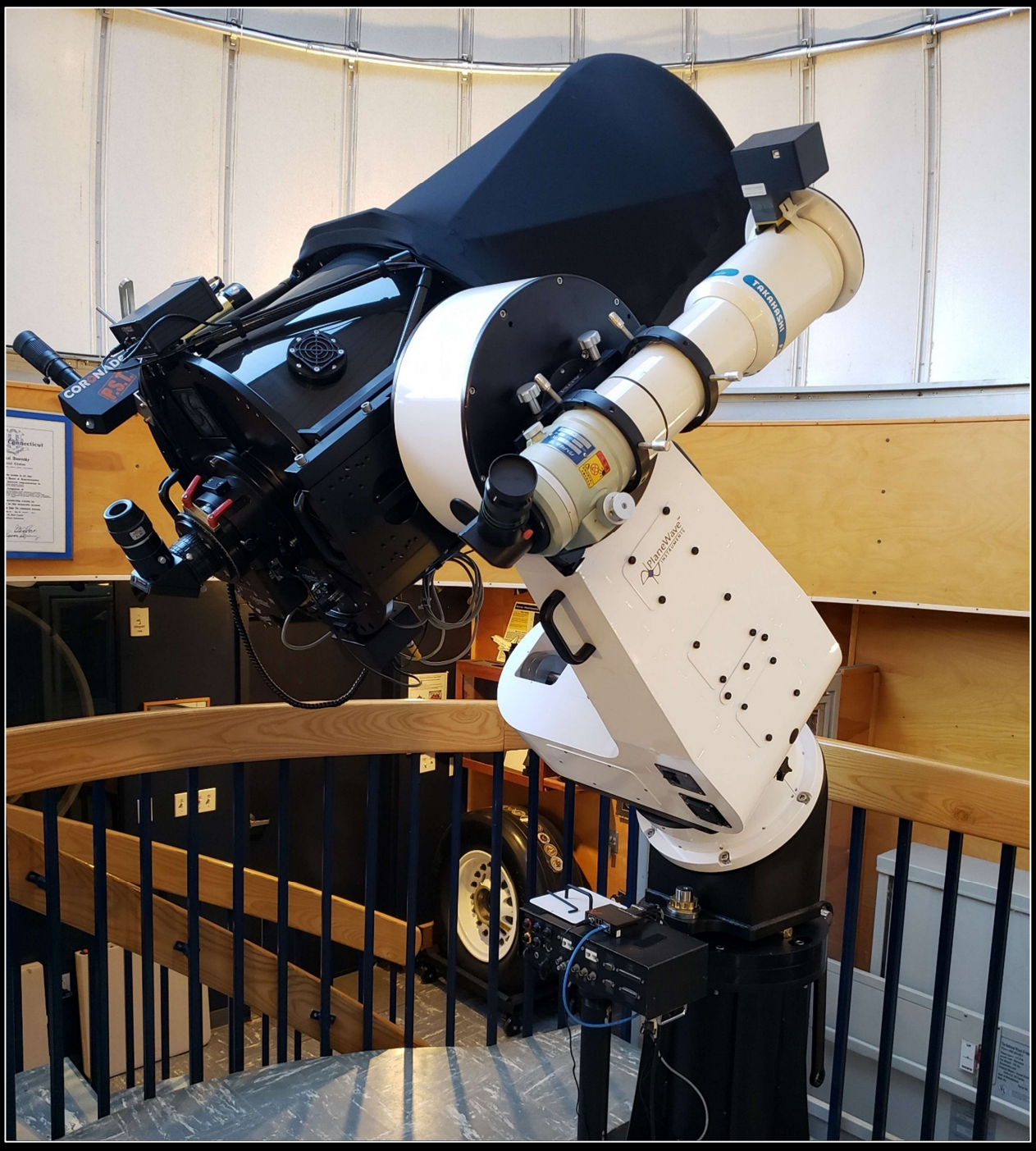
Galactic Observer

John J. McCarthy Observatory

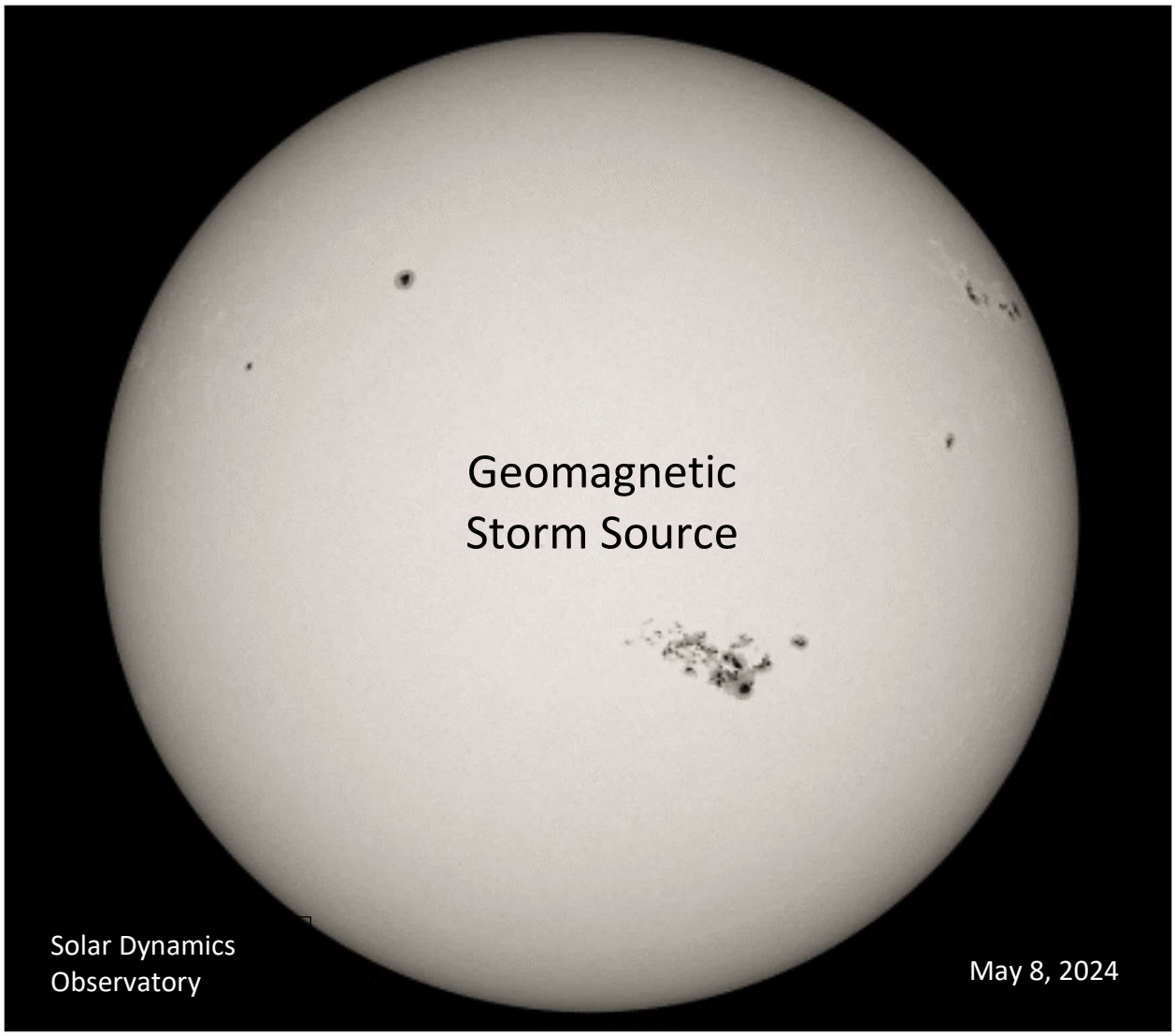
Volume 17, No. 6 June 2024

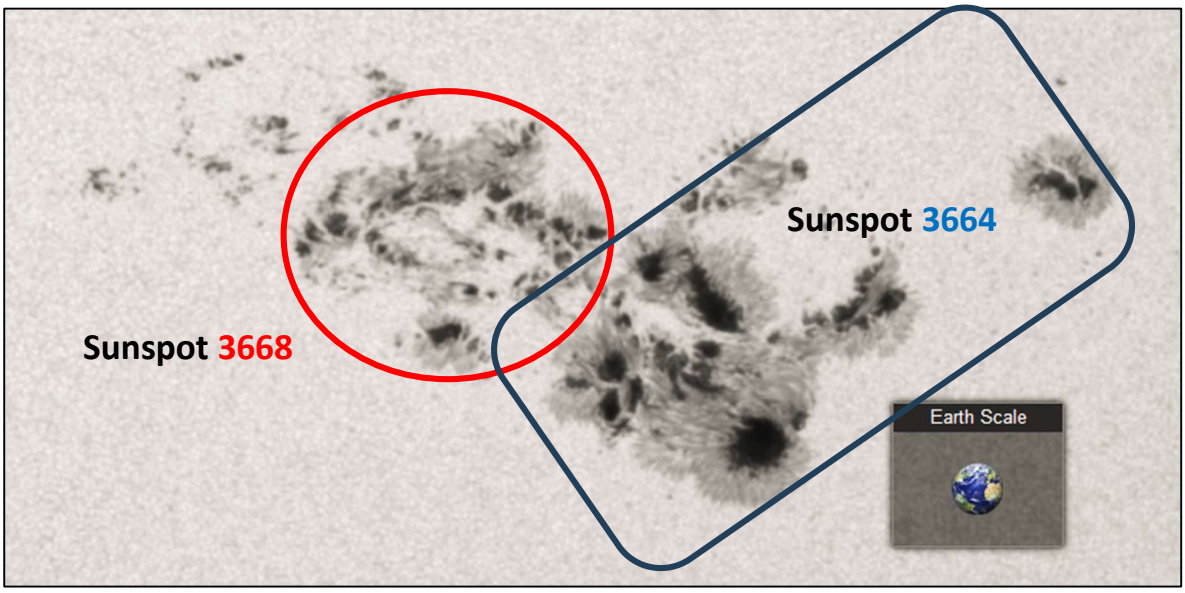


McCarthy Observatory's next generation telescope, a 17-inch (0.43 m) f/6.8 corrected Dall-Kirkham Astrograph, is now fully operational

Photo: Bill Cloutier

June Astronomy Calendar and Space Exploration Almanac

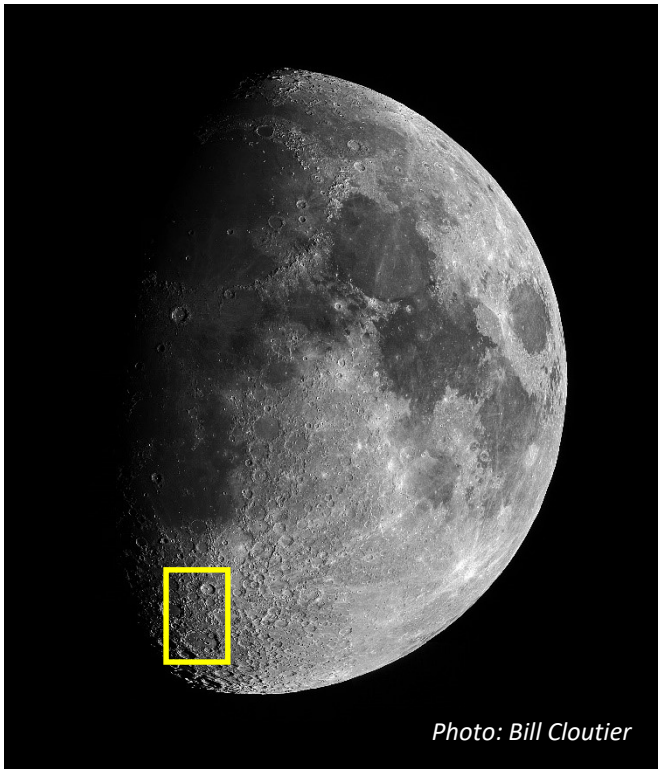




In This Issue

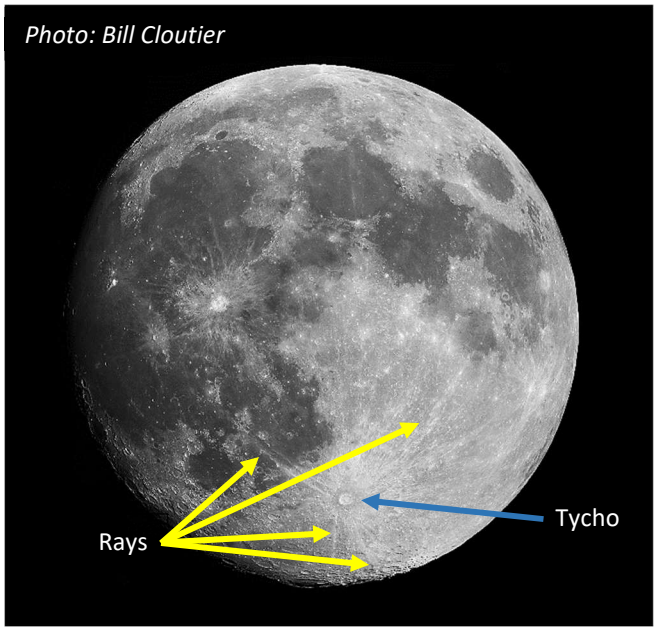
"Out the Window on Your Left"

It's been almost 55 years since Neil Armstrong first stepped onto the Moon's surface and more than 51 years since Gene Cernan left the last footprint. As a nation founded on exploration and the conquest of new frontiers, today's commitment to return to the Moon has been as fleeting as the funding. But what if the average citizen had the means to visit our only natural satellite; what would they see out the window of their spacecraft as they entered orbit around the Moon? This column may provide some thoughts to ponder when planning your visit (if only in your imagination).



Southern Lunar Highlands

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

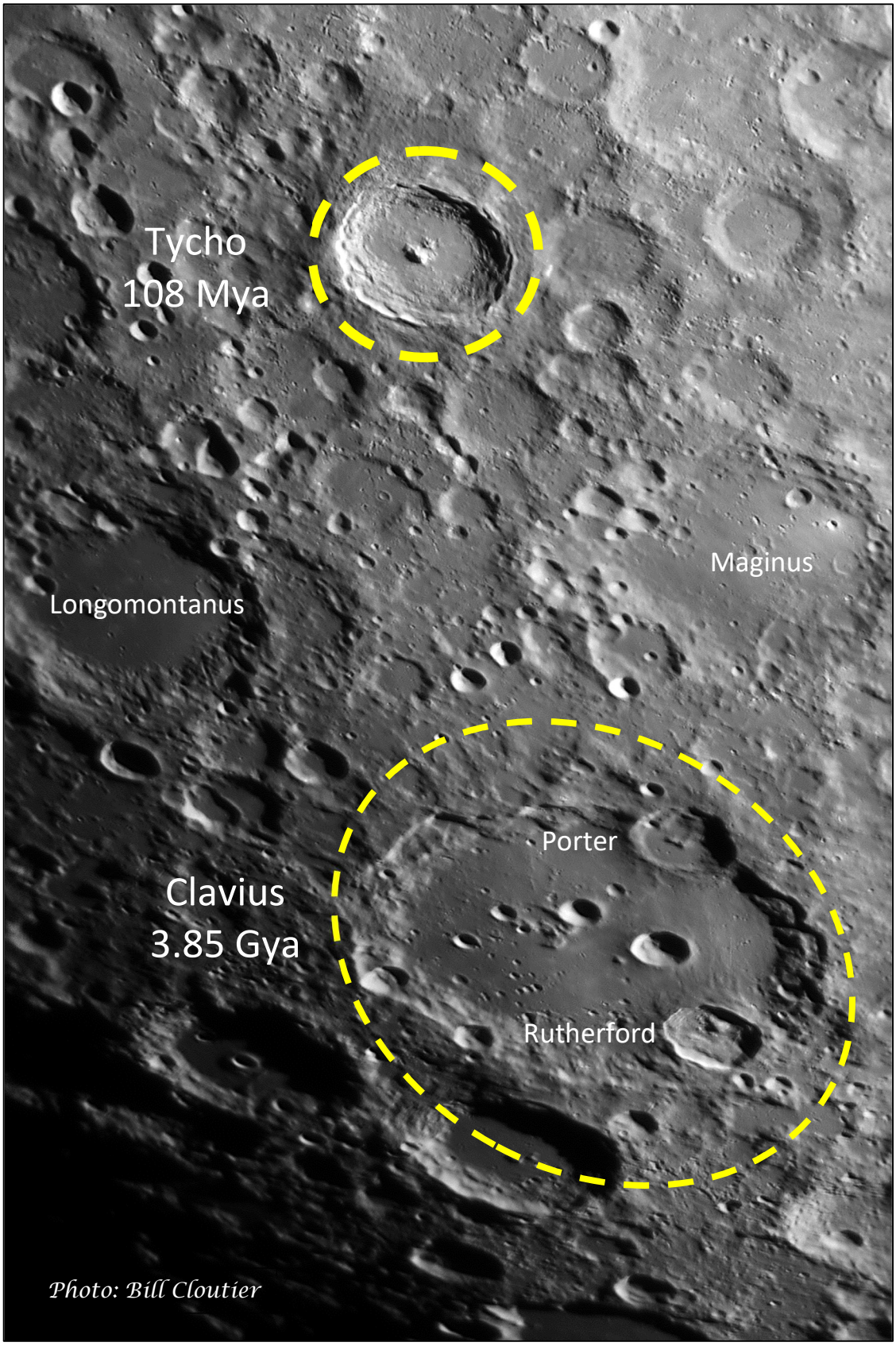


Rays from Tycho Crater

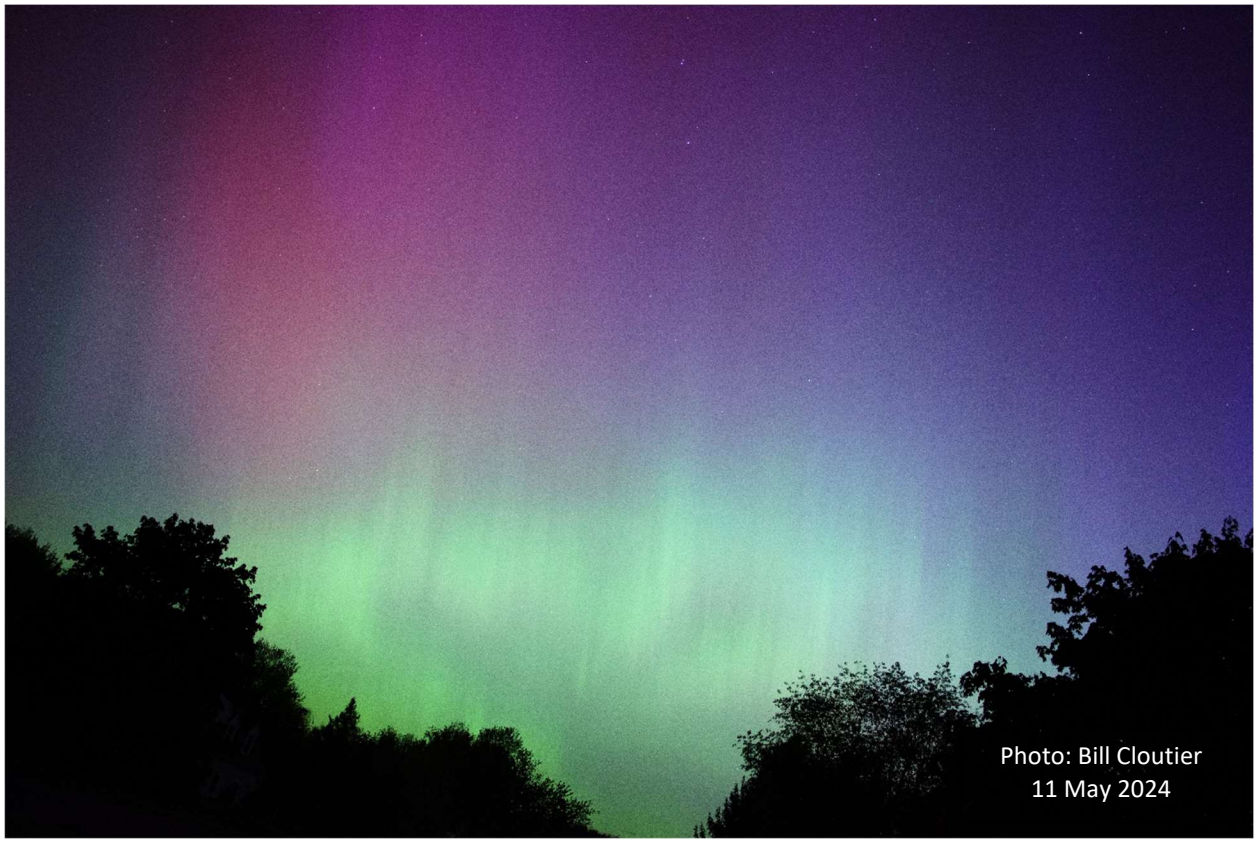
Located in the crater-filled southern highlands are two craters from vastly different geological eras – Clavius and Tycho. Clavius, one of the largest craters on the near side, formed at the end of the lunar Nectarian period, approximately 3.85 billion years ago. This large "walled plain" spans more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

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

Tycho and Clavius



Solar Maximum Approaching

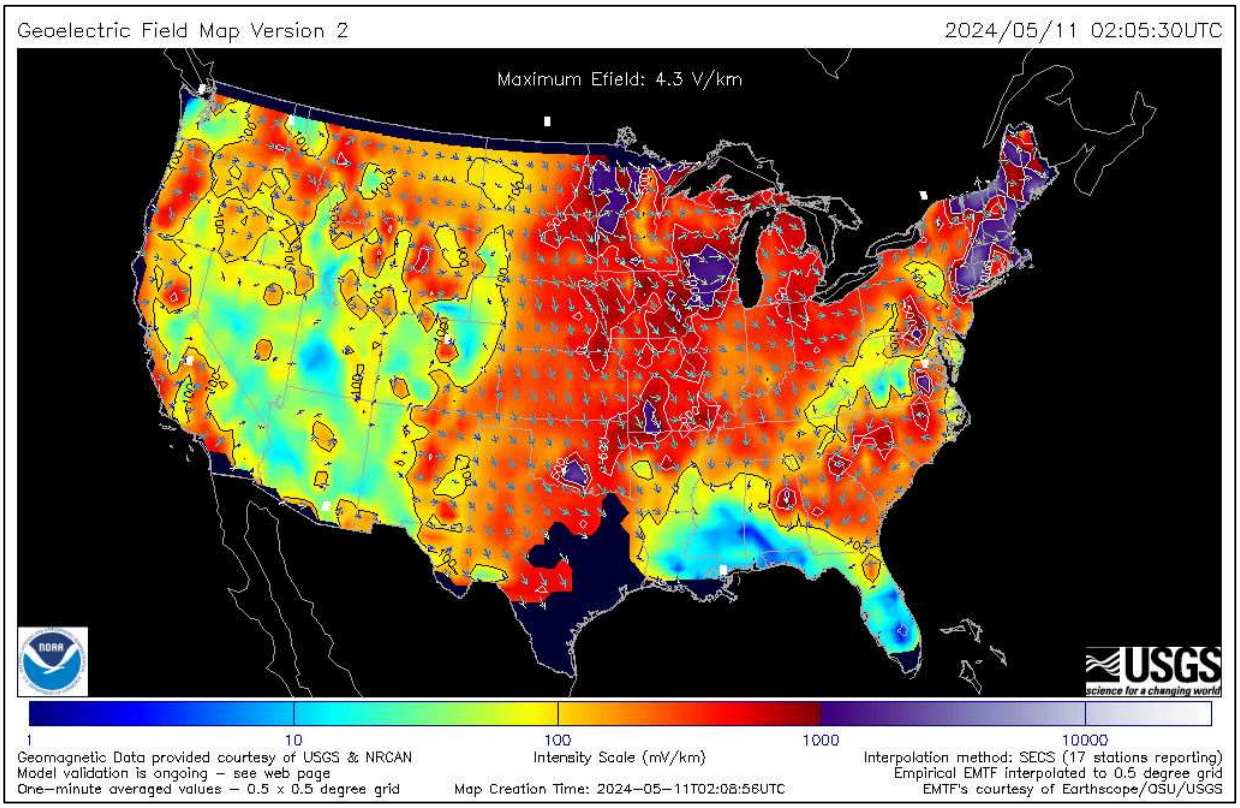


Auroral colors are produced by the collision of charged particles in the solar wind with molecules in the Earth's atmosphere. Nitrogen gas dominates the lower atmosphere, while oxygen is the primary constituent of the upper region. The most common color, green, is the result of collisions with oxygen atoms at altitudes up to 150 miles (240 km), although the excitation of oxygen can also produce red emissions above that altitude. Pink and dark red colors are produced by nitrogen molecules at altitudes around 60 miles (100 km), while blue and purple auroras, which can be difficult to see with the eye, are from the excitation of hydrogen and helium molecules, which are more prevalent in the upper atmosphere.

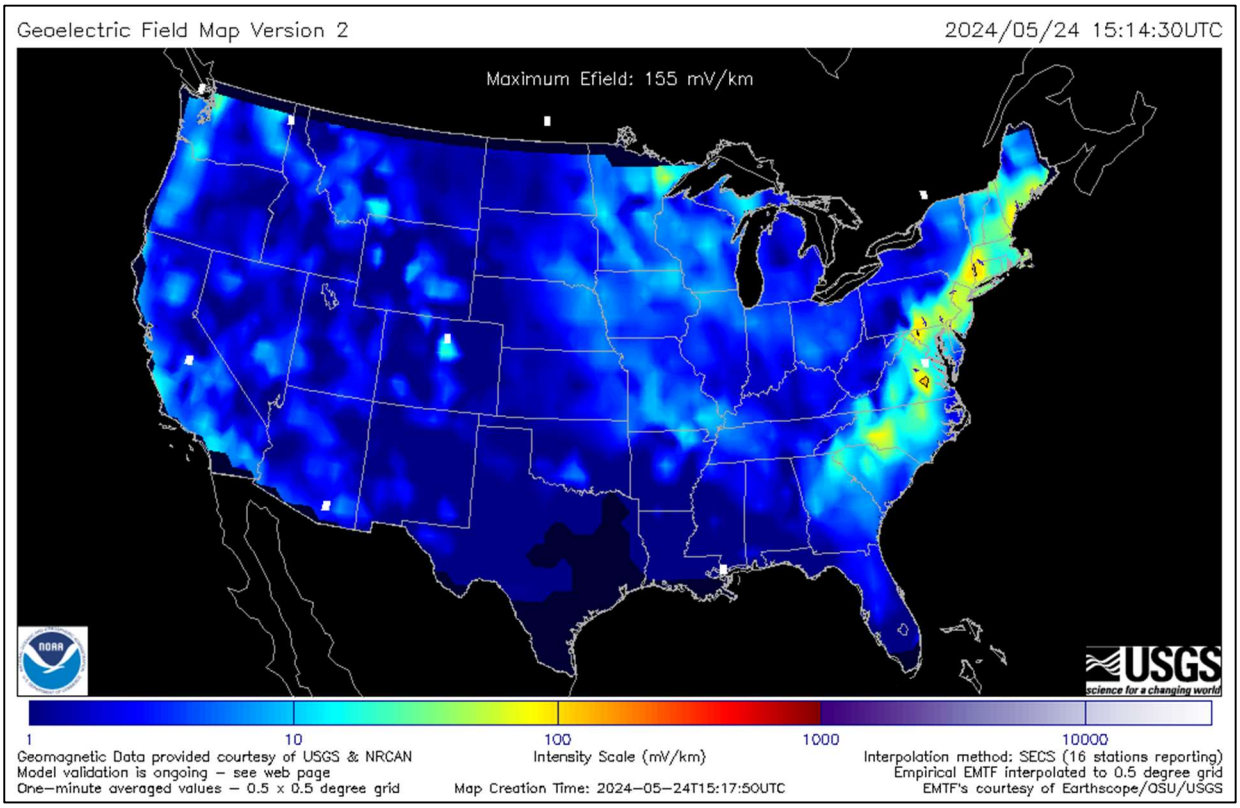
The month of May began with the sudden appearance of a large and unstable sunspot (AR3663), which at that time, was the most active sunspot of the current solar cycle. This was followed by an even larger and more dangerous sunspot (AR3664) which grew to span 125,000 miles (200,000 km) across the solar photosphere, 15 times the diameter of Earth.

Sunspot AR3664 produced a series of high-energy flares, known as X-class, and launched at least seven Coronal Mass Ejections or CMEs (clouds of plasma, charged particles with an embedded magnetic field) towards Earth during the first week in May. Several days later, the arrival of the CMEs sparked a "Severe" class geomagnetic storm, producing an auroral display that was visible as far south as the Caribbean.

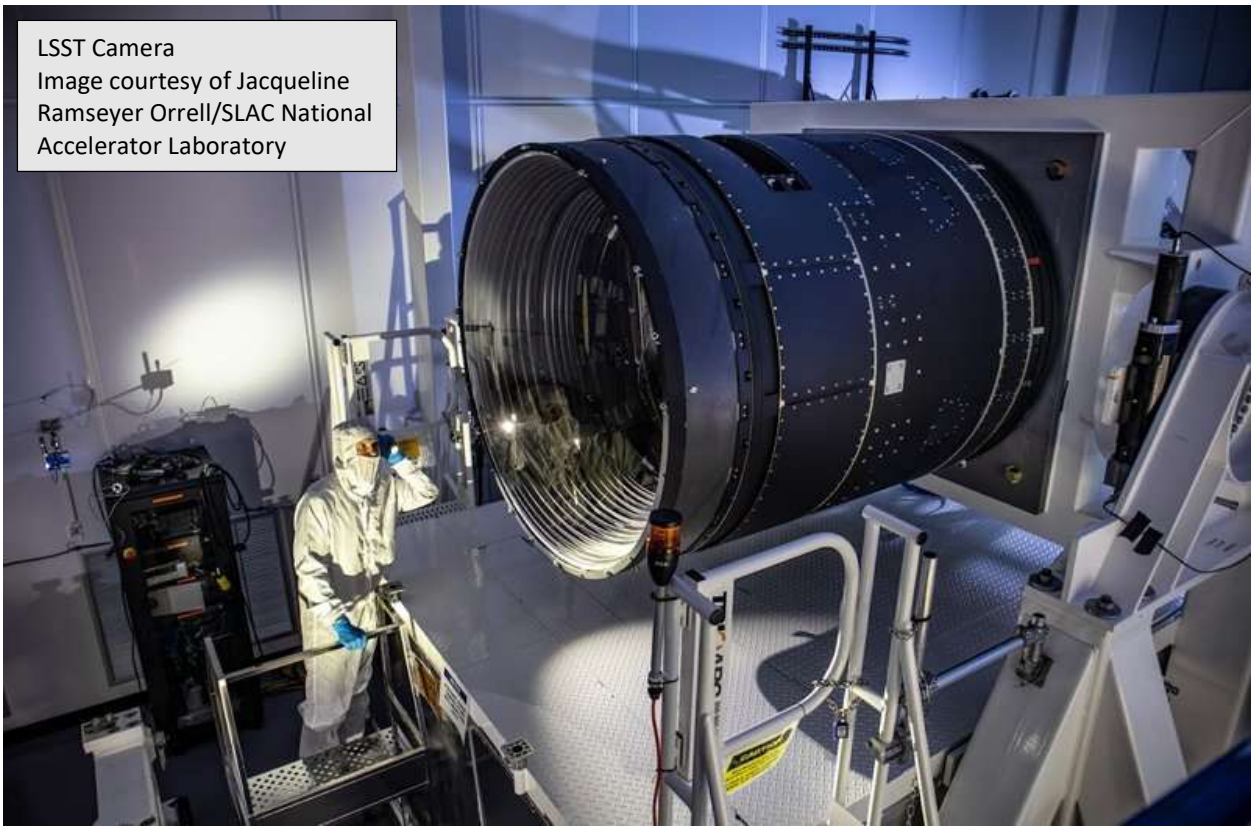
Geomagnetic storms can have significant impacts on power grids, inducing currents in power lines and causing damage to transformers. They can also affect satellite communications, as well as GPS and other navigation systems, and radio communications that rely on high frequencies.



The intense geomagnetic storm in early May produced significant geoelectric fields (shown above) in the Earth's electrically conducting crust, mantle, and ocean, sending strong electrical currents surging through rocks and soil, as compared to periods of relatively calm space weather (below). In March 1989, an intense magnetic storm caused the collapse of the entire Hydro-Québec electric power grid in Canada.



A New Eye on the Sky



LSST Camera
Image courtesy of Jacqueline Ramseyer Orrell/SLAC National Accelerator Laboratory

The Legacy Survey of Space and Time (LSST) Camera, two decades in the making, has been delivered to the summit of Cerro Pachón, more than 8,900 feet from sea level in Chile. The 6,200 pound (2,800 kg), 3,200 megapixel camera will be installed on the Vera C. Rubin Observatory's telescope along with Rubin's newly-coated 8.4-meter primary mirror. The camera is designed to further research into dark matter and dark energy.

The observatory is a federal project jointly funded by the National Science Foundation and the Department of Energy Office. LSST will be used to conduct a 10-year survey of the Southern Hemisphere sky, imaging the entire sky every 3 to 4 nights. With the light gathering power of the Simonyi Survey Telescope, combined with the world's largest imaging system, billions of new galaxies are expected to be revealed, as well as objects that fluctuate in brightness (e.g., nova) or position (e.g., asteroids).

The camera, built at the SLAC National Accelerator Laboratory in Menlo Park, California, traveled to Chile in a custom-outfitted shipping container aboard a 747 cargo plane. From the airport in Santiago, the $168 million camera was moved by a dedicated transport vehicle to the base of Cerro Pachón and then up a 21.7 mile (35 km) dirt road to the summit where it was placed into a "clean room" at the observatory.

The Vera C. Rubin Observatory is named after an American astrophysicist who pioneered work on galaxy rotation rates, which provided some of the strongest evidence that dark matter exists. Her work suggested that galaxies could contain ten times more mass than can be accounted for by the visible stars (referred to as "dark matter"). Survey images from LSST are expected to reveal more about the nature of this unseen substance.

Sailing on the Solar Wind

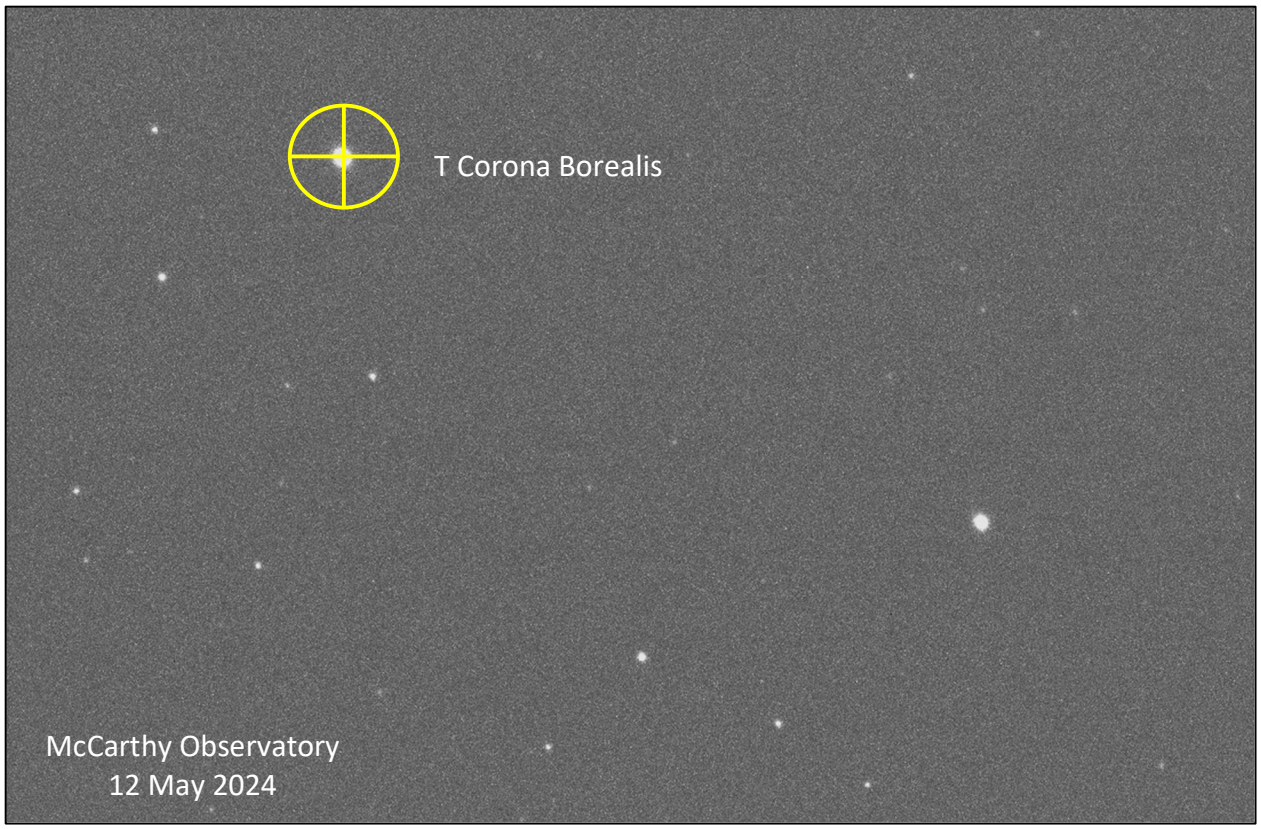
NASA's Advanced Composite Solar Sail System (ACS3) was successfully placed into a 621-mile (1,000 km) high, sun-synchronous orbit on a Rocket Lab ride-share mission, accompanying an imaging satellite provided by the Korea Advanced Institute of Science and Technology. The two participants' payloads rode into low-Earth orbit aboard an Electron rocket, launched from Rocket Lab's site in New Zealand on April 24th (NZT).

The ACS3 spacecraft is based around a twelve-unit CubeSat bus. Once commissioning is complete, the satellite will be instructed to deploy its flexible polymer and carbon fiber booms to a length of about 30 feet (9.1 meters). ACS3's composite booms are 75% lighter than previously flown metallic booms and won't be as prone to thermal heating and distortion.

Once deployed, the ultrathin plastic sail, held taught by the booms, will measure about 860 square feet (80 square meters). Mission objectives include the evaluation of the efficacy of the shape and design of the solar sail, as well as assessing system performance as the spacecraft gradually changes orbit.

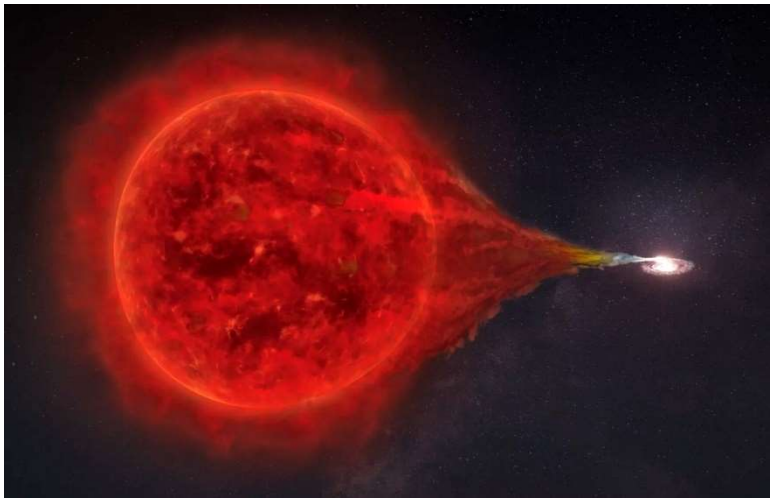
Solar sails use the pressure of sunlight for propulsion. The ACS3 mission is a technology demonstration. The data from this mission will be used to design future, and larger sail craft that could be used for asteroid and other small body reconnaissance missions, as well as solar scouting missions. Since solar radiation pressure exerts such a small force, solar sails must be very large to efficiently generate thrust. However, sailing on sunlight, inner solar system missions would be extraordinarily fuel-efficient.

Awaiting the Arrival of a Thermonuclear Explosion



T Corona Borealis is a binary star located in the constellation Corona Borealis, near Boötes and just to the west of Hercules. The system is comprised of a white dwarf and a late-stage red giant, separated by a distance roughly equivalent to half that between our Sun and Earth.

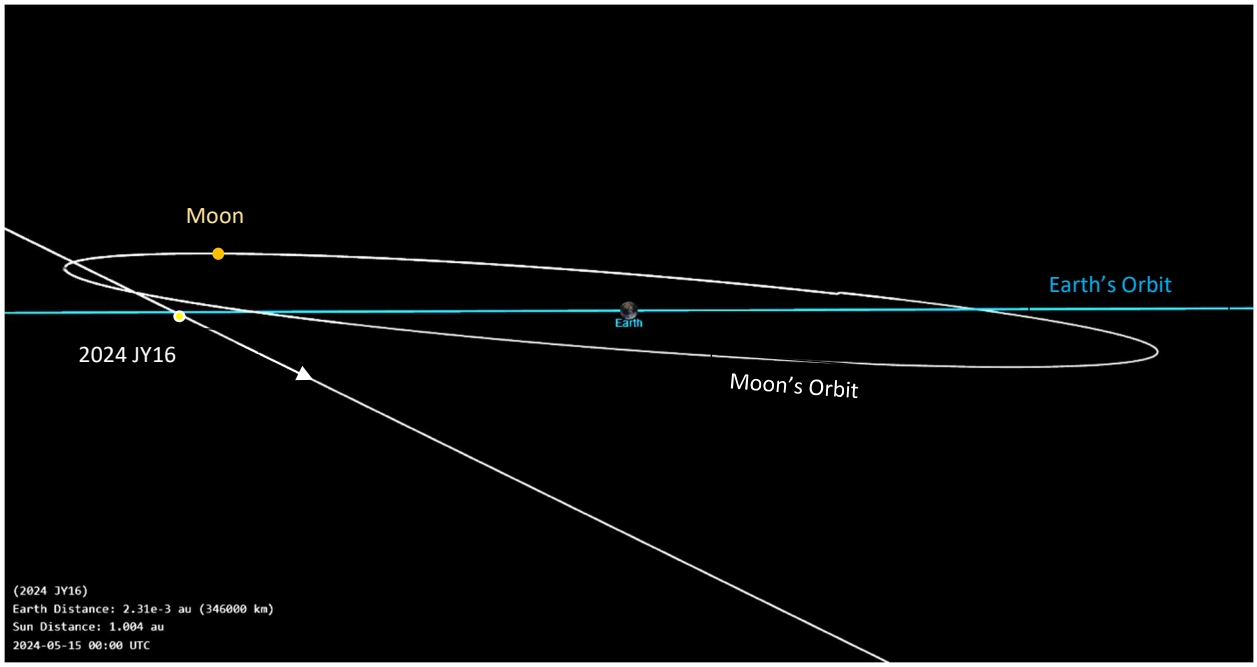
The white dwarf is accreting material from the red giant. Over a period of about 80 years, the white dwarf accumulates enough mass, which becomes compressed and heated, that a thermonuclear reaction is triggered.



An artist's impression of a symbiotic binary system
Image credit: superbossa.com / MPP

The detonation releases enough energy to brighten the "star," currently invisible to our eye without optical aid, fifteen hundred fold. T Corona Borealis is one of less than a dozen known "recurrent novae" that appear on a predictable schedule. Previous nova appearances were documented in 1866 and 1946, and another outburst may have been recorded as early as 1217. The next outburst is likely to occur sometime in the next few months. The McCarthy Observatory has been, and will continue to monitor the binary for any impending changes in its brightness, which would signify the arrival of light from a cataclysmic event 3,000 light years away.

McCarthy Observatory and Planetary Protection



A network of telescopes scans the skies every clear night, looking for space rocks that might be on a collision course with Earth. Discoveries are reported to organizations such as the Minor Planet Center where the information is made available to other observatories around the world in a request for additional observations (which are used to refine the initial orbital parameters). The McCarthy Observatory is one of the observatories that provides confirmatory observations, with 2,167 highly accurate observations submitted since receiving its International Astronomical Union (IAU) code (932) in 2001.

On May 13th (Coordinated Universal Time or UTC), a space rock estimated to be about 130 feet across (39 meters) was discovered to be on close approach to Earth. The rock belongs to a group of near-Earth asteroids and, while spending most of their time outside Earth's orbit, will periodically cross our planet's orbit.

The McCarthy Observatory conducted observations of, what would be called, 2024 JY16 on May 14th, less than 24 hours after its discovery. Within two days of its discovery, the newly-found asteroid passed between the Earth and Moon at a speed in excess of 37,500 miles per hour (60,500 kph). Despite a relatively short orbital period of 1,305 days, 2024 JY16 next close encounter with Earth won't be until May 2061.

There are 2,518 observatories that have an observatory code issued by the IAU's Minor Planet Center. For the lunation between April 23rd and May 23rd, the McCarthy Observatory was ranked among the top 20 observatories in the world for their follow-up observations that confirm newly discovered and possibly Earth-threatening asteroids. Many of the other 19 observatories are large telescopes situated on mountain tops that are funded by governments and space agencies and operated by paid professionals.

Threat Assessment

Orbital debris has become the foremost hazard to human spaceflight. Derelict spacecraft, expended rocket stages, bits and pieces of material released during spacecraft deployment, solid rocket motor effluent, and debris from explosions or collisions, have served to create a virtual minefield that any spacecraft operator must navigate. More than 25,000 objects larger than 4 inches (10 cm) are known to exist, with greatest concentration of debris found between 470 and 620 miles (750-1000 km). Traveling in low-Earth orbit at speeds between 15,000 and 18,000 miles per hour (7 to 8 kps), collisions involving even the smallest particles can impart enormous energy. The estimated population of particles less than 4 inches (10 cm) in diameter is approximately 500,000, with particles larger than 1 mm exceeding 100 million.

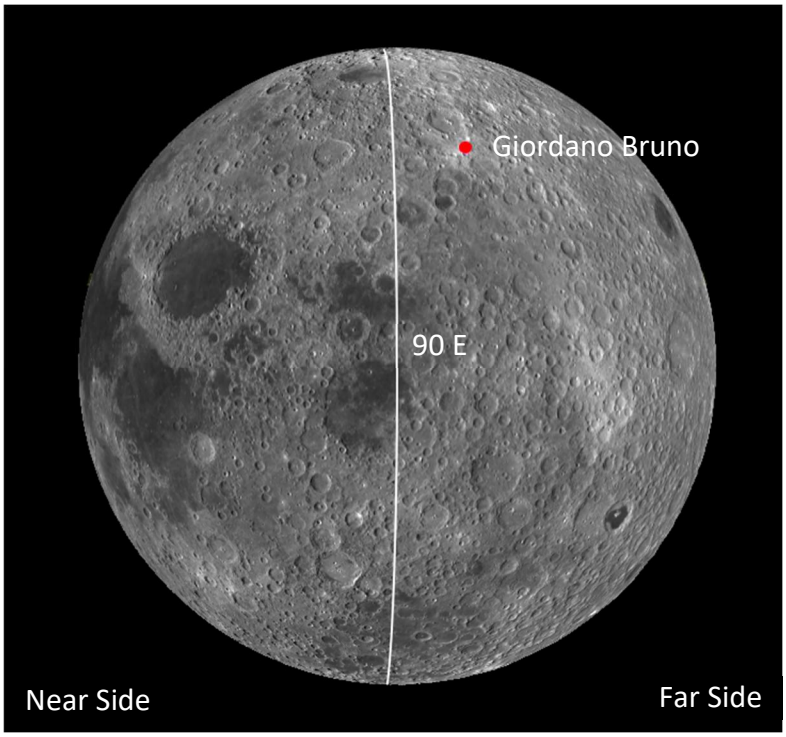
A derelict rocket imaged by the Astroscale ADRAS-J mission
Credit: Astroscale

The Japanese satellite technology company, Astroscale, used its ADRAS-J satellite to rendezvous with an upper stage rocket body. ADRAS-J was launched on a Rocket Lab Electron rocket from Mahia, New Zealand on February 18th and has been incrementally altering its trajectory to cautiously approach the uncontrolled and non-communicative target. Using its on-board rendezvous sensors and precision control thrusters, the satellite was able to establish a proximity orbit around the target.

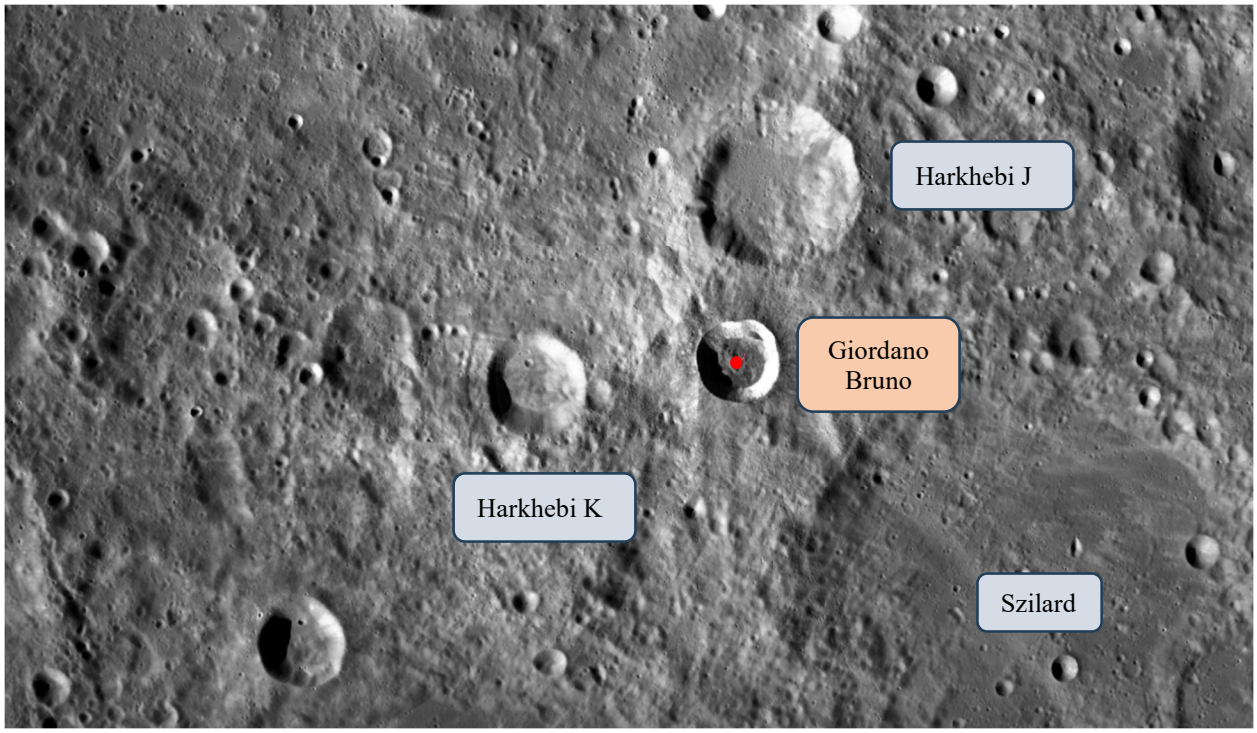
Designed to gather data on the rocket's condition and motion (e.g., is it tumbling? and, if so, how fast?), the pioneering mission is part of Japan Aerospace Exploration Agency's (JAXA's) "Commercial Removal of Debris Demonstration." In the next phase, if selected, the company would use its "in-house robotic arm technologies" to capture and deorbit large pieces of space debris such as this booster.

Lunar Flotsam?

The Earth and Moon are not alone in their annual trek around the Sun. A small group of almost 60 co-orbital objects have been identified on quasi-coplanar orbits for the Sun–Earth system. The most well-known member of this group, asteroid 2016 HO3 or 469219 Kamo'oalewa, was discovered by astronomers at Haleakalā Observatory in Hawaii in 2016. The small asteroid, 118 to 197 feet (36 to 60 meters) in diameter loops out as far as 100 times the distance of the Moon, and has a rapid spin rate, rotating once every 28 minutes.

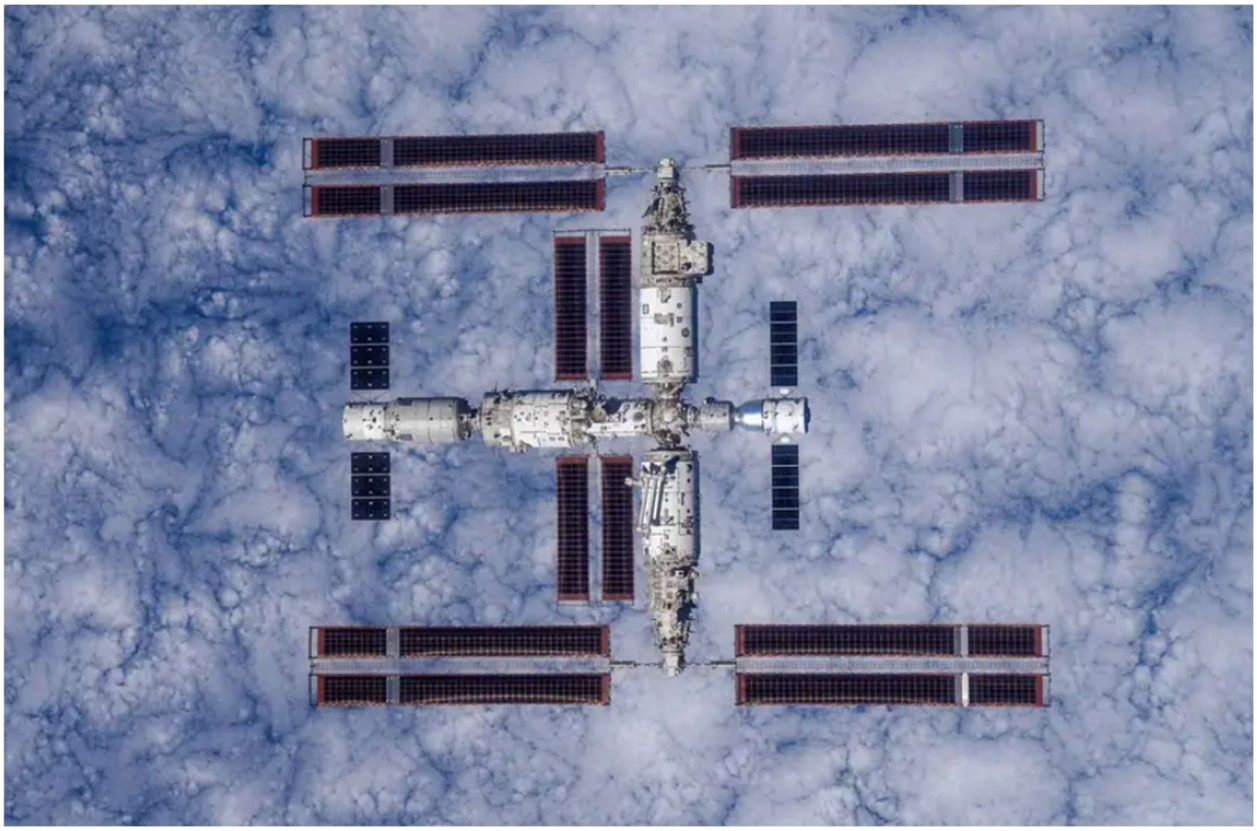


Analysis of the light reflected from Kamo'oalewa's surface has found a strong similarity with the chemical nature of the lunar soil returned by the Apollo astronauts, including the presence of olivine and/or pyroxene. This suggests that the asteroid may be of lunar origin, having been ejected as the result of an impact millions of years ago. Researchers simulating different formation scenarios, have narrowed down the place of origin for this space rock to a 14-mile wide (22-km) crater on the far side of the Moon called Giordano Bruno. They may get to test their hypothesis in the near future when China's Tianwen-2 spacecraft, scheduled to launch in 2025, is expected to retrieve samples from Kamo'oalewa's surface.



Debris Strike

The core module, "Tianhe," of China's Tiangong space station suffered a partial loss of power from an impact on its solar panel's power cables. China's Manned Space Agency (CMSA) did not indicate whether the impactor was a micrometeoroid (natural) or debris resulting from human activity in low-Earth orbit. Chinese astronauts, sometimes called taikonauts, repaired the damage in the course of two spacewalks.



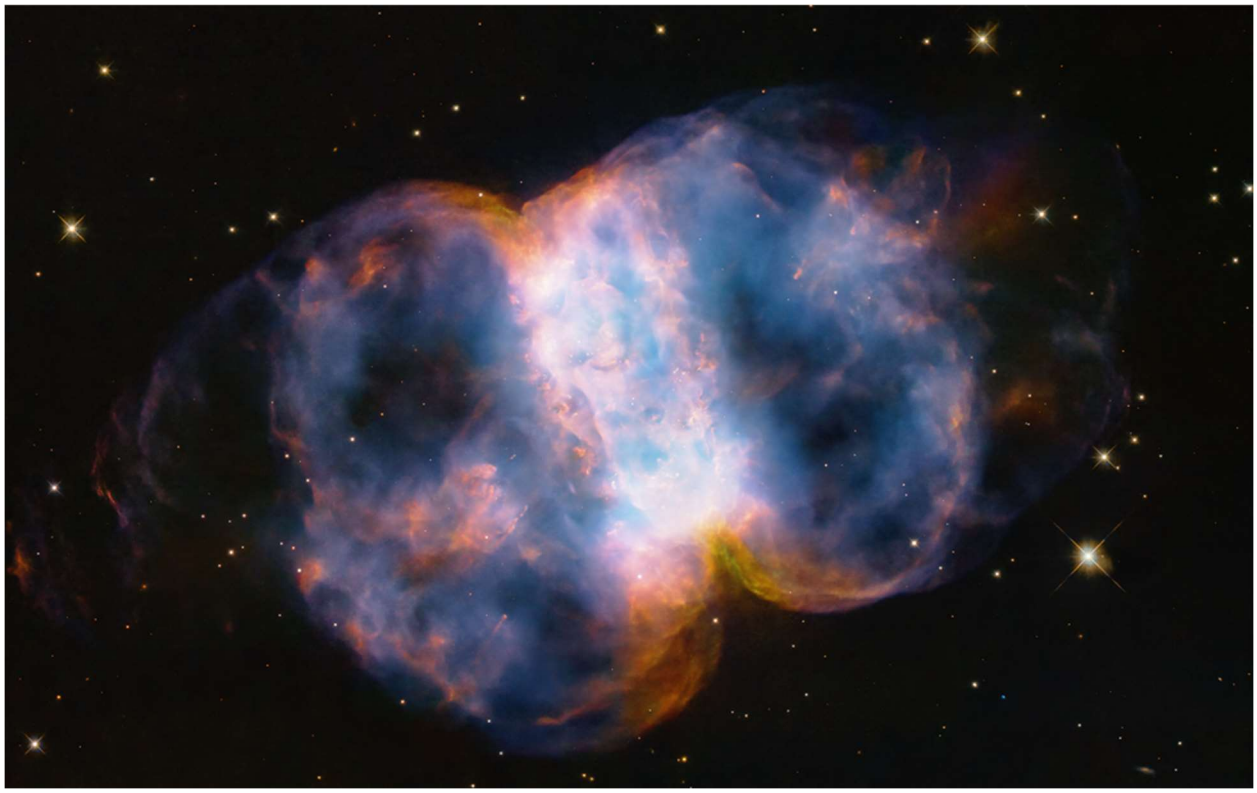
China's Tiangong space station, photographed from a Shenzhou spacecraft. The Tianhe module, at the center, contains astronauts' living quarters and a docking hub. The Mengtian module, at the top of the image, and Wentian, at the bottom, are both laboratory modules. Image credit: CMSA

The space station, which was completed in late 2022, has been occupied by rotating three person crews with personnel changed out roughly every six months. Tiangong orbits at an altitude of between 217 and 280 miles (340 to 450 kilometers), slightly higher than the International Space Station but on a much different inclination. China plans to expand Tiangong with additional modules in the future. It also plans to launch a Hubble-class space telescope that will share the station's orbit and be able to dock with it for repairs and maintenance. The telescope will have a slightly smaller mirror than Hubble but with a much wider field of view for deep sky surveys.

While China has reported having to take evasive maneuvers on multiple occasions to avoid space debris, this latest incident has prompted CMSA to upgrade its forecasting capabilities for collision warning and avoidance. They also plan to conduct more video surveys of the station exterior with its robotic arm and install additional shielding on extravehicular piping, cables and critical equipment.

Hubble Birthday Portrait

Astronomers are celebrating the 34rd anniversary of the launch of NASA's Hubble Space Telescope with the release of an image of Little Dumbbell Nebula, also known as Messier 76, or M76. The nebula is located in the constellation Perseus. approximately 3,400 light-years from Earth.



M76: NASA, ESA, STScI

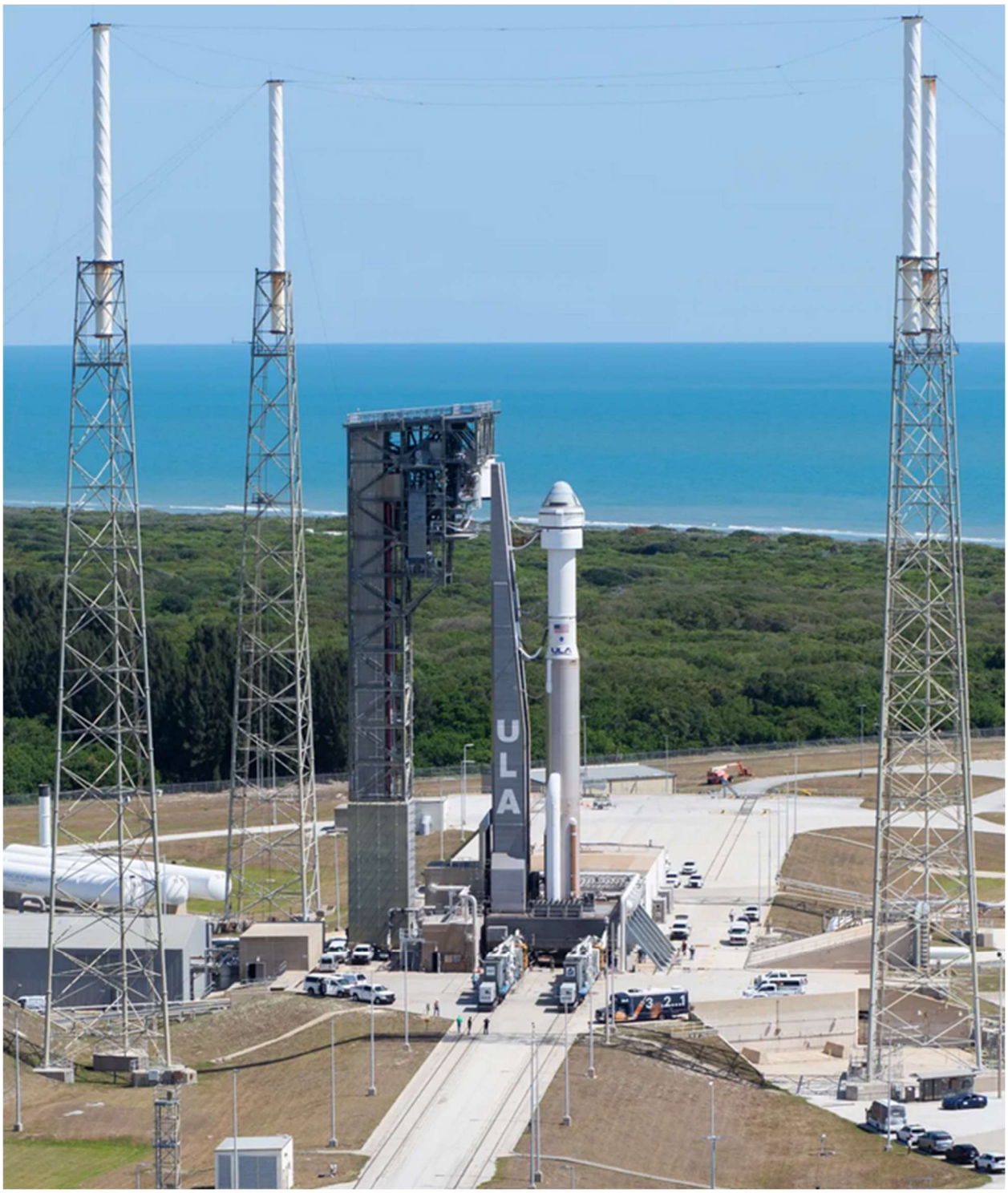
The telescope was deployed into orbit around Earth on April 25, 1990, by NASA astronauts aboard the Space Shuttle Discovery. To date, Hubble's cameras have taken approximately 1.6 million images of nearly 53,000 celestial targets.

The two lobes of glowing gas, which gives the nebula its name, are from a dying star in the center of the cloud. The image showcases Hubble's unique capability to obtain images over a range of wavelengths, from ultraviolet to near-infrared light.

Classified as a "planetary nebula," M76 was created from expanding shells of gas expelled from a dying red giant star. Its fuel exhausted, the red giant collapsed to an ultra-dense white dwarf (about the size of Earth). The superheated gases flowing outward from the white dwarf are moving across space at a speed of two million miles an hour (1.25 kph), plowing into cooler, slower moving gas that was expelled during the red giant's earlier evolution. Intense ultraviolet radiation from the white dwarf is causing the gases to glow - the red color from nitrogen and blue from oxygen. The nebula is projected to dissipate and vanish from our view in as little as 15,000 years.

The summer sky is home to many fine planetary nebulas including NGC 7027, the Jewel Bug Nebula and NGC 6826, the Blinking Nebula in Cygnus, NGC 6543, the Cat's Eye Nebula in Draco, M57, the Ring Nebula in Lyra, NGC 6210 in Hercules, M27, the Dumbbell Nebula in Vulpecula, and NGC 3242, the Ghost of Jupiter Nebula in Hydra (last Spring).

Starliner



Years behind schedule, more than a billion over budget, Boeing's Starliner has been beset by software, technical and management issues that have prevented a crewed flight – critical to the desired multiple transportation alternatives NASA intended to create with it's "Commercial Crew Program" (SpaceX's Crew Dragon has been shuttling astronauts to and from the International Space Station since 2020). Boeing hopes to finally achieve that milestone in early June.

On its first uncrewed flight in 2019, the Boeing spacecraft failed to reach the ISS due to a software issue, but did return safely to Earth. After a major review and dozens of corrective actions, an uncrewed Starliner succeeded in docking with the station in 2022, but getting astronauts onboard has been elusive.

On the evening of May 6th, with NASA astronauts Butch Wilmore and Suni Williams strapped in to the Starliner capsule and only hours from launch, the mission was aborted when a chattering oxygen regulating valve on the liquid oxygen tank on the Atlas V rocket's Centaur upper stage required the rocket to return to the "barn." While the valve was successfully replaced, technicians discovered a helium leak in the spacecraft's service module

The small helium leak was traced to a flange on a single reaction control system thruster. The connection was tightened and pressure testing indicated that the leak in the flange was stable and would not pose a risk at the current level during flight. However, in the course of the investigation, engineers uncovered an additional issue in Starliner's propulsion system that NASA's commercial crew chief Steve Stich calls a "design vulnerability." The issue, under certain circumstances, could render the spacecraft's backup thrusters inoperable and threaten a safe return to Earth. While a software workaround will be implemented for this mission, a more permanent solution may be needed for future flights. Boeing is currently targeting June 1st for launch, with additional opportunities during the first week, After that, some perishable items would need to be replaced on both the spacecraft and the rocket. In addition, other launch priorities on Cape Canaveral, could result in another significate delay of the Starliner flight.

Boeing Crew Flight Test crew members Suni Williams and Butch Wilmore in the Boeing Starliner simulator at the Johnson Space Center in Houston
Photo: NASA/Robert Markowitz

Remembering "Oppy"

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

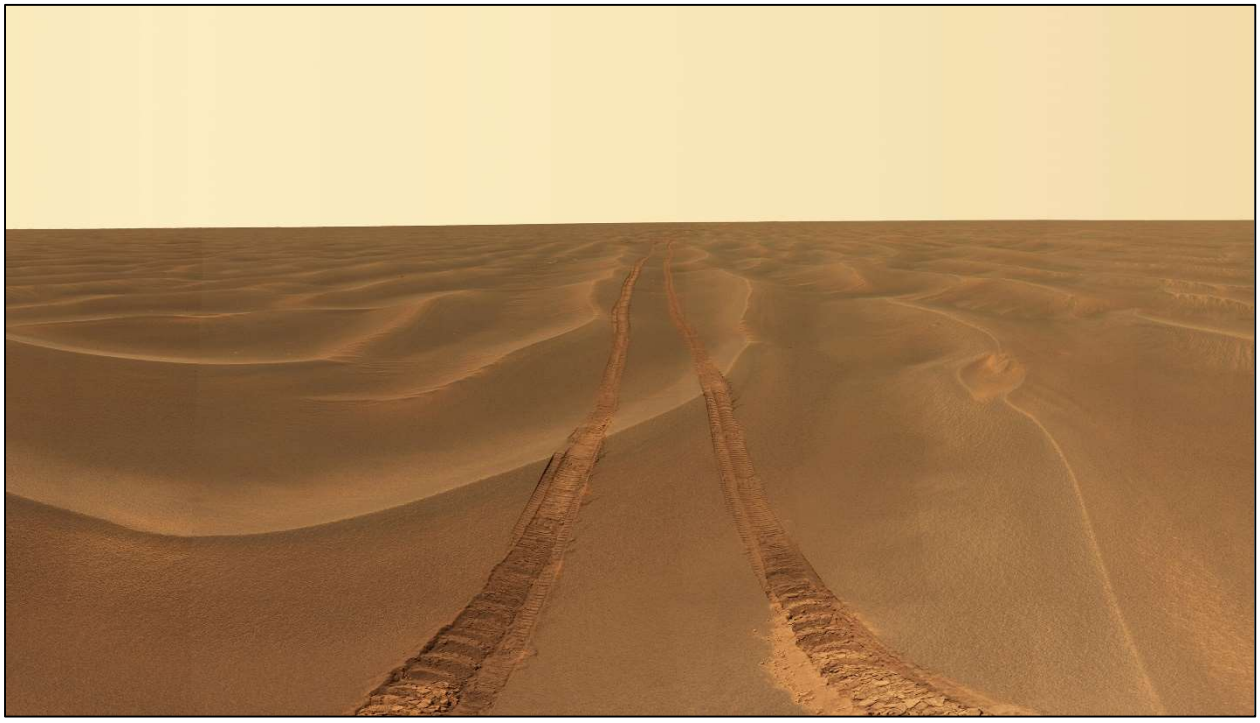
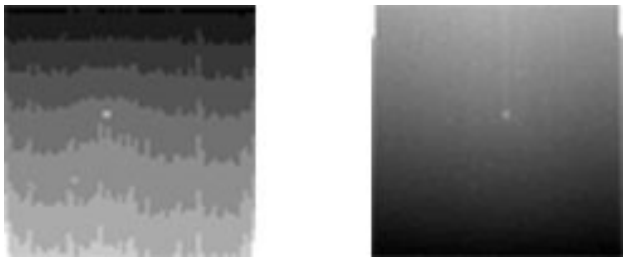


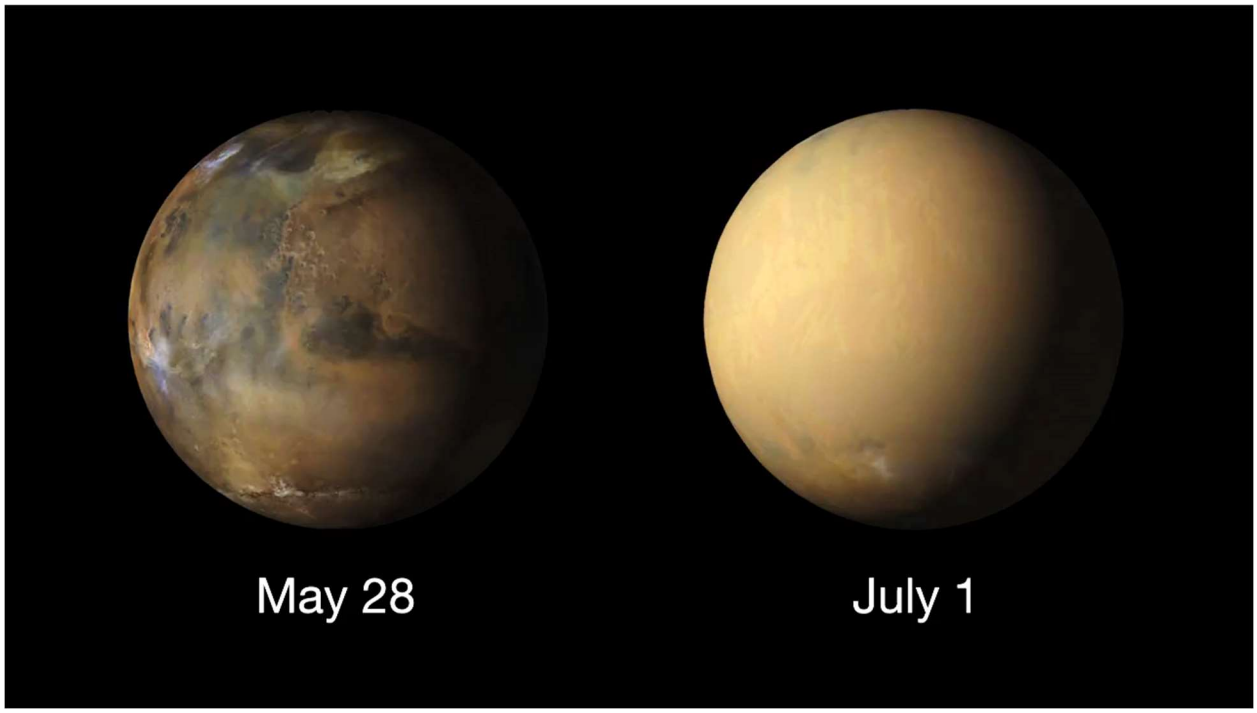
Image Credit: NASA/JPL-Caltech/Cornell Univ./Arizona State Univ.

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

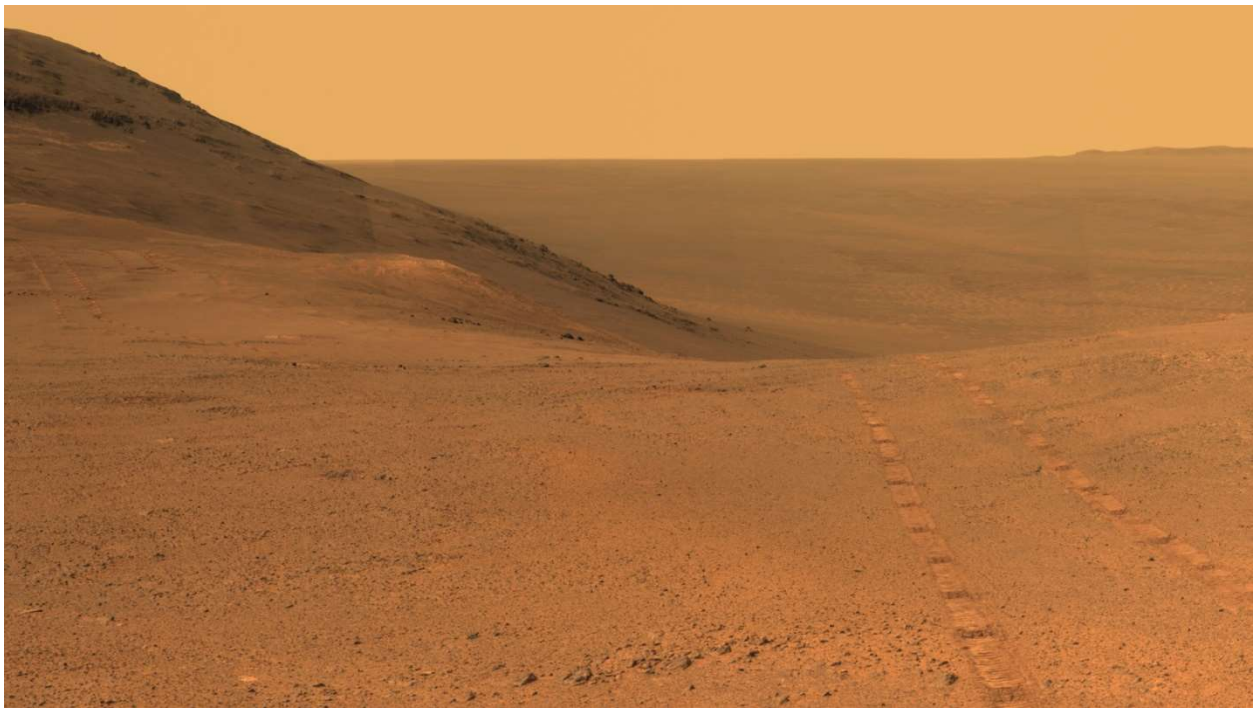


Credit: NASA/JPL-Caltech/Cornell/ASU

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



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



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

Milky Way Season

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

June History

Women in Space

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

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

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

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

An Extraordinary Feat

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

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

On June 3, 1965, Gemini 4 lifted off on a four-day mission. The highlight of the mission was to be a spacewalk by Ed White. NASA was very concerned with "putting guys in vacuums with nothing between them but that little old lady from Worcester, Massachusetts [the seamstress at the David Clark Company], and her glue pot and that suit." However, the Soviets had challenged the United States with a spacewalk by Cosmonaut Alexei Leonov in March during a Voskhod II mission, and the United States did not want to appear to be falling behind its adversary.

After struggling with a faulty hatch, Ed White finally exited the spacecraft as it passed over the Pacific Ocean. Using a gun powered by compressed oxygen, he was able to maneuver outside the capsule, avoiding the Orbital Attitude Maneuvering System thrusters that were keeping the Gemini capsule on course. After a 23-minute spacewalk, Jim McDivitt struggled to get the six-foot-tall Ed White back inside the capsule and close the balky door.

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

Sunrise and Sunset (from New Milford, CT)

Sun	Sunrise	Sunset
June 1st (EDT)	05:21	20:21
June 15th	05:18	20:29
June 30th	05:23	20:31

Astronomical and Historical Events

1st Close approach of Near-Earth Object and Amor-class asteroid 2024 JP1
1st Close approach of Near-Earth Object and Apollo-class asteroid 2024 JC1
1st Close approach of Near-Earth Object and Apollo-class asteroid 1998 KY26
1st History: final landing of Space Shuttle Endeavour (STS-134) (2011)
1st History: launch of the ROSAT (Röntgen) X-ray observatory; cooperative program between Germany, the United States, and United Kingdom; among its many discoveries was the detection of X-ray emissions from Comet Hyakutake (1990)
1st History: Founding of the Caltech Rocket Research Group (precursor to the Jet Propulsion Laboratory) (1936),
2nd Moon at perigee (furthest distance from Earth)
2nd History: founding of the Baikonur Cosmodrome, Kazakhstan (Soviet and Russian launch complex) (1955)
2nd History: launch of the Mars Express spacecraft and ill-fated Beagle 2 lander (2003)
2nd History: launch of the Space Shuttle Discovery (STS-91); ninth and final Mir docking (1998)
2nd History: launch of Soviet Venus orbiter Venera 15; side-looking radar provided high resolution mapping of surface in tandem with Venera 16 (1983)

Astronomical and Historical Events (continued)

2nd History: Surveyor 1 lands on the Moon (1966)
2nd History: Gemini 5, Gemini 11, Apollo 12 and Skylab 2 astronaut Pete Conrad born (1930)
2nd History: discovery of Comet Donati by Italian astronomer Giovanni Battista Donati; brightest comet of the 19th century and first comet to be photographed (1858)
3rd History: discovery of two rings around the centaur asteroid 10199 *Chariklo*, the smallest known object to have rings (2013)
3rd History: discovery of Jupiter impact event by Anthony Wesley (2010)
3rd History: launch of Gemini 9 with astronauts Thomas Stafford and Eugene Cernan (1966)
3rd History: launch of Gemini 4; Ed White becomes first American to walk in space (1965)
3rd History: dedication of the 200-inch Hale Telescope at Palomar Mountain (1948)
4th Venus at Superior Conjunction (directly behind the Sun as viewed from Earth)
4th History: maiden flight of SpaceX's Falcon 9 rocket; launched from Cape Canaveral, Florida (2010)
4th History: discovery of Classical Kuiper Belt Object 50000 *Quaoar* by Mike Brown and Chad Trujillo from images acquired at the Samuel Oschin Telescope at Palomar Observatory (2002)
5th Close approach of Near-Earth Object and Apollo-class asteroid 2024 JR17
5th Close approach of Near-Earth Object and Apollo-class asteroid 2008 YN2
6th New Moon
6th Close approach of Near-Earth Object and Aten-class asteroid 2021 LW3
6th History: launch of Soviet Venus orbiter Venera 16; side-looking radar provided high resolution mapping of surface in tandem with Venera 15 (1983)
8th History: New Horizons spacecraft, on its way to Pluto, crosses the orbit of Saturn (2008)
8th History: discovery of Nova Aquila; a supernova explosion from the collapse of a white dwarf (1918)
8th History: launch of Soviet Venus orbiter/lander Venera 9; transmitted the first black and white images of the surface of Venus (1975)
8th History: Giovanni Cassini born, observer of Mars, Jupiter and Saturn (1625)
9th History: Abee meteorite fall in Canada (1952)
9th History: dedication of the Kathleen Fischer Sundial at the McCarthy Observatory (2012)
10th Close approach of Near-Earth Object, Potentially Hazardous and Amor-class asteroid 2024 CR9
10th History: launch of Mars Exploration Rover A (Spirit) in 2003
10th History: launch of Explorer 49, Moon orbiter and radio astronomy explorer (1973)
11th History: flyby of Venus by Soviet spacecraft Vega 1 on its way to Comet Halley; dropped off lander and a balloon to study middle cloud layers (1985)
12th Close approach of Near-Earth Object and Apollo-class asteroid 2022 XC1
12th History: launch of Venera 4, Soviet Venus lander; first to enter atmosphere of another planet (1967)
13th History: return of the sample capsule from the Hayabusa (MUSES-C) spacecraft (2010)
13th First Quarter Moon
14th Moon at apogee (furthest distance from Earth)
14th History: launch of a V-2 rocket carrying a rhesus monkey (Albert II) – monkey survived flight and successfully transmitted biomedical data, but died on impact when parachutes failed to open (1949)

Astronomical and Historical Events (continued)

14th History: first radar astrometry for an asteroid from Goldstone and Haystack antennae observations of the asteroid 1566 *Icarus* (1968)
14th History: launch of Mariner 5; Venus flyby mission (1967)
14th History: launch of Venera 10; Soviet Venus orbiter/lander (1975)
15th History: flyby of Venus by Soviet spacecraft Vega 2 on its way to Comet Halley; dropped off lander and a balloon to study middle cloud layers (1985)
16th History: Liu Yang becomes the first Chinese woman in space aboard a Shenzhou-9 spacecraft, joining two other crew members on a thirteen-day mission to the orbiting Tiangong 1 laboratory module (2012)
16th History: Valentina Tereshkova; first woman in space aboard Soviet Vostok 6 (1963)
18th History: launch of the Lunar Reconnaissance Orbiter (LRO) and Lunar CRater Observation and Sensing Satellite (LCROSS) to the Moon (2009)
18th History: Sally Ride becomes the first American woman in space aboard the Space Shuttle Challenger (1983)
19th History: discovery of the potentially hazardous asteroid (PHA) 99942 *Apophis* – on April 13, 2029, the asteroid will pass within 19,000 miles (31,000 km) of the Earth (2004)
19th History: flyby of Earth by the ill-fated Nozomi spacecraft on its way to Mars (2003)
20st Summer Solstice at 4:51 P.M. EDT (20:51 UT)
20th History: successful landing of the Viking 1 spacecraft on Mars' Chryse Planitia (Plains of Gold) (1976)
20th History: discovery of Nova 1670 in Vulpeculae (1670)
21st Full Moon (Strawberry Moon)
21st History: SpaceShipOne makes first privately funded human spaceflight (2004)
22nd History: launch of Soviet space station Salyut 5 (1976)
22nd History: founding of the Royal Greenwich Observatory (1675)
22nd History: discovery of Pluto's largest moon *Charon* by Jim Christy (1978)
24th History: launch of the Salyut 3 Soviet space station (1974)
24th History: Fred Hoyle born; British astronomer and proponent of nucleosynthesis (1915)
24th History: Sir William Huggins makes first photographic spectrum of a comet (1881)
25th History: Rupert Wildt born, German-American astronomer and first to hypothesize that the CO_2 in the Venusian atmosphere was responsible for the trapped heat (1905)
25th History: Hermann Oberth born, father of modern rocketry and space travel (1894)
26th History: Discovery of Saturn's moons Surtur, Jarnsaxa, Greip and Loge (2006)
26th History: Charles Messier born, famed comet hunter (1730)
27th Moon at perigee (furthest distance from Earth)
27th Close approach of Near-Earth Object and Amor-class asteroid 2019 NJ
27th Close approach of Near-Earth Object, Potentially Hazardous and Apollo-class asteroid 415029 (2011 UL21)
27th Close approach of Near-Earth Object and Aten-class asteroid 2022 MM1
27th Close approach of Near-Earth Object and Apollo-class asteroid 2010 XN
27th History: discovery of the Mars meteorite SAU 060, a small 42.28 g partially crusted grey-greenish stone found near Sayh al Uhaymir in Oman (2001)
27th History: flyby of the asteroid *Mathilde* by the NEAR spacecraft (1997)
27th History: Space Shuttle Atlantis (STS-71) first docking with the Russian space station Mir (1995)

Astronomical and Historical Events (continued)

27th History: launch of SEASAT, the first Earth-orbiting satellite designed for remote sensing of the Earth's oceans (1978)
27th History: Alexis Bouvard born, French astronomer, director of Paris Observatory, postulated existence of eighth planet from discrepancies in his astronomical tables for Saturn and Uranus. Neptune was subsequently discovered by John Couch Adams and Urbain Le Verrier after his death where he had predicted (1767)
28th Last Quarter Moon
28th History: discovery of Pluto's moon *Kerberos* by Mark Showalter, et al., using the Hubble Space Telescope (2011)
28th History: Nakhla meteorite fall in Egypt (Mars meteorite), a piece of which was claimed to have vaporized a dog; first direct evidence of aqueous processes on Mars (1911)
29th Close approach of Near-Earth Object and Apollo-class asteroid 2022 HD1
29th History: George Ellery Hale born, founding father of the Mt. Wilson Observatory (1868)
30th Close approach of Near-Earth Object and Apollo-class asteroid 2017 MB3
30th History: the Cassini-Huygens spacecraft enters orbit around Saturn (2004)
30th History: discovery of *Haume*a's moon *Namaka*, the smaller, inner moon of the dwarf planet, by Mike Brown, Chad Trujillo, David Rabinowitz, et al. (2005)
30th History: crew of Soyuz 11 dies upon return from the Salyut space station when capsule depressurizes (1971)
30th History: Tunguska Explosion Event (1908)

Commonly Used Terms

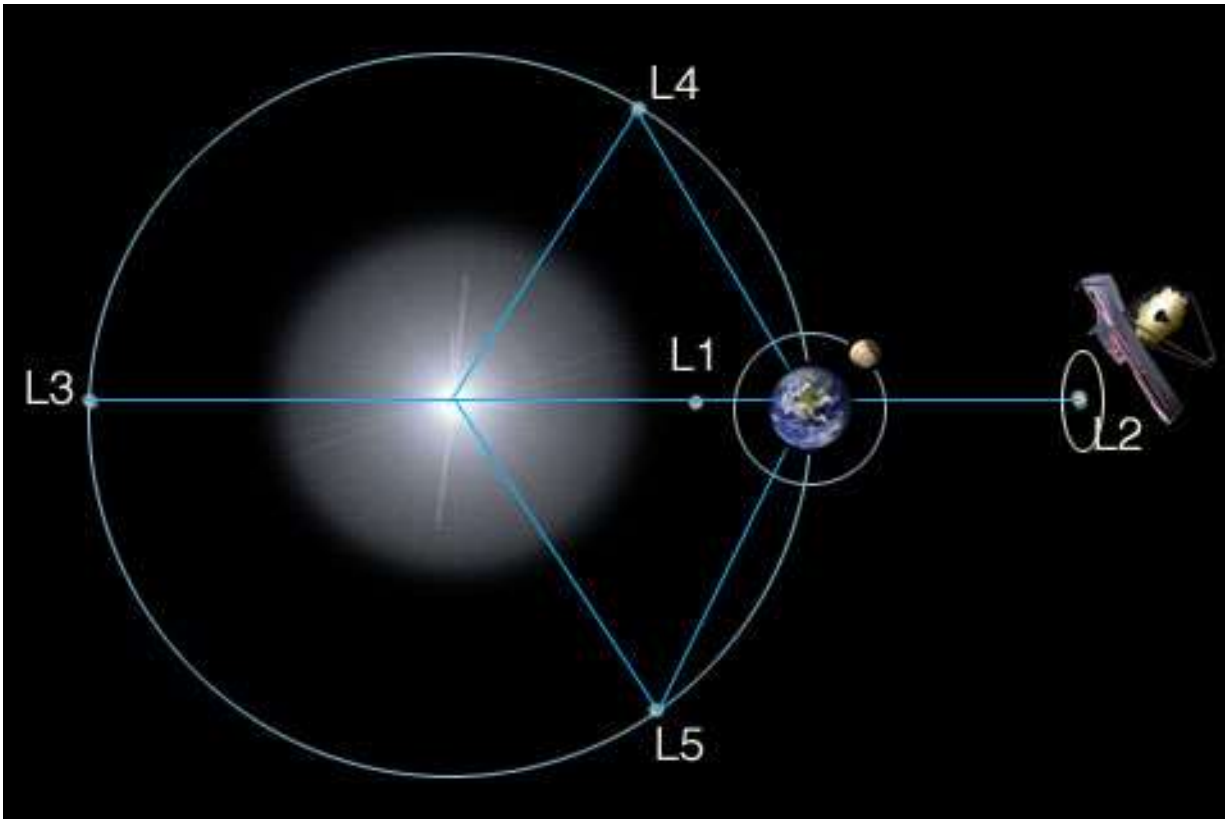
- Apollo: a group of near-Earth asteroids whose orbits also cross Earth's orbit; Apollo asteroids spend most of their time outside Earth orbit.
- Aten: a group of near-Earth asteroids whose orbits also cross Earth's orbit, but unlike Apollos, Atens spend most of their time inside Earth orbit.
- Atira: a group of near-Earth asteroids whose orbits are entirely within Earth's orbit
- Centaur: icy planetesimals with characteristics of both asteroids and comets
- Kuiper Belt: region of the solar system beyond the orbit of Neptune (30 AUs to 50 AUs) with a vast population of small bodies orbiting the Sun
- Opposition: celestial bodies on opposite sides of the sky, typically as viewed from Earth
- Plutino: an asteroid-sized body that orbits the Sun in a 2:3 resonance with Neptune
- Trojan: asteroids orbiting in the 4th and 5th Lagrange points (leading and trailing) of major planets in the Solar System

References on Distances

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

Lagrange Points

Five locations discovered by mathematician Joseph Lagrange where the gravitational forces of the Sun and Earth (or other large body) and the orbital motion of the spacecraft are balanced, allowing the spacecraft to hover or orbit around the point with minimal expenditure of energy. The L2 point (and location of the Webb and Euclid telescopes) is located 1 million miles (1.5 million km) beyond the Earth (as viewed from the Sun).



James Webb Space Telescope

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

Euclid Space Telescope

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

International Space Station and Artificial Satellites

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

Solar Activity

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

NASA's Global Climate Change Resource

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

Mars – Mission Websites

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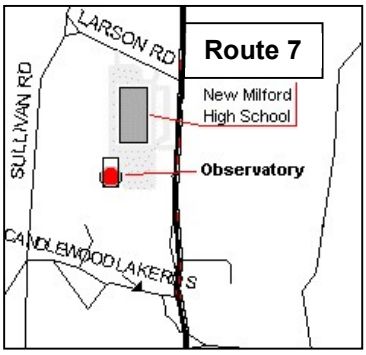

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