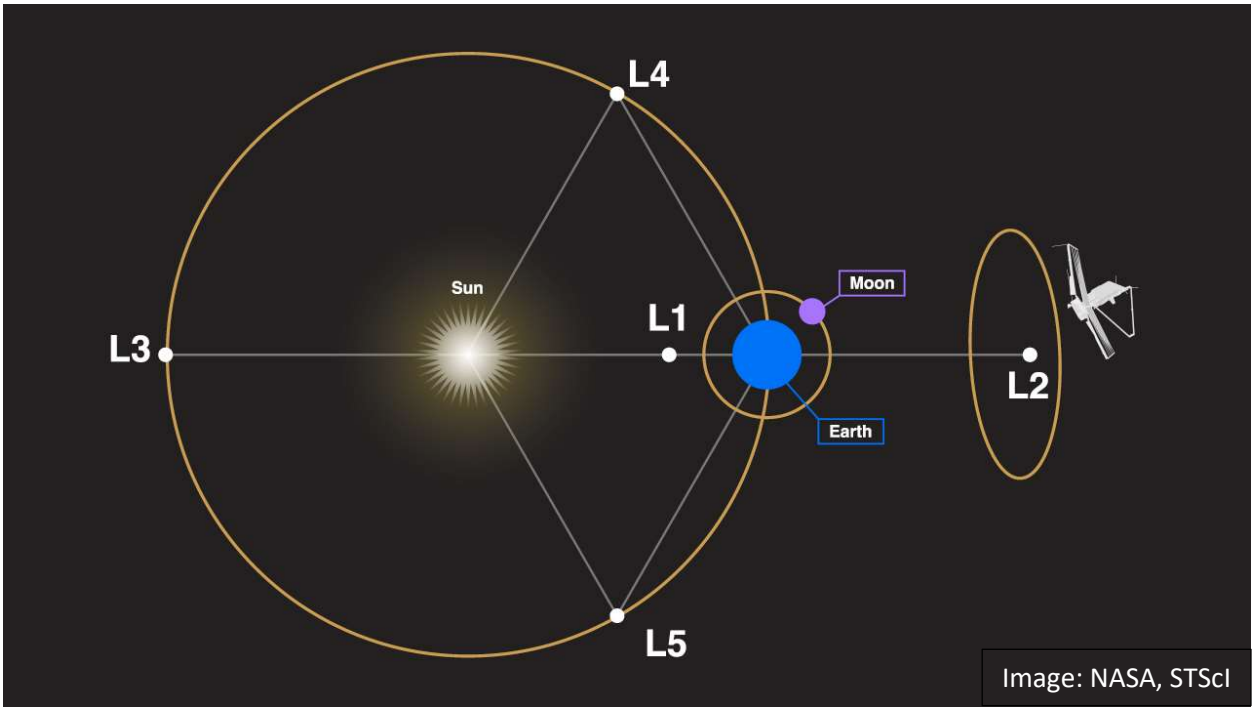
Visit www.heavens-above.com for the times of visibility and detailed star charts for viewing the International Space Station and other man-made objects in low-Earth orbit.

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.

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 James Webb, Gaia and Euclid telescopes) is located 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

Gaia Star Surveyor
https://www.esa.int/Science_Exploration/Space_Science/Gaia

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 Science Laboratory (Curiosity rover): https://mars.nasa.gov/msl/home/
- Mars Atmosphere and Volatile EvolutioN (MAVEN): https://science.nasa.gov/mission/maven/

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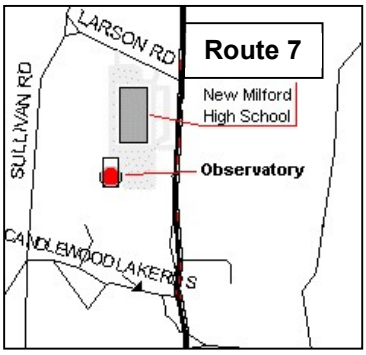

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