Galactic Observer

John J. McCarthy Observatory

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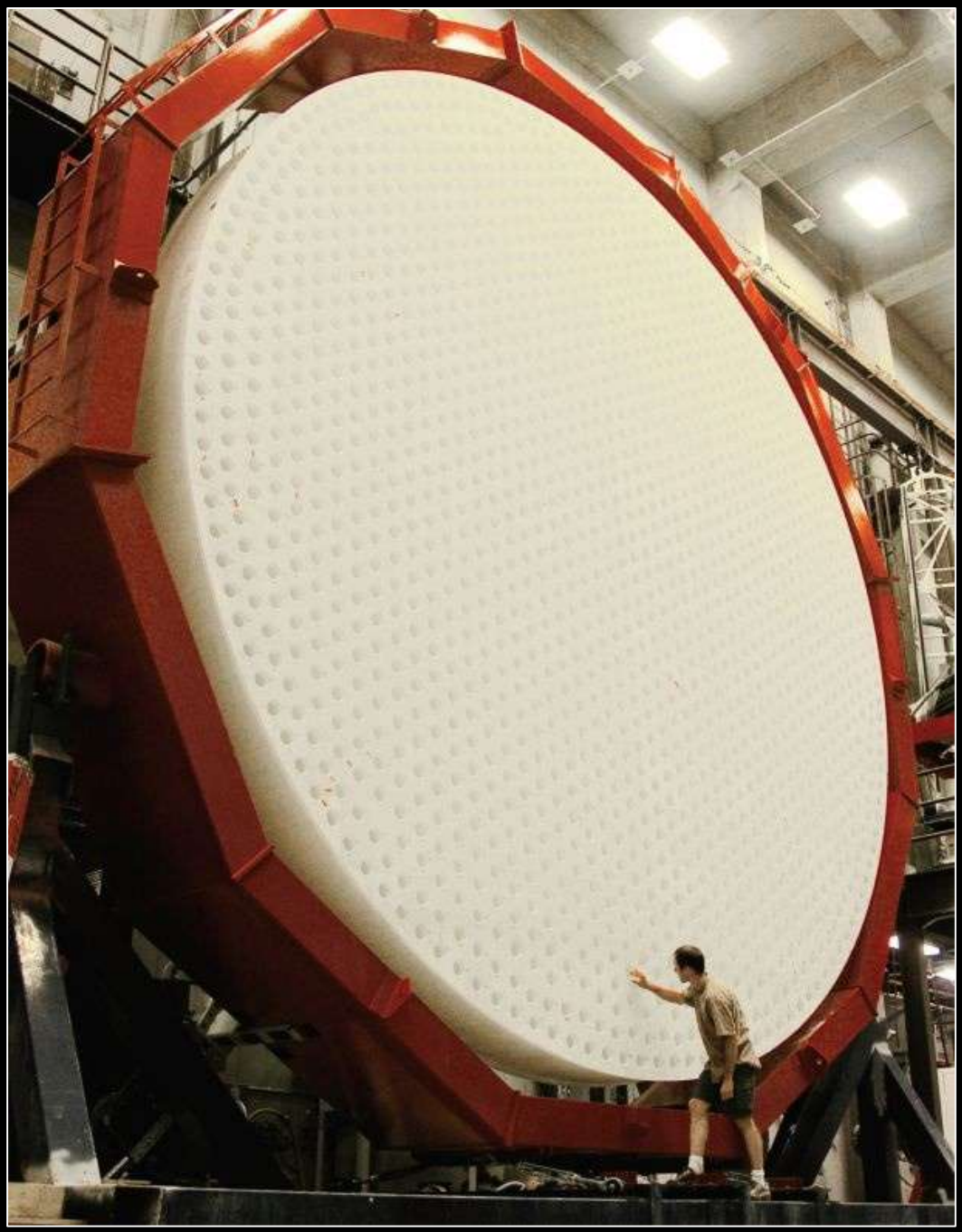
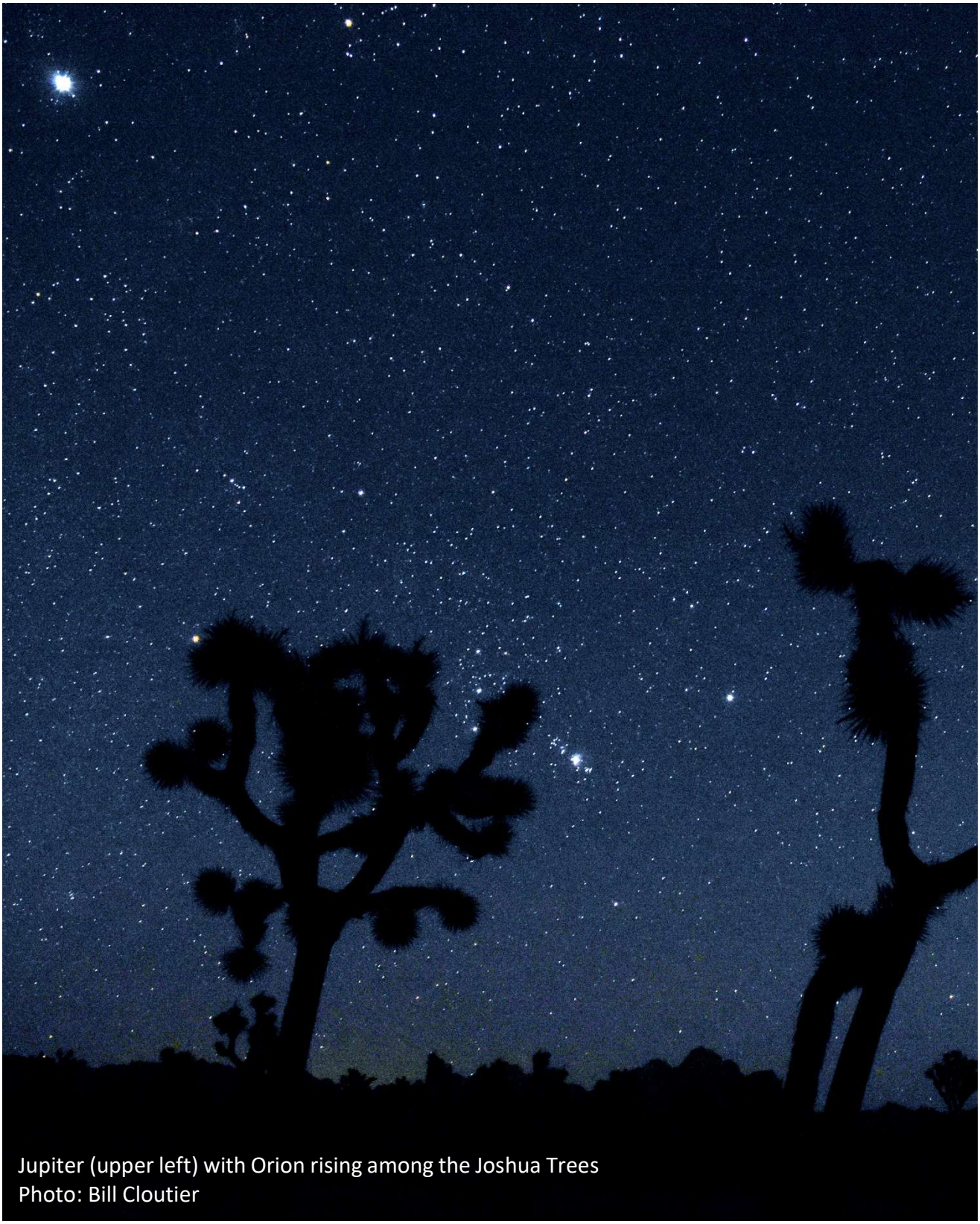


The back surface of one of the seven mirrors cast for the Giant Magellan Telescope. Each 8.4 meter (27.5 foot) mirror is formed from nearly 20 tons of pure optical glass in a rotating furnace at the University of Arizona's Richard F. Caris Mirror Lab located beneath the football stadium. Photo: Ray Bertram/UA

January Astronomy Calendar and Space Exploration Almanac



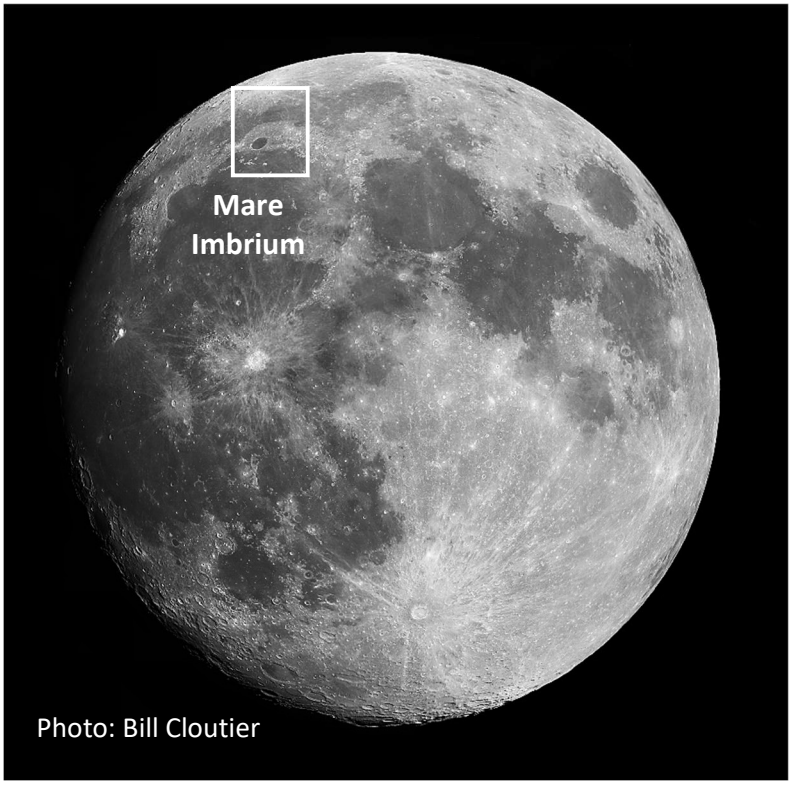
Jupiter (upper left) with Orion rising among the Joshua Trees
Photo: Bill Cloutier

In This Issue

"Out the Window on Your Left"

It has been 52 years since Gene Cernan left the last boot print on the Moon's surface. As a nation founded on exploration and the conquest of new frontiers, today's commitment to return to the Moon has been as fleeting as the funding. But what if the average citizen had the means to visit our only natural satellite; what would they see out the window of their spacecraft as they entered orbit around the Moon? This column may provide some thoughts to ponder when planning your visit (if only in your imagination).

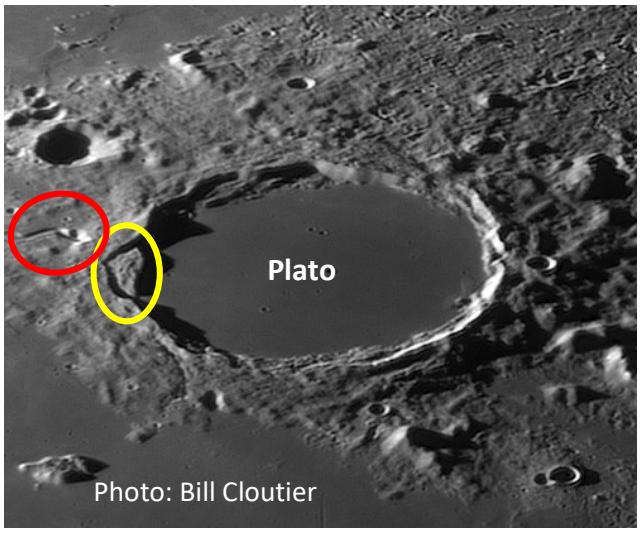
Along the rim of the Imbrium impact basin is the magnificent crater Plato, its dark, smooth floor in stark contrast to the rugged, light-colored lunar highlands. Named for the Greek philosopher, the crater rim is 63 miles (101 km) across. Its central peak, characteristic of large, complex lunar craters, is submerged in the 1.6 miles (2.6 km) of basaltic lava that fills the crater.



Location of the crater Plato (center latitude 51.62°N)

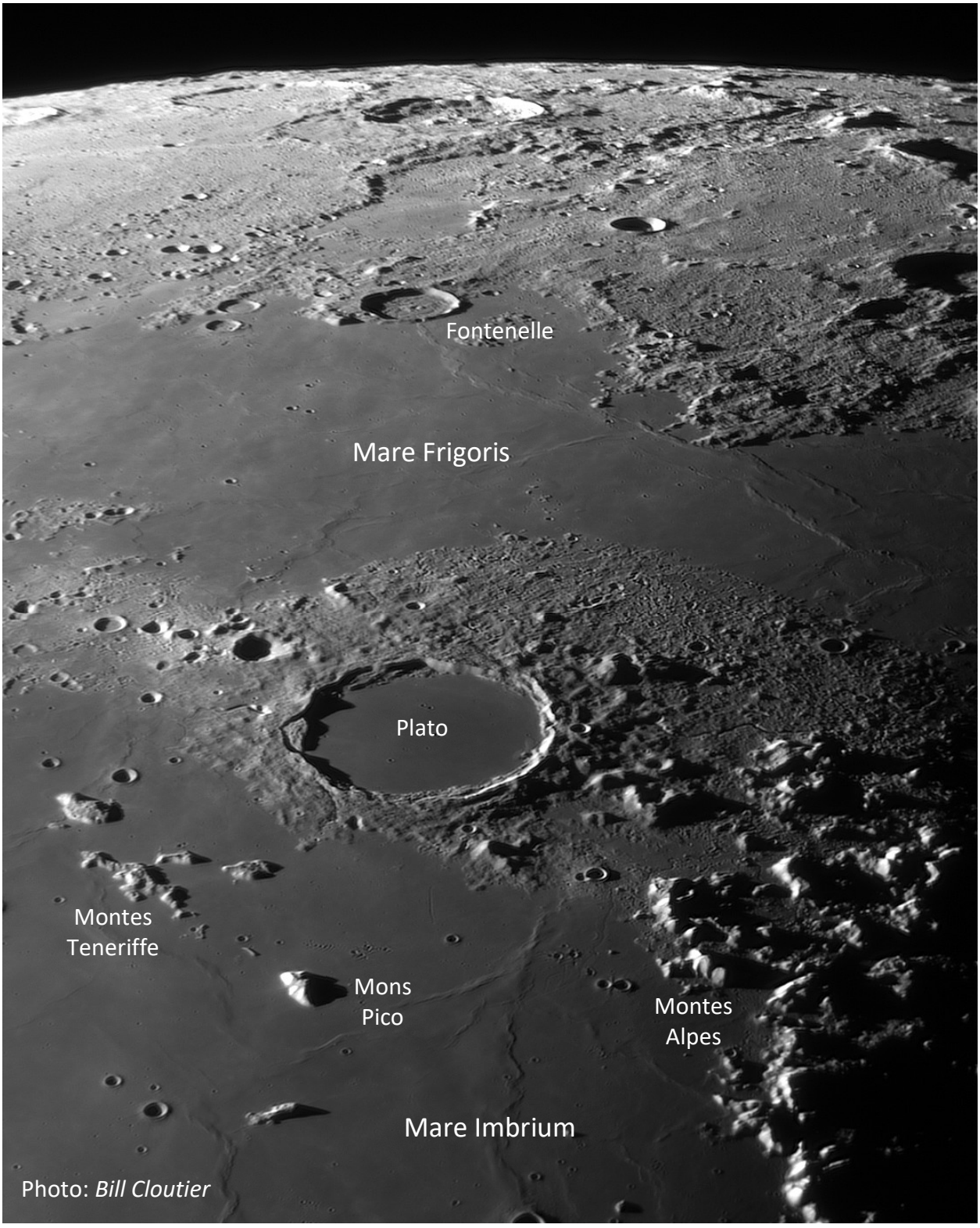
The event that created Plato crater is estimated to have occurred about a hundred million years after the Imbrium Basin impact. The crater's floor is covered with two different basalt units which differ slightly in color and composition and likely came from two separate eruptions around 2.82 billion years ago.

Few large craters dot Plato's floor. On the western rim, a roughly triangular block or massif, about 14 miles (23 km) in length, is partially disconnected from the crater rim (circled in yellow). Just to the west of this feature is a volcanic vent (circled in red).



The volcanic vent, which is about 3.5 miles (5.7 km) wide and 2700 feet (830 meters) deep, empties into an unnamed channel (called a rille) that winds west and south before flowing into Mare Imbrium. While scientists do not know when the vent was active, it likely contributed to the filling of the Imbrium basin, a process which lasted over a billion years.

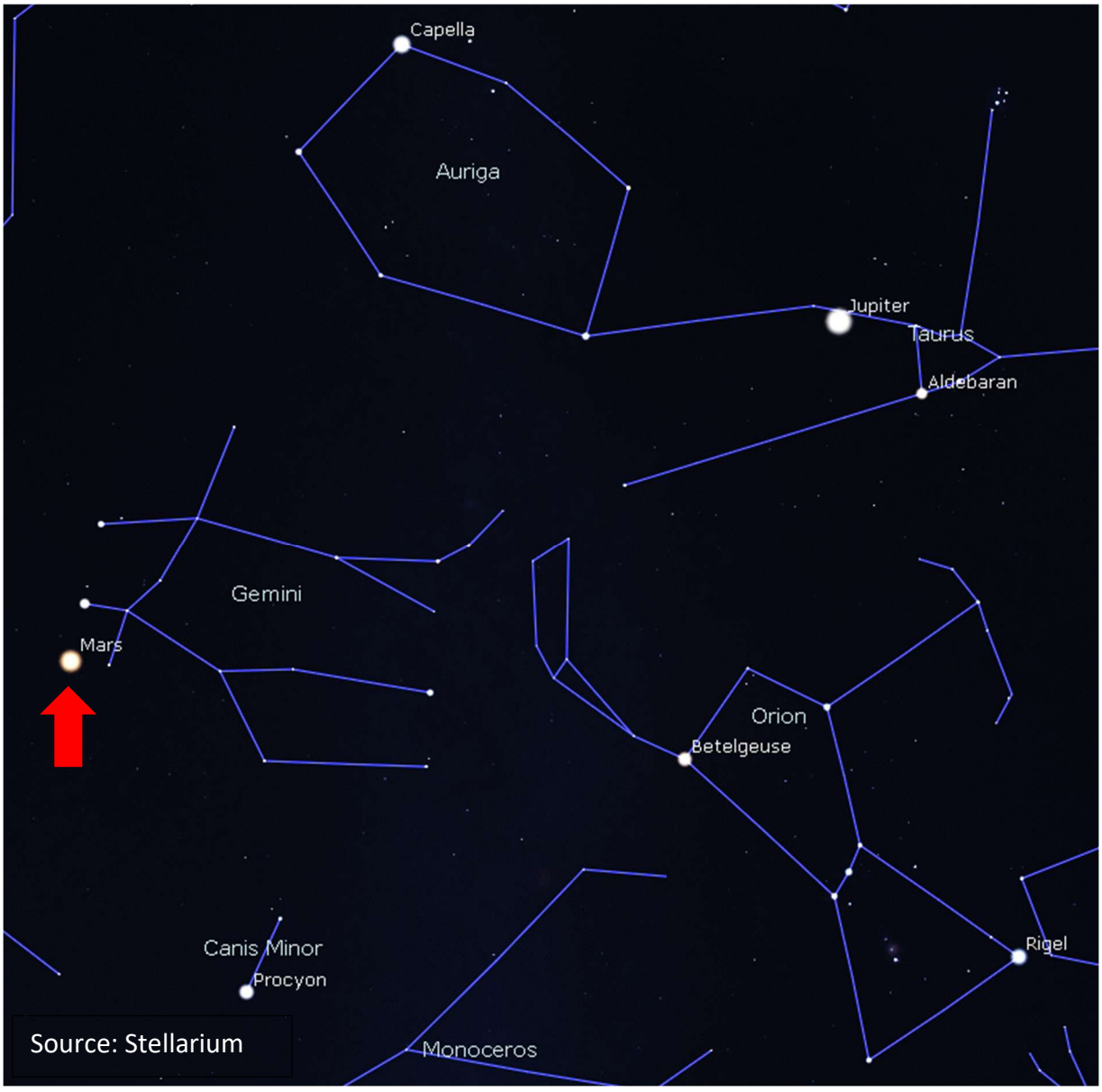
Plato


Fontenelle
Mare Frigoris
Plato
Montes
Teneriffe
Mons
Pico
Montes
Alpes
Mare Imbrium
Photo: *Bill Cloutier*

Mars at Opposition

Mars reaches Opposition on January 16th when it will be on the opposite side of Earth from the Sun. On that date, the Red Planet will rise shortly before 5 pm and will be highest in the sky just around midnight (at 73°). The minimum distance between Earth and Mars occurs four days earlier on the 12th, with a separation of 59.7 million miles (96 million km).

Mars' orbit (as compared to Earth) is highly elongated. As such, the distance between the two planets can vary from 34.6 million miles or 55.7 million kms when Mars is closest to the Sun (perihelion) to 63 million miles or 101.4 million kms at it furthest distance (aphelion). Since Mars will be approaching aphelion in April, it will appear slightly smaller than it did in 2022. Its declination (altitude), however, should provide steady views for observers when at its highest in the sky. Mars can be found in the constellation Gemini, to the east of Orion and trailing Jupiter.



Black Beauty Reveals Watery Past

The "Black Beauty" meteorite, officially designated as NWA 7034, was found in the Moroccan Sahara Desert in 2011. The stone, weighing about 320 grams, was determined to be Martian in origin having been ejected from the planet's surface between 5 million and 10 million years ago.

Main mass of NWA 7034
Image: Agee et al. 2012

The meteorite is classified as a polymict breccia as it contains a matrix of rock and mineral fragments from different ages of the 4.5 billion years of Martian history, including very ancient material. NWA7034 and 18 paired other stones, are unusually water-rich and highly magnetized, providing researchers a rare opportunity to study hydrothermal activity in the earliest geological eras.

A recent study published in the journal Science Advances presents an analysis of a single grain of the mineral zircon, with traces of water, found within a fragment of the meteorite. Unlike other zircon grains present in the matrix, the age of this particular grain predates the formation of the regolith breccia with an estimated age of 4.45 billion years.

The meteorite's age suggests that water was present on Mars just 100 million years after the planet formed and, with that fundamental ingredient, had conditions to support life early in its history. It is also plausible that Mars could have developed life before it was established on Earth since the fourth planet from the Sun should have received a higher influx of organic material from impacting asteroids and comets, has a greater percentage of dry land despite its smaller size, and is sulfur-rich, an important element for biology.

A micro sample of NWA 7034 in the McCarthy Observatory's meteorite collection
Image: Agee et al. 2012

While a fleet of orbiters, landers and rovers have found convincing evidence of surface water and a landscape modified by rivers and lakes in the distant past, the unanswered question remains as to when and for how long water resided on the Martian surface. The samples collected by NASA's Perseverance rover from the river delta in Jezero crater may provide an answer when returned, at least for that location.

Ingenuity Accident Analysis

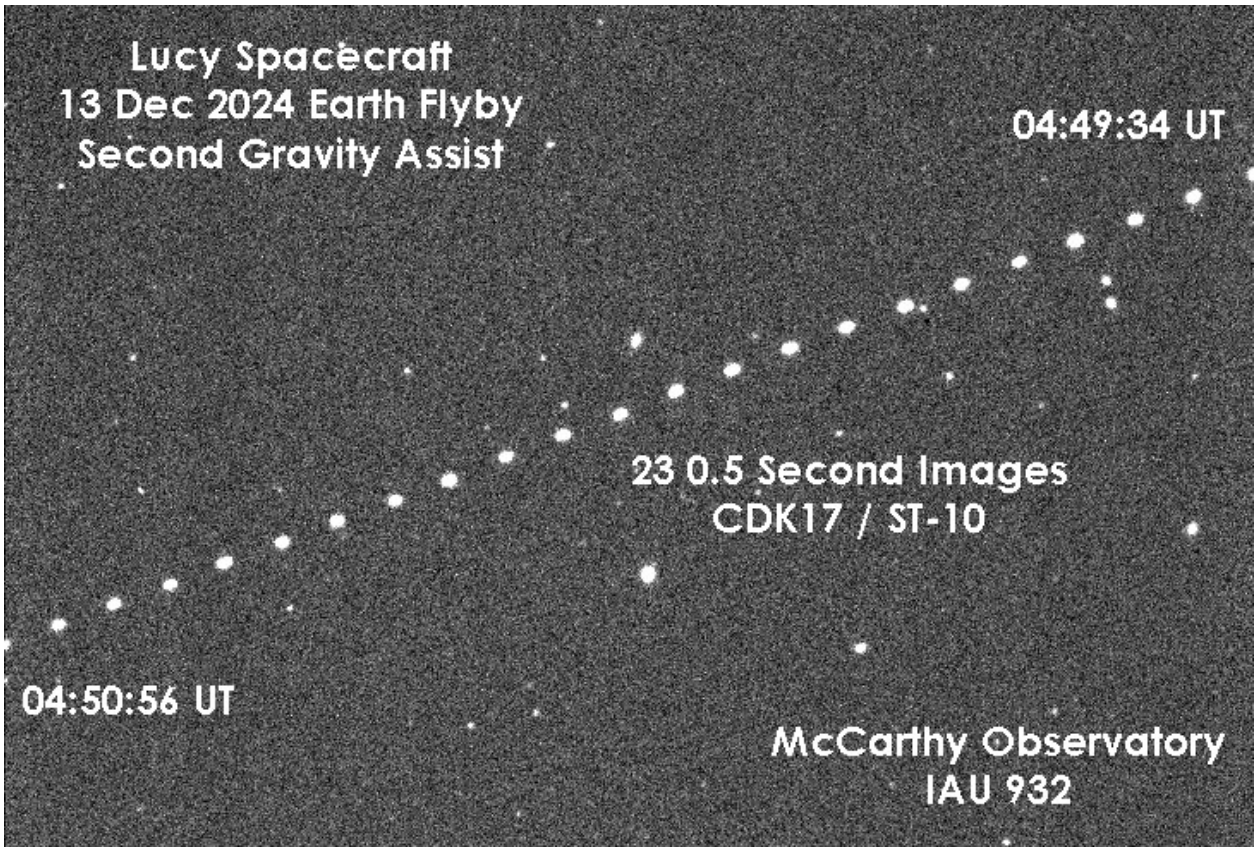
The final resting place of NASA's Ingenuity Mars Helicopter on a sand dune in Jezero Crater
Credit: NASA/JPL-Caltech/LANL/CNES/CNRS

Engineers from NASA's Jet Propulsion Laboratory (JPL) and AeroVironment have completed a detailed assessment of the Mars Helicopter's final flight on January 18, 2024. It will be published as a NASA technical report.

The helicopter, called Ingenuity, had been added to the Mars 2020 mission as a technology demonstration. The JPL rotorcraft team was given a 30-day window on Mars to conduct up to five short, pre-programed flights at a favorable location under the observation of the Perseverance rover. The resounding success of the first few flights led NASA to extend its mission and repurpose the helicopter as a long-range scout for the rover. Over the next three years, Ingenuity completed 72 flights, was airborne for a total of 128.8 minutes and covered 10.5 miles (17.0 kms) while reaching altitudes as high as 78.7 feet (24.0 meters).

Ingenuity was designed to ascertain whether flight was possible in Mars' rarefied atmosphere. With a 30-day design life, the helicopter was constructed with off-the-shelf components and with the bare essential software necessary to conduct the demonstration. While Earth-bound engineers were able to upgrade its navigation software as the mission expanded, it was still terrain-based (using camera images of the ground to identify waypoints and progress). The helicopter's 72nd flight was intended to be a brief surveillance of the surrounding river bed. Unfortunately, the sand dunes in that vicinity were relatively featureless, providing little or no input to the helicopter's navigation system. Flight data indicated that around 20 seconds into the flight, the navigation camera couldn't find enough surface features to establish its position. This led to a high horizontal velocity at touchdown and a hard impact. As a result, several of the rotor blades were snapped off which led to further damage of the rotor system. While grounded, Ingenuity is still operational and beaming weather and avionics test data to the Perseverance rover about once a week.

Boost to the Asteroid Belt and Beyond

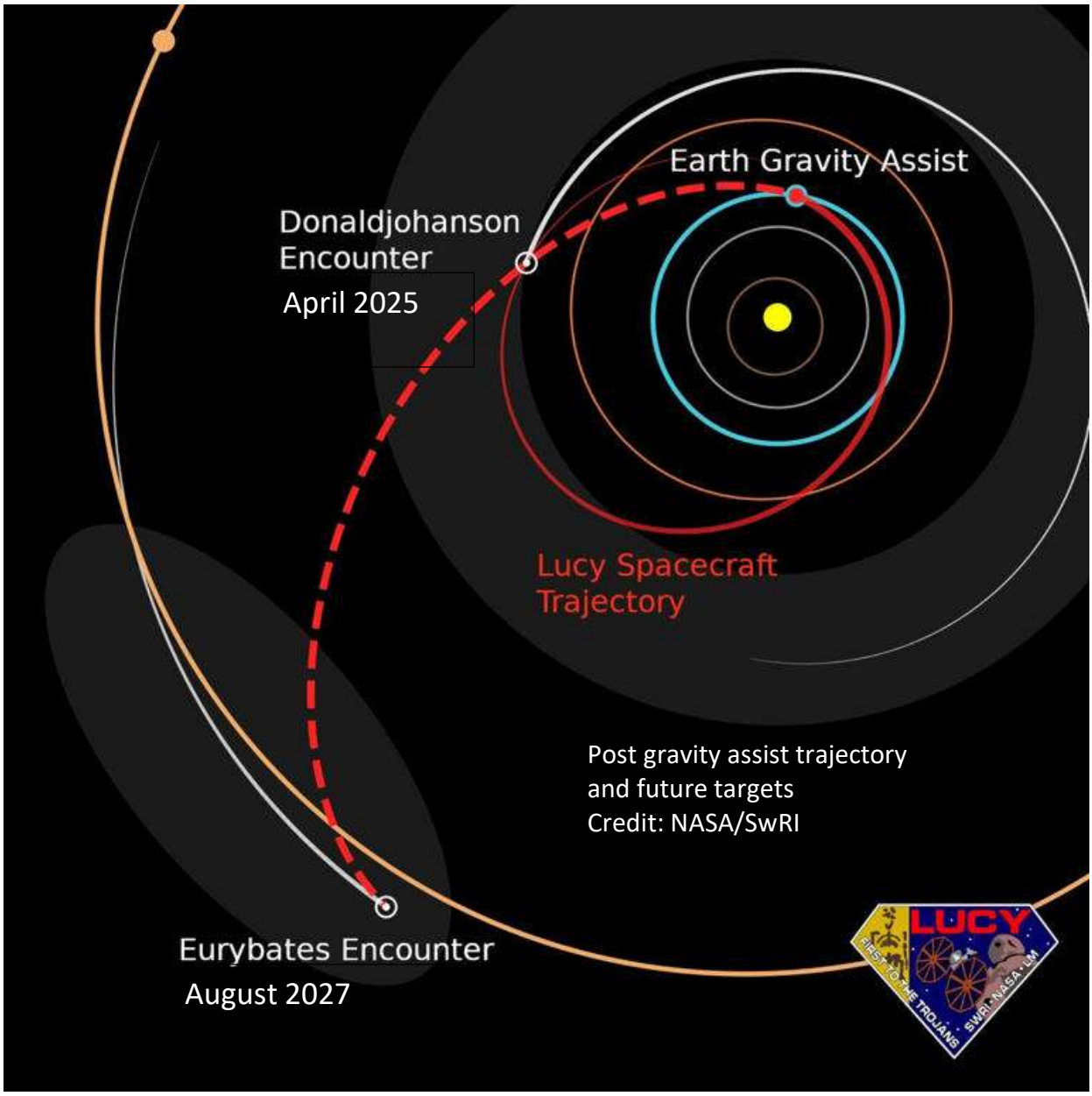


A composite of spacecraft images from the Lucy spacecraft flyby captured with the McCarthy Observatory's telescope. The sequence represents an elapsed time of about 81 seconds.

Shortly before midnight on December 12th (EST), NASA's Lucy spacecraft executed a high speed flyby of the Earth. The spacecraft, launched in 2021, had been placed into an orbit around the Sun. During the flyby the spacecraft came within 220 miles (360 km) of the Earth's surface. The result was a "gravity assist" that will slingshot the spacecraft out through the main asteroid belt to a group of asteroids that share the orbit of Jupiter. These "Trojan" asteroids are believed to be primordial, remnants from the formation of the solar system.

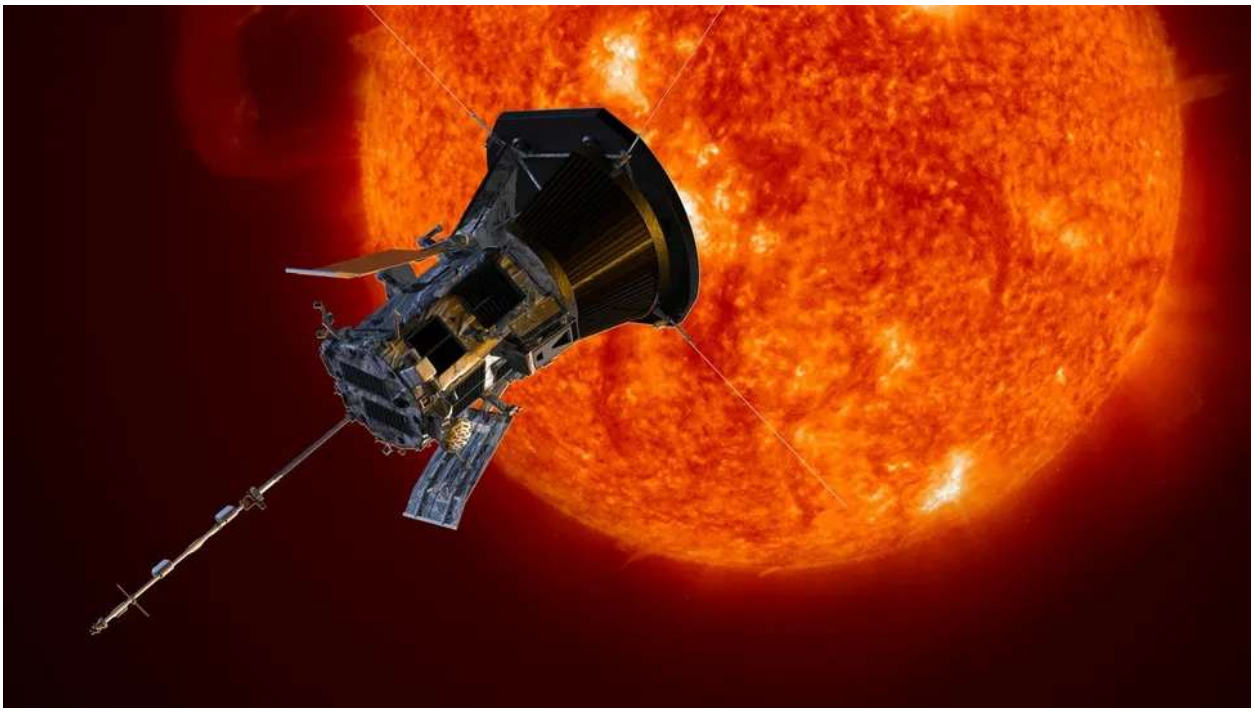
This was the spacecraft's second gravity assist. The first, in October 2022, boosted its orbit to the inner region of the asteroid belt where Lucy encountered a small asteroid called Dinkinesh and its satellite Selam (the first 'contact binary' moon ever discovered). This time, as Lucy enters the asteroid belt it will fly by the asteroid "Donaldjohanson" (named for the American paleoanthropologist who discovered the early hominin nicknamed "Lucy" in Ethiopia in 1974). The spacecraft will encounter its first Trojan asteroid, (3548) Eurybates and its satellite Queta, in August 2027. Over the twelve-year mission, Lucy will visit eight Trojans (five asteroids and the satellites of three), in two difference locations. The first group of Trojans is situated at the Lagrange 4 or L4 position relative to Jupiter, 60° ahead of the planet in its orbit. The second group occupies the L5 position, 60° behind the planet. During the L5 encounter in 2033, Lucy will fly by the asteroid Patroclus and its satellite Menoetius. The McCarthy Observatory is participating in an observation campaign of Patroclus in response to a call for additional observations of this binary pair to support the last scheduled rendezvous in this epic mission.

Asteroid Dinkinesh and its contact binary satellite Selam as seen by Lucy's Long-Range Reconnaissance Imager
Image credit: NASA/Goddard/SwRI/Johns Hopkins APL)



Post gravity assist trajectory and future targets
Credit: NASA/SwRI

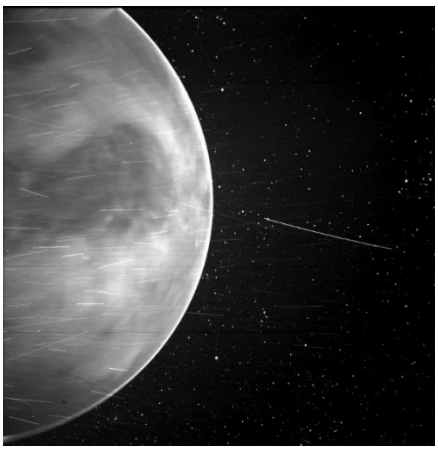
A Blistering Encounter



An artist's concept of NASA's Parker Solar Probe as it approaches the Sun
Image credit: NASA/Johns Hopkins APL/Steve Gribben

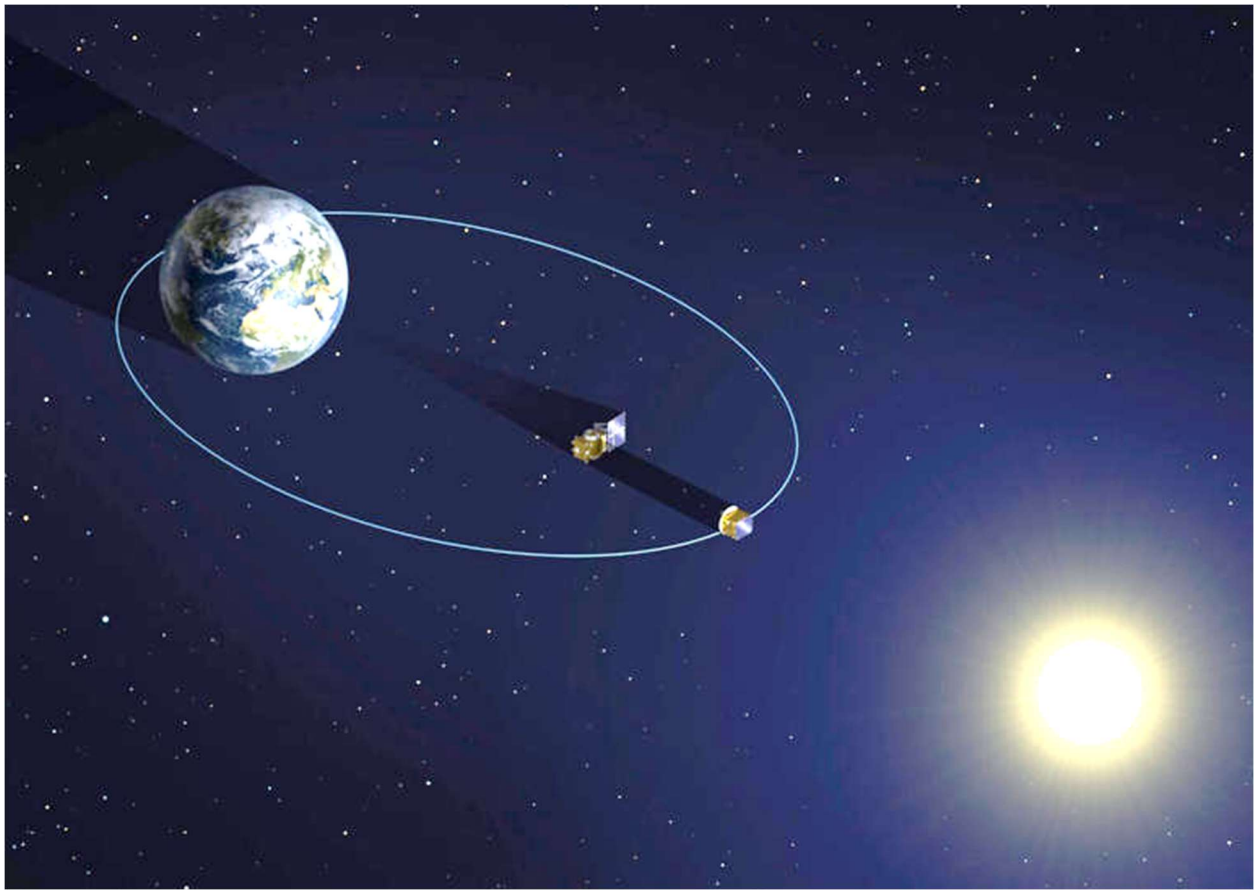
On Christmas Eve, NASA's Parker Solar Probe made its closest approach of the Sun, flying within 3.8 million miles (6.1 million km) of the photosphere (often described as its surface), about seven times closer than any previous spacecraft, at a breakneck speed of 430,000 mph (690,000 kph). During this passage, the Sun-facing side of the heat shield reached a scorching 1,800°F (982°C). However, the spacecraft's 4.5-inch-thick (11.43-centimeter-thick) carbon-composite shield, which can withstand temperatures of nearly 2,500°F, kept the spacecraft's instruments at a relatively comfortable 85°F (30°C) and protected from the Sun's intense radiation.

The probe was designed, built, and is operated by the Johns Hopkins Applied Physics Laboratory. It carries four instruments designed to study electric and magnetic fields, plasma, and energetic particles, as well as image the solar wind. The 22nd perihelion of the six year mission launched in 2018, and closest approach yet to the Sun, was made possible by a gravity assist from Venus (its seventh). The latest Venusian flyby, which are used to progressively shrink the spacecraft's orbit around the Sun, took the probe within 233 miles (376 km) of our sister planet's surface.



Venus imaged by the spacecraft's Wide-field Imager during a close pass
Credits: NASA/Johns Hopkins APL/Naval Research Laboratory/Guillermo Stenborg and Brendan Gallagher

Casting Shadows



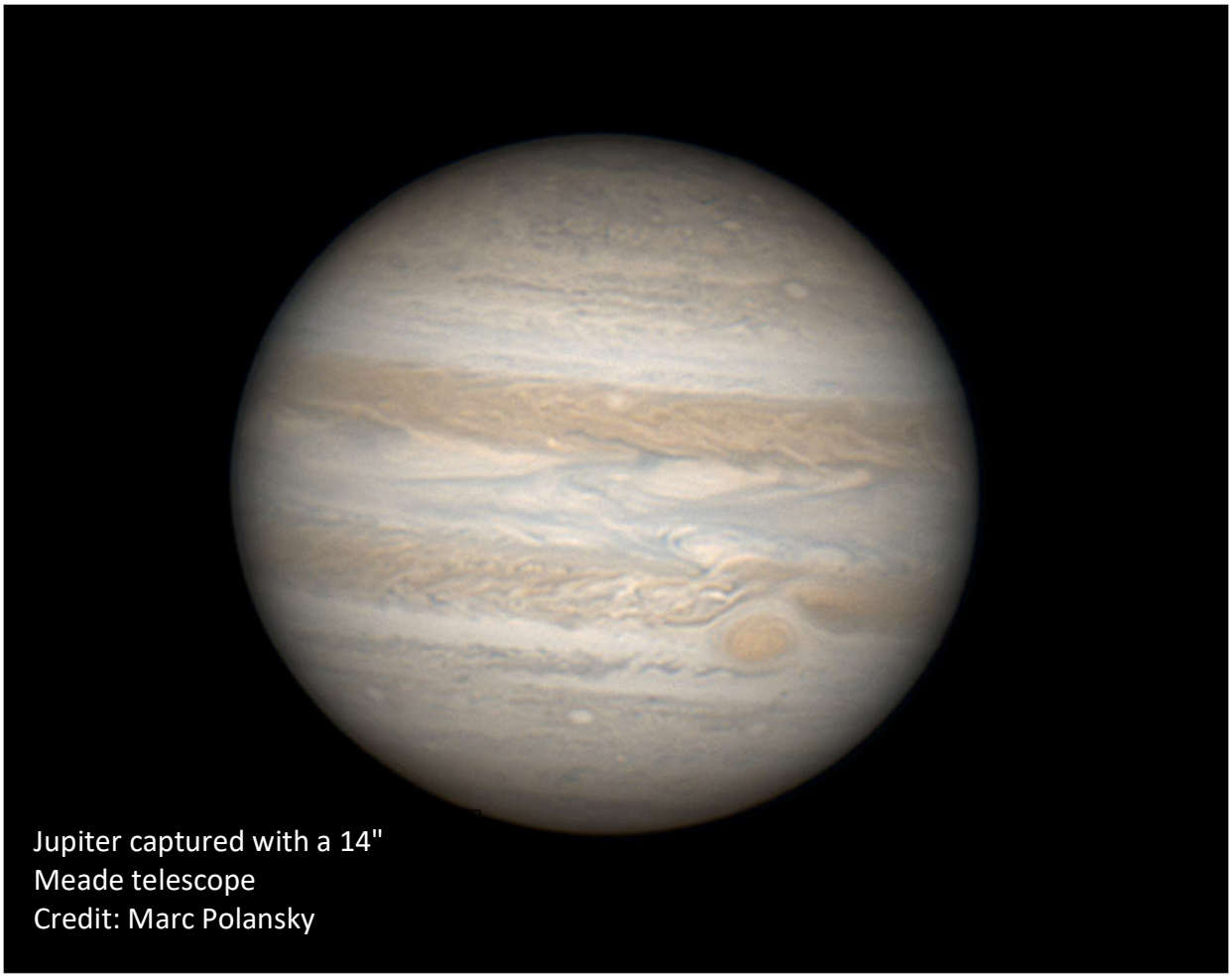
The two Proba-3 spacecraft will orbit Earth in an elliptical path with an apogee of nearly 37,300 miles (60,000 km) and a perigee of some 370 miles (600 km) – (NOT TO SCALE)

The corona, the outermost layer of the Sun, is a million times fainter than the photosphere (which is typically described as the surface of our star). This tenuous layer is also much hotter than the layers beneath and is the source of the solar wind (a constant stream of charged particles that flows throughout the solar system). Unraveling the inner workings of the corona will advance our understanding of this luminous ball of plasma and may provide a means of predicting certain solar events that impact life on Earth.

The vast difference in brightness between the corona and photosphere limits the opportunities to study the Sun's atmosphere to brief periods of eclipse totality (when the moon completely blocks the solar disk). Spacecraft and space telescopes can use a device called a coronagraph to block the majority of the light from a star to reveal faint planets. The efficacy (reduction of light leaking around the occulter) is increased with the distance between the occulter and the detector.

The European Space Agency's Proba-3 mission, launched on December 5th, aims to create a long-lasting artificial eclipse. The two spacecraft will fly just 490 feet (150 meters) apart with a precision of just 0.04 inch (1 millimeter). By flying in formation and in line with the Sun, one spacecraft will cast a controlled shadow on the other. If successful, the Sun's corona could be observed for up to six hours during each orbit.

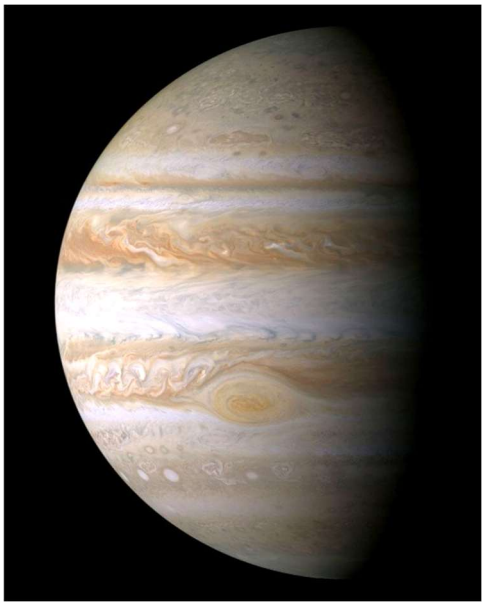
Jupiter at its Best



Jupiter captured with a 14"
Meade telescope
Credit: Marc Polansky

With the tools available today (digital cameras, techniques to nullify the effects of Earth's turbulent atmosphere, as well as Jupiter's swift rotation rate, and rapidly evolving image processing software), talented amateur astronomers can capture spectacular images of planets and galaxies that rival those once available from only the world's largest telescopes or visiting spacecraft.

As an illustration, NASA's Cassini spacecraft flew by Jupiter in December 2000. From a distance of 6.2 million miles (10 million km), its camera captured the most detailed global true-color portrait of the planet ever produced at that time (right). Twenty-five years later, and taking full advantage of the technology available, Marc has captured an equally astounding view of the gas giant from his backyard (above).



Jupiter from the Cassini spacecraft during its closest approach and on its way to Saturn
Credit NASA/JPL/Space Science Institute

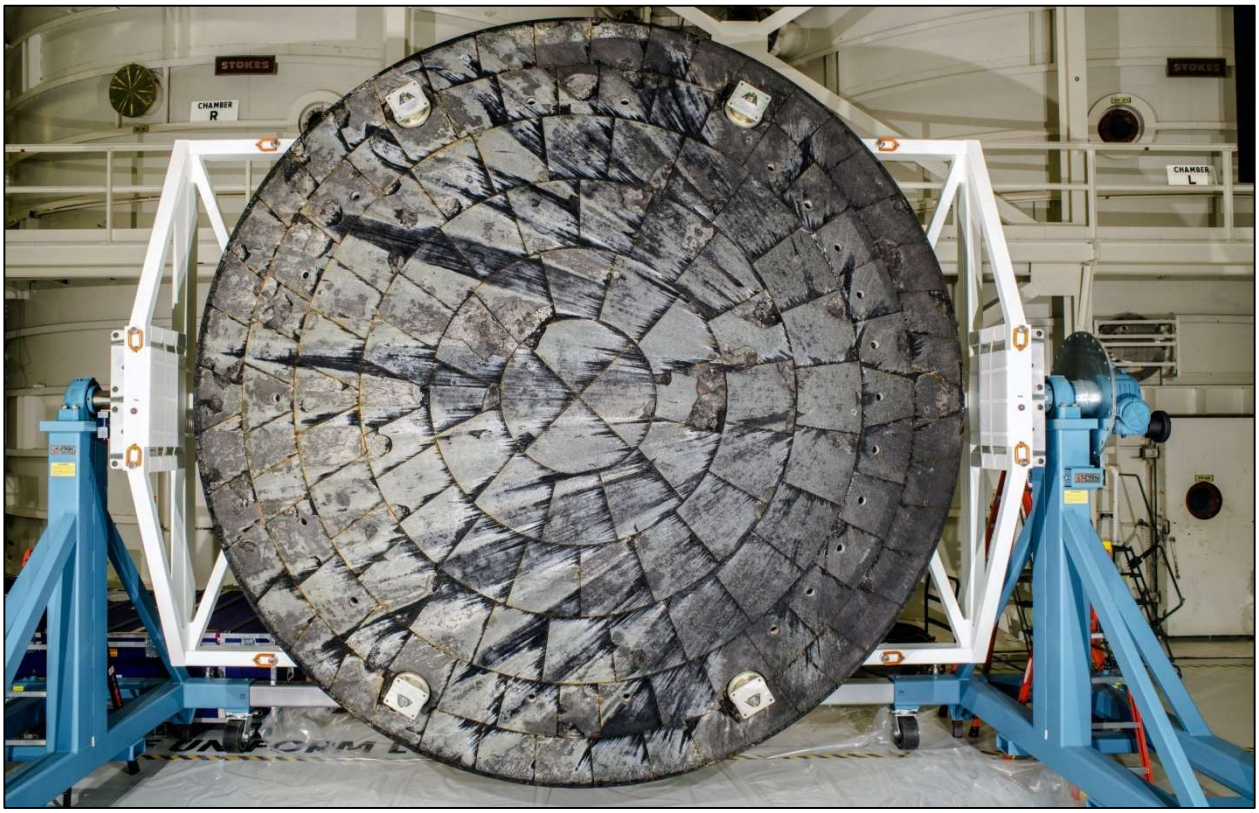
Giant Magellan Telescope

Artist conception of the primary and secondary mirrors of the GMT
Credit: GMTO Corporation

The rotating furnace where the giant mirrors are cast is located beneath the stands of the University of Arizona Wildcats football stadium
Photo: Bill Cloutier

The primary mirror for the Giant Magellan Telescope is comprised of seven circular segments, each 8.4 meters (27½ feet) in diameter. The array, when complete, will create a light collecting surface of 368 square meters (3,961 square feet). Each mirror undergoes a four-year process to fabricate and polish. The first three mirrors are complete with the remaining four in various stages of polishing and testing (the seventh mirror was cast in 2023). Once delivered to the construction site, the mirrors will be installed in a massive, mechanized enclosure (weighing over 5,000 metric tons) that will protect their finely honed surface from the extreme weather that can be expected at the southern edge of Chile's Atacama Desert. The telescope is scheduled to be operational in the early 2030s.

Heat Shield Analysis Findings



The thermal shield from NASA's Orion spacecraft. The 16.5 feet in diameter (5 meters) shield was removed from the spacecraft at the conclusion of the Artemis I test flight for inspection. Credit: NASA

Unexpected erosion of heat shield material was one of the few anomalies on an otherwise very successful Artemis 1 test flight and a central consideration in delaying the Artemis 2 crewed flight. Despite the heat shield exceeding performance expectations and flight data that showed that it would not have adversely affected the crew, had a crew been aboard, NASA wanted to determine the cause of the loss and identify corrective actions before sending astronauts back to the Moon.

The heat shield is a honeycomb structure filled with Avcoat; a material originally developed by Avco for the Apollo program. It is a resin-based composite with silica fibers designed to keep the command module at a comfortable temperature during reentry as the spacecraft enters the Earth's atmosphere at nearly 25,000 mph (40,200 kph). The heat of reentry is removed by convection through charring of the heatshield's outer layer. The char layer is designed to gradually burn away. However, on Artemis 1 there were areas of the heat shield where this did not happen. Instead, the char broke off in ways that NASA had not expected, exposing the underlayer to the intense heat.

As a test flight, the heat shield was heavily instrumented. This allowed investigator to recreate the conditions during the entire retry sequence, including the skip maneuver (where the spacecraft dips into the Earth's upper atmosphere to slow down and then skips back out before final descent). The investigation showed that during the skip, when the heat loading decreased, the permeability of Avcoat was not sufficient to allow the gases generated to escape. This increased the internal pressure causing stress fractures to develop and leading to uneven shedding of the outer layer.

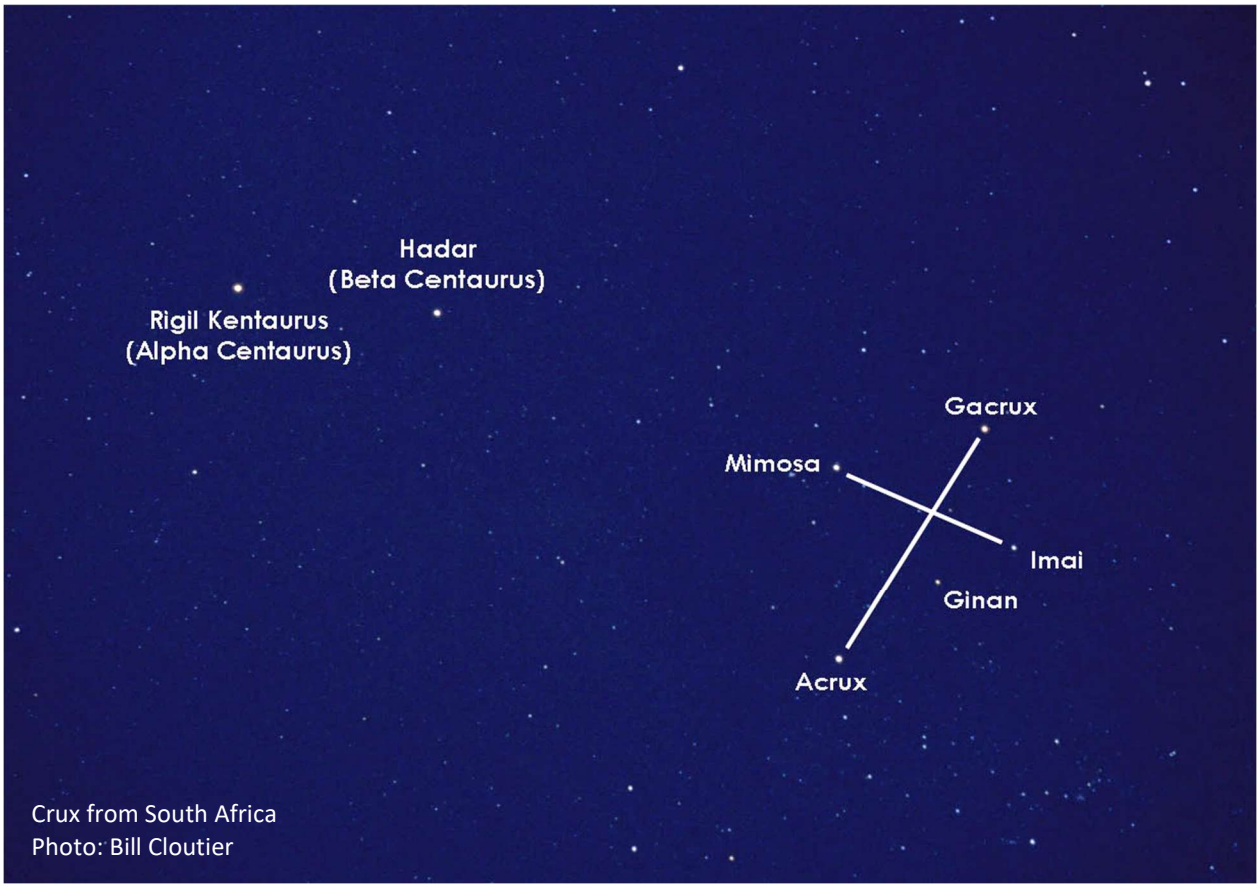
Milky Way Companions

The Magellanic Clouds
Image credit: NASA/Don Pettit

When NASA astronaut Don Pettit arrived at the International Space Station (ISS) in September 2024 aboard a Soyuz MS-26 spacecraft, it was his fourth visit to the orbiting laboratory. The 69-year-old astronaut (oldest active) is a chemical engineer, an avid astrophotographer and the recipient of the first ever patent for an object invented in space - the Zero G Coffee Cup.

Once of his more recent photographs, taken from a window of a SpaceX Dragon crew spacecraft that was docked at the station, is a long exposure of the southern sky (as viewed from Earth). Pettit was able to capture the Large and Small Magellanic Clouds as the ISS passed over the Pacific Ocean. The "clouds" are actually two dwarf satellite galaxies of the Milky Way Galaxy. The Large Magellanic Cloud is approximately 160,000 light-years away in the constellations Dorado and Mensa while the Small Magellanic Cloud is a bit further at 200,000 light-years in distance and located in the constellations Tucana and Hydrus.

When You See the Southern Cross For the First Time …



While the best views of the Southern Cross (the International Astronomical Union or IAU recognizes the constellation as "Crux") are from the southern hemisphere, it can also be seen at certain times of the year from the extreme southern portions of the continental U.S. and Hawaii.

Crux is the smallest of the 88 IAU constellations. It was first described by the Italian navigator Andrea Corsali in 1515. The constellation boundary contains just 42 stars with four bright stars in a cross shape. The Ancient Greeks considered it part of the nearby constellation "Centaurus" (the cross can be found by using the two bright stars in Centaurus as pointers).

With no bright star near the celestial pole (unlike Polaris in the northern hemisphere), the Southern Cross has been used for navigation. It is circumpolar below 35° south latitude (visible all night) and a line drawn from the star Gacrux through the star Acrux points in the general direction of the south celestial pole.

The Milky Way runs behind the Cross with the area rich in observing highlights. The Coalsack Nebula is a dark patch of dust and gas located in the southeastern corner of the constellation. Not far from the Coalsack and near Mimosa is the Jewel Box (NGC4755), a colorful cluster of stars surrounding the red giant Kappa Crucis. Nearby can be found Omega Centauri (NGC 5139) located at a distance of 17,000 light-years and the largest known globular cluster in the Milky Way with a diameter of roughly 150 light-years, and the Carina Nebula (NGC 3372), a massive stellar nursery four time larger than the Orion Nebula located 7,500 light-years from Earth.

Gas Giant Watch

Saturn

Saturn reached Opposition on September 8th when the ringed-world was closest to Earth. Since that time, the distance between the Earth and Saturn has been gradually increasing with Earth's higher orbital velocity. Saturn is still well placed in the evening sky in the constellation Aquarius. The planet's north pole is currently tilted towards the Earth with its rings inclined at an angle just less than 4° to our line of sight.


Image: Marc Polansky

We see the ring tilt change (from our perspective) over Saturn's 29.5-year orbit. The last ring crossing (when Earth crosses the ring plane and the rings disappear from our view) was in 2009. Since then the rings have opened to a maximum of 27° before starting to close. The rings will disappear in late March before the sequence begins anew. When they start to open back up again, we will see the southern hemisphere tilted toward Earth. Unfortunately, Saturn will be too close to the Sun in our sky to view the disappearance.


Image: Marc Polansky

Jupiter

Jupiter reached Opposition on December 7th. By mid-January, the gas giant shines brightly in the southeastern sky at the end of twilight (almost 31 times brighter than Saturn). The largest planet in the solar system can be found in the constellation Taurus and to the east of Saturn.

	Rise and Meridian Transit Times			
	January 1 (EST)		January 31 (EST)	
Planet	Rise	Transit*	Rise	Transit*
Saturn	10:39 am	4:13 pm	8:47 am	2:25 pm
Jupiter	2:27 pm	9:52 pm	12:22 pm	7:47 pm

* The celestial meridian is an imaginary the line that connects the north and south points of the horizon with the observer's zenith (point directly overhead). A planet is highest in the sky when it crosses or transits the meridian.

Jovian Moons

Jupiter's four Galilean moons are large enough to be seen with a small telescope. The orbits of the inner three moons are synchronized (orbital resonance) with Europa's orbital period twice Io's period, and Ganymede's orbital period twice that of Europa (e.g., in the time it takes Ganymede to go around Jupiter once, Europa makes two orbits and Io makes four orbits). On nights of good

visibility, the shadow(s) of Jupiter's moon(s) can also be seen on the cloud tops as they cross (transit) the planet's disk.

Only events that start in the evening are included. A more complete listing can be found in Sky & Telescope's monthly magazine.

Jovian Moon Transits

Date	Moon	Transit Begins	Transit Ends
31st (Dec)	Io	11:11 pm	1:23 am (1st)
2nd	Io	5:40 pm	7:52 pm
6th	Europa	9:53 pm	12:27 am (7th)
9th	Io	7:35 pm	9:47 pm
16th	Io	9:30 pm	11:42 pm
18th	Io	3:59 pm	6:11 pm
20th	Ganymede	5:37 pm	7:56 pm
23rd	Io	11:26 pm	1:38 am (24th)
24th	Europa	4:22 pm	6:56 pm
25th	Io	5:55 pm	8:07 pm
27th	Ganymede	9:38 pm	11:58 pm
31st	Europa	6:57 pm	9:34 pm

Great Red Spot Transits

The Great Red Spot is a large, long-lived cyclone in the upper Jovian atmosphere. The Earth-size storm will cross the center line of the planetary disk on the following evenings during the hours between 7 pm to midnight local time.

Date	Transit Time	Date	Transit Time
2nd	10:33 pm	19th	9:35 pm
5th	8:03 pm	21st	11:13 pm
7th	9:41 pm	22nd	7:05 pm
9th	11:19 pm	24th	8:43 pm
10th	7:10 pm	26th	10:22 pm
12th	8:49 pm	29th	12:00 am
14th	10:27 pm	29th	7:52 pm
17th	7:52 pm		

Explorer 1

Sixty-seven years ago, on January 31, 1958, the United States successfully launched its first satellite, Explorer 1. The launch occurred during the International Geophysical Year, a global initiative which actually ran from July 1957 to December 1958 and coincided with the peak in the 11-year solar cycle. Unlike Sputnik 1, which had been launched by the Soviet Union in October of 1957 and designed to only broadcast radio pulses (or Sputnik 2 which carried a dog into space as a crude biological demonstration), Explorer 1 carried a suite of instruments to study cosmic rays, micrometeoroids, and the satellite's temperature. It was the first artificial satellite designed to return scientific data.

The launch of Explorer 1 followed the unsuccessful launch of a U.S. satellite on a Navy Vanguard rocket in December (the rocket fell back to the pad and exploded shortly after liftoff). Following the humiliating loss of Vanguard, which was widely publicized by the Soviets, the competing Army's rocket team (headed by Wernher von Braun) offered their Jupiter C ballistic missile as an alternative launch vehicle. Teamed with the Jet Propulsion Laboratory (JPL) which designed and constructed the satellite and James Van Allen who designed the cosmic ray detector, the 31-pound (14 kg) satellite was successfully placed into an orbit around Earth with an apogee of 1,563 miles (2,515 km) and a perigee of 220 miles (354 km).

L to R: Pickering, Van Allen and von Braun
Credit: NASA

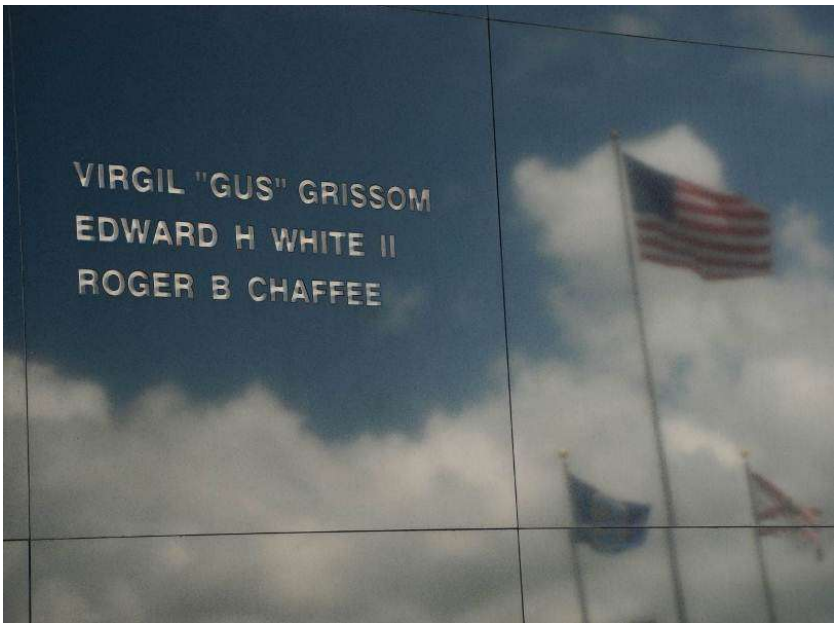
During a 1:00 am press conference at the National Academy of Sciences on February 1, shortly after the successful night launch of Explorer 1, the three team leaders Bill Pickering (JPL), James Van Allen (State University of Iowa) and Wernher von Braun (Army's Redstone Arsenal) celebrate by holding aloft a model of the satellite.

Explorer 1 would end up completing more than 58,000 orbits before reentering the Earth's atmosphere on March 31, 1970. The lower-than-expected counts recorded by the cosmic ray detector led Van Allen to theorize that the instrument had been affected by charged particles trapped by the Earth's magnetic field. The existence of two and sometimes three toroidal "radiation belts" encircling the Earth were later confirmed by subsequent missions and named the Van Allen Belts.

In August 2012, NASA launched the Van Allen Probes to study this dynamic region of space (http://vanallenprobes.jhuapl.edu/). With two identical spacecraft, traveling in tandem, scientists were able to measure changes in the belts over time and space. The probes have provided researchers a new understanding of how the belts respond to fluctuations in the Sun's output. The two-year mission was later extended to seven years as the probes continued to return ground-breaking results. The orbits of the two probes were lowered in 2019, before they ran out of fuel, to ensure that they would eventually burn up in the Earth's atmosphere and not add to the growing orbital debris fields that pose hazards to spacecraft and space travelers. NASA's mission to explore Earth's radiation belts ended when ground controllers shut down the first probe in July 2019 and the second in October.

January History

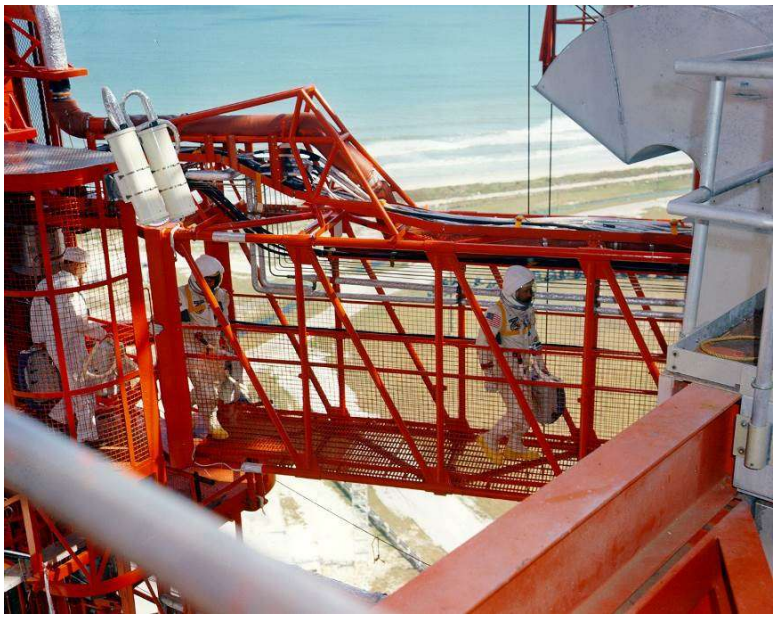
The month of January has been a difficult one for both the American and Soviet space programs. Untimely deaths set back both the American and Soviet moon programs. The two space shuttles that have been lost were also launched in January.



Space Mirror Memorial on the grounds of the Kennedy Space Center Visitor Complex Photo: Bill Cloutier

Sergei Korolev, the "Chief Designer" of the Soviet space program, died on January 14, 1966 from a botched medical procedure. Korolev co-founded the Moscow rocketry organization in the 1930s before being thrown into prison during the peak of Stalin's purges. He spent a year in the Kolyma gold mine, the most dreaded part of the Gulag in Siberia before he was recalled to Moscow to aid the Red Army in developing new weapons.

Korolev went on to lead the Soviet space effort. Unfortunately, the Soviet Moon program died with Korolev in 1966. While the race continued for some time after his death, his N-1 moon rocket never made a successful flight.



The crew of Apollo 1 crosses the gantry to the spacecraft on the day of the fire, Jan. 27, 1967 Credit: NASA

In January of 1967, after a successful conclusion to the Gemini program, NASA was moving forward with testing the new Apollo spacecraft. On the afternoon of the 27th, Gus Grissom, Ed White and Roger Chaffee were sealed inside the Apollo 1 command module sitting on top of an unfueled Saturn rocket in a simulated countdown. The command module had been plagued with problems and was in a state of constant redesign. At 6:31 pm, a spark from a damaged wire ignited the pure oxygen atmosphere in the spacecraft. Within seconds the temperature reached 2,500°. The astronauts never had a chance to undo the bolts of the hatch before they were asphyxiated. Following their deaths, the spacecraft was completely redesigned. Lessons learned from this accident served to make the spacecraft much safer and contributed to the success of the six moon landings.

Thirty-nine years ago, on January 28, 1986, the United States lost its first space shuttle, the Challenger. Due to the low temperature on the launch pad, a rubber-like O-Ring used to seal the joints of the solid rocket boosters failed to seat and stop the hot gasses from escaping. The gas produced a blowtorch-like flame that penetrated the external tank filled with liquid oxygen and hydrogen. The tank exploded 73 seconds after liftoff, destroying the shuttle and killing all seven crew members. Among the crew was Christa McAuliffe, a New Hampshire teacher. Christa graduated from Framingham State College (Framingham, Massachusetts) in 1970. Following her death, the college established *The Christa McAuliffe Center* on the campus as a means to continue the educational mission which was Christa's life's work.

On February 1, 2003, a second space shuttle, the Columbia, was lost. The Columbia was the oldest shuttle in the fleet, having been first flown in 1981 by astronauts John Young and Robert Crippen. On its 28th flight, Columbia broke apart during reentry at an altitude of some 200,000 feet and a speed of 12,500 miles per hour. The shuttle and its crew of seven had just completed a 16-day science mission. The most likely cause of the accident was damage to a seal on the left wing from a piece of insulating foam that broke loose from the external fuel tank at launch, striking the wing. The resulting gap in the wing allowed the superheated atmosphere to penetrate the wing during reentry and destroy the spacecraft. The Columbia accident ultimately led to the decision to stop flying the space shuttle once the International Space Station was complete and spurred efforts to develop a safer manned vehicle.

The "Forever Remembered" memorial in the Space Shuttle Atlantis exhibit at the Kennedy Space Center Visitor Complex in Florida. Visitors entering the darkened room will see a section of the fuselage recovered from space shuttle Challenger (left) and the flight deck window frames recovered from the space shuttle Columbia.

Photo: Bill Cloutier

January Nights

January nights can be clear and cold with frigid blasts of polar wind. They also present an opportunity to see stars at every stage in their life cycle, from birth (Orion Nebula) to fiery demise (Crab supernova remnant).

If you are out observing the open star clusters Pleiades or Hyades (in mythology, half-sisters to the Pleiades) in the constellation Taurus, don't overlook the orange-colored star Aldebaran (spectral type of K5 with a surface temperature of 4,010° K as compared to the Sun's 5,780° K temperature). While not part of the Hyades cluster (which is more than twice as far away as the red giant), the "eye of the bull," and the brightest star in Taurus, is estimated to be about 67 light years away and the fourteenth brightest star in our sky.

Sunrise and Sunset (from New Milford)

Sun	Sunrise	Sunset
January 1st (EST)	07:20	16:34
January 15th	07:17	16:48
January 31st	07:06	17:08

Astronomical and Historical Events

1st History: flyby of the Kuiper Belt Object 486958 *Arrokoth* (2014 MU69) by the New Horizons spacecraft (2018)
1st History: GRAIL-B spacecraft enters lunar orbit (2012)
1st History: Giuseppe Piazzi discovers the first asteroid, now dwarf planet, *Ceres* (1801)
2nd History: flyby of comet *Wild 2* by the Stardust spacecraft (2004)
2nd History: launch of the Soviet spacecraft Luna 1; first probe to fly by the Moon (1959)
3rd History: exploration rover Spirit lands on Mars in Gusev Crater; operational for six years before getting bogged down in loose soil at a winter haven called Troy (2004)
3rd History: Stephen Synnott discovers Uranus' moons *Juliet* and *Portia* (1986)
4th Earth at Perihelion – closest distance from Sun (0.983 AU)
4th Closest approach of Apollo class Near Earth Object (NEO) 2021 AO4
4th Quadrantids meteor shower peaks in the early morning hours; radiates from the constellation Boötes (name from an obsolete constellation called Quadrans Muralis)
4th History: Isaac Newton born; inventor of the reflecting telescope, described universal gravitation, compiled the laws of motion, and invented calculus (1643)
5th Closest approach of Apollo class NEO and Potentially Hazardous Asteroid (PHA) 2020 BC6
5th History: discovery of dwarf planet *Eris* (the Pluto killer) by Mike Brown, et al. (2005)
5th History: President Nixon announces the development of the space shuttle; "a space vehicle that can shuttle repeatedly from Earth to orbit and back" (1972)
5th History: launch of the Soviet atmospheric probe, Venera 5, to Venus (1969)
5th History: discovery of Jupiter's moon *Elara* by Charles Perrine (1905)
6th First Quarter Moon
6th History: launch of the Lunar Prospector spacecraft; detected signs of water ice in permanently shadowed craters, mapped surface composition and Moon's gravity field and detected outgassing events in the vicinity of craters Aristarchus and Kepler (1998)
6th History: launch of Surveyor 7, the last of the unmanned Surveyor spacecrafts; soft-landed near Tycho crater (1968)
7th Moon at perigee (closest distance from Earth)
7th History: discovery and first recorded observations of Jupiter's four largest moons *Io*, *Europa*, *Ganymede* and *Callisto* by Galileo Galilei (1610)
8th Closest approach of Apollo class NEO 2024 BM1
8th Closest approach of Apollo class NEO 2024 PT5
8th Inaugural flight of a United Launch Alliance Vulcan Centaur rocket, carrying the Peregrine commercial lunar lander for Astrobotic and two prototype satellites for Amazon's Kuiper broadband constellation. The launch was conducted from the Cape Canaveral Space Force Station, Florida (2024)
8th History: launch of Japanese spacecraft Sakigake with mission to rendezvous with Comet *Halley*; measured the solar wind and magnetic field (1985)
8th History: launch of Luna 21 and the Lunokhod 2 moon rover (1973)
8th History: Stephen Hawking born (exactly 300 years after the death of Galileo); discovered that black holes could emit radiation - subsequently known as Hawking radiation (1942)
9th History: Alex Wolszczan and Dale Frail discover two exoplanets (Poltergeist and Phobetor) orbiting a pulsar PSR B1257+12 (1992)
9th History: Voyager 2/Stephen Synnott discovers Uranus' moon *Cressida* (1986)
10th Closest approach of Aten class NEO 2012 UK171

Astronomical and Historical Events (continued)

10th History: launch of the Soviet atmospheric probe, Venera 6, to Venus (1969)
10th History: U.S. Army first bounces radio waves off the Moon (1946)
11th Second Saturday Stars – Open House at the McCarthy Observatory, 7 to 9 PM
11th History: Lunar Prospector spacecraft enters lunar orbit for a nineteen-month chemical mapping mission (1998)
11th History: William Herschel discovers Uranus' moons *Titania* and *Oberon* (1787)
12th History: launch of the Deep Impact spacecraft for a flyby of comet *Tempel 1*; a small "impactor" was later released from the main spacecraft for a July 4th collision with the comet's nucleus (2005)
12th History: Sergei Pavlovich Korolev born, Chief Designer of the Soviet space program (1907)
12th History: Astronomical Society of London conceived with Sir William Herschel first President (chartered in 1831 as the Royal Astronomical Society) (1820)
13th History: Stephen Synnott discovers Uranus' moons *Desdemona*, *Rosalind* and *Belinda* (1986)
13th History: discovery of the Martian meteorite EETA 79001 in Antarctica; second largest Martian meteorite recovered after *Zagami* (1980)
14th Full Moon
14th Closest approach of Apollo class NEO 2023 OS
14th History: first of three flybys of the planet Mercury by the Messenger spacecraft (2008)
14th History: landing of the Huygens probe on Saturn's largest moon *Titan* (2005)
15th History: Stardust spacecraft returns samples of Comet P/*Wild 2* (2006)
15th History: launch of the spacecraft Helios 2, solar orbiter (1976)
15th History: Lunokhod 2, the second of two Soviet unmanned lunar rovers, lands in Le Monnier crater; covered a total distance of 23 miles (37 km) in almost five months of exploring the floor of the crater and its southern rim (1973)
16th Closest approach of Apollo class NEO 2022 CE2
16th History: final launch of space shuttle Columbia (STS-107); lost on re-entry (2003)
17th Closest approach of Apollo class NEO 2022 OB5
17th History: Astronomer Edwin Hubble publishes paper that the Universe is expanding – "*A Relation Between Distance and Radial Velocity Among Extra-Galactic Nebulae*" (1929)
17th History: launch of Jason 3, an ocean altimetry satellite from the Vandenberg Air Force Base, California (2016)
17th History: Pierre Mechain's discovery of Comet 2P/*Encke* (1786); short period comet that completes a circuit around the Sun every 3.3 years, named after Johann Encke who computed the comet's orbit, recognizing it as a periodic comet
19th History: launch of the New Horizons spacecraft to Pluto; executed a close encounter with the dwarf planet in July 2015 (2006)
19th History: Mars Exploration Rover "Opportunity" discovers first meteorite on Mars (Heat Shield Rock) (2005)
19th History: discovery of the Martian meteorite SAU 090, a basaltic shergottite, in Oman (2002)
19th History: discovery of Saturn's moon *Janus* by the Voyager 1 spacecraft (1980)
19th History: launch of Gemini 2, an unmanned suborbital flight designed to test the spacecraft's heat shield (1965)

Astronomical and Historical Events (continued)

19th History: Johann Bode born, popularized an empirical law on planetary distances originally developed by J.D. Titius, known as "Bode's Law" or "Titius-Bode Law" (1747)
20th Moon at apogee (furthest distance from Earth)
20th History: Rich Terrile discovers Uranus' moons *Cordelia* and *Ophelia* (1986)
21st Last Quarter Moon
21st History: launch of the rocket Little Joe-1B and a rhesus monkey named "Miss Sam" in a successful test of the Mercury capsule's escape system (1960)
21st History: John Couch Adams born, astronomer and mathematician who was the first person to predict the position of a planet beyond Uranus (1792)
22nd History: launch of Apollo 5, the first Lunar Module flight (1968)
23rd History: Brad Smith discovers Uranus' moon *Bianca* (1986)
24th History: launch of space shuttle Discovery (STS-51-C); 100th human spaceflight to achieve orbit (1985)
24th History: discovery of the Martian meteorite Dhofar 019 in Oman (2000)
24th History: launch of Japan's Hiten spacecraft; first use of a low-energy transfer to modify an orbit and the first demonstration of a transfer to the Moon requiring no change in velocity for capture (1990)
24th History: flyby of Uranus by the Voyager 2 spacecraft (1986)
25th History: exploration rover Opportunity lands on Mars at Meridiani Planum; operated for over 14 years before being crippled by a global dust storm in 2018 (2004)
25th History: launch of the Infrared Astronomical Satellite (IRAS); first space telescope to survey of the entire sky at infrared wavelengths (1983)
25th History: launch of the U.S. Moon orbiter Clementine (1994)
25th History: Joseph Lagrange born (1736); mathematician who discovered five special points in the vicinity of two orbiting masses where a third, smaller mass can orbit at a fixed distance from the larger masses. The L1 Lagrange Point of the Earth-Sun system is the current home of the Solar and Heliospheric Observatory Satellite (SOHO), the James Webb Space Telescope is heading for L2 (1 million miles beyond the Earth and away from the Sun).
26th History: discovery of dwarf planet *Haumea*'s moon *Hi'laka* by Mike Brown, et al. (2005)
26th History: discovery of Saturn's moon *Epimetheus* by the Voyager 1 spacecraft (1980)
26th History: launch of the International Ultraviolet Explorer (IUE); space telescope and spectrographs; designed to take ultraviolet spectra (1978)
27th History: fire in the Apollo 1 spacecraft kills astronauts Gus Grissom, Edward White and Roger Chaffee (1967)
27th History: Philibert Melotte discovers Jupiter's moon *Pasiphae* (1908)
28th History: final launch of the space shuttle Challenger (STS-51L); lost on lift-off (1986)
28th History: Johannes Hevelius born; leading observational astronomer of the 17th century, published detailed maps of the Moon and determined the rotational period of the Sun (1611)
29th New Moon
29th History: Soviet spacecraft Phobos 2 enter orbit around Mars; successfully returned 38 images before contact was lost; its lander was not deployed (1989)
30th History: Yuji Hyakutake discovers the Great Comet of 1996 (1996)
31st Closest approach of Apollo class NEO 2015 DJ155

Astronomical and Historical Events (continued)

31st History: launch of SMAP (Soil Moisture Active Passive) satellite into a polar orbit around Earth (2015)
31st History: launch of Apollo 14; third manned moon landing with astronauts Alan Shepard, Stuart Roosa and Edgar Mitchell (1971)
31st History: launch of Soviet Moon lander Luna 9; first spacecraft to land and to transmit photographs from the Moon's surface (1966)
31st History: launch of Mercury-Redstone 2 rocket with Ham the chimpanzee (1961)
31st History: launch of the first U.S. satellite, Explorer 1; detected inner radiation belt encircling the Earth (1958)

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

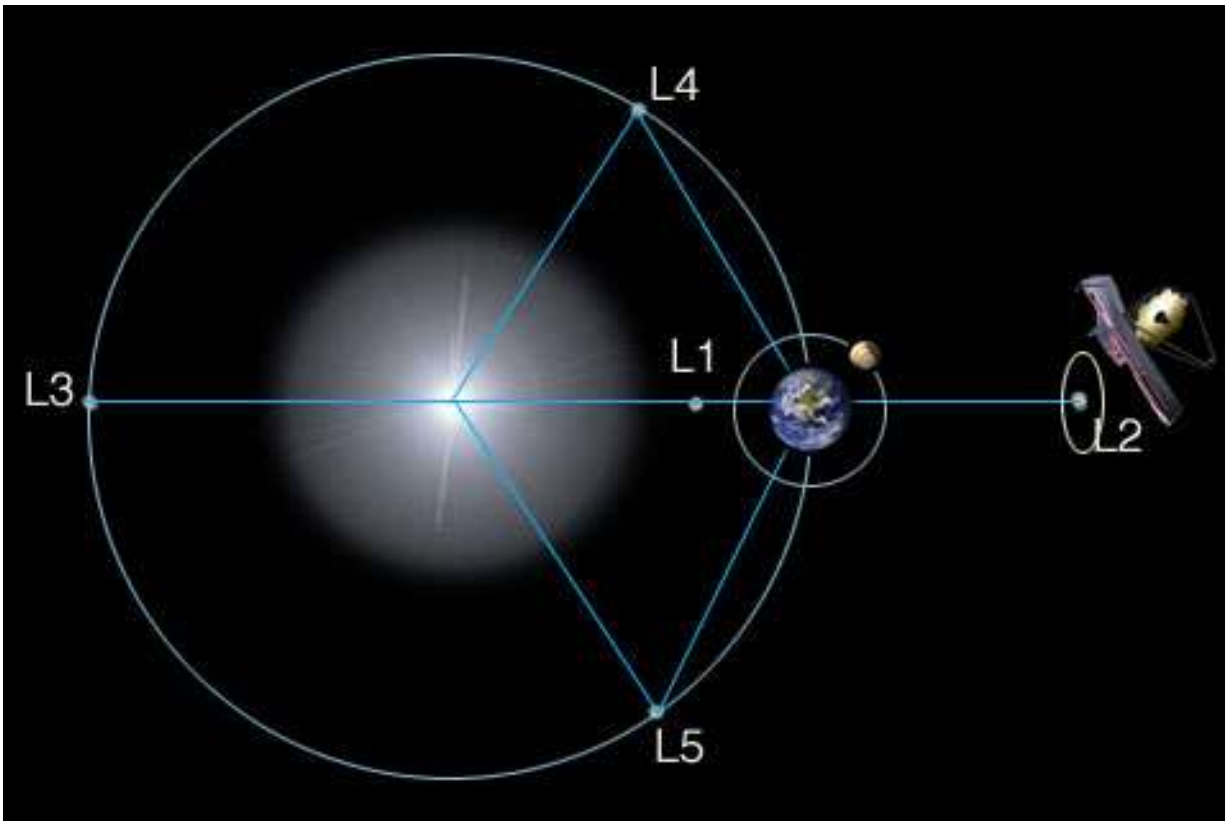
References on Distances

- 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 the bright flares from Iridium satellites.

Lagrange Points



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

James Webb Space Telescope

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

Euclid Space Telescope

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

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

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 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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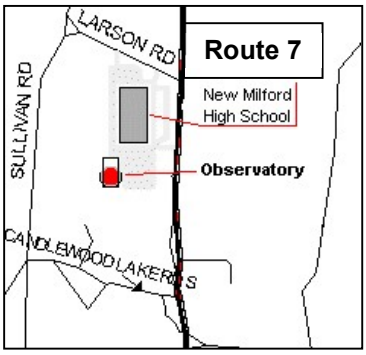

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