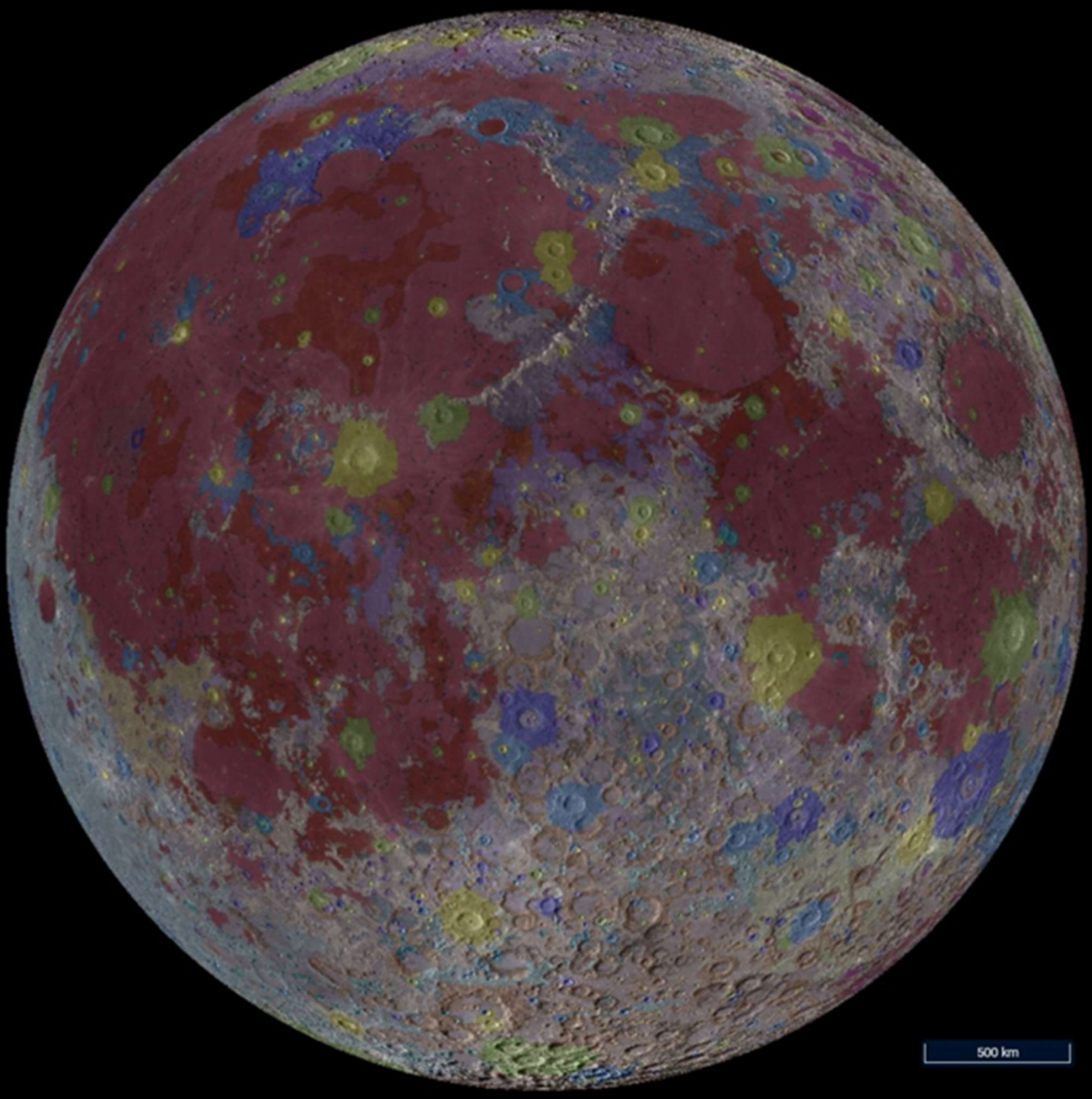
Galactic Observer

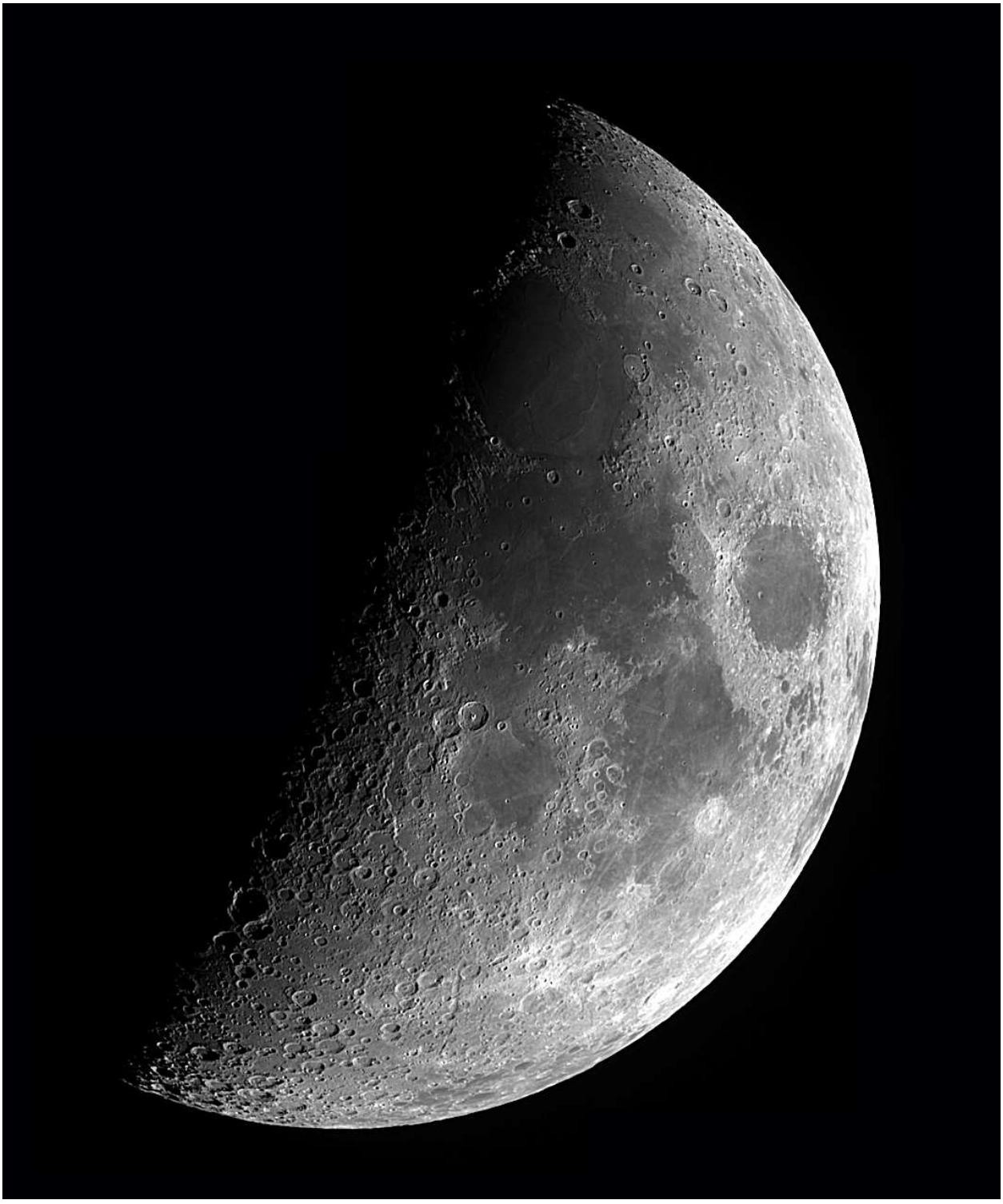
John J. McCarthy Observatory

Volume 15, No. 10 October 2022



The “Unified Geologic Map of the Moon” summarizes the current state of lunar geologic knowledge. The map represents a synthesis of six Apollo-era regional geologic maps, updated based on data from recent satellite missions.
Credit: NASA/GSFC/USGS

October Astronomy Calendar and Space Exploration Almanac



International Observe the Moon Night 2022 - October 1st

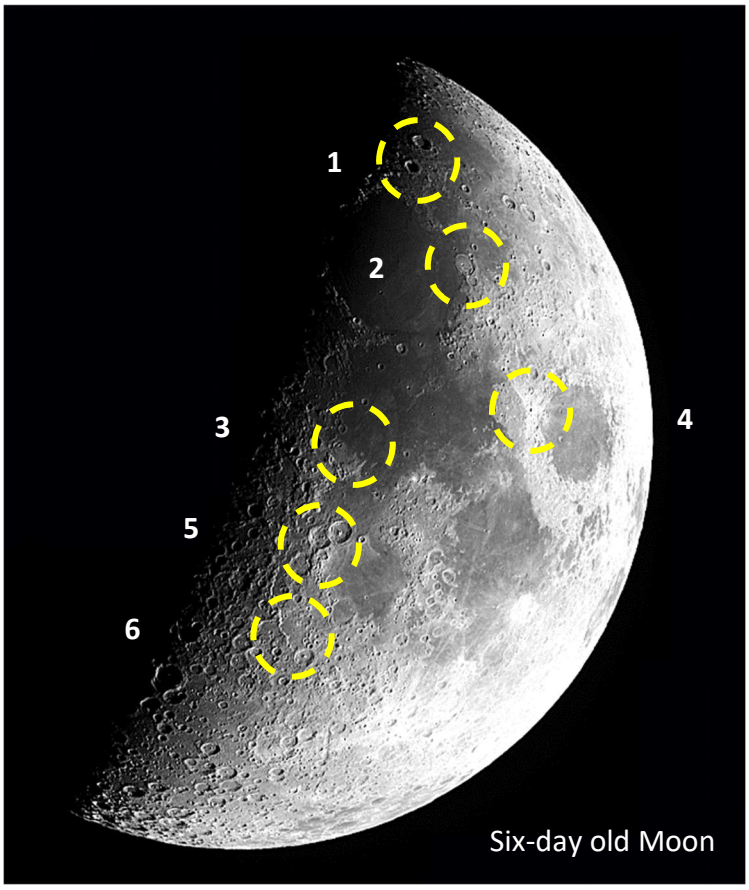
6 Day Old Moon Mosaic: Bill Cloutier

In This Issue

International Observe the Moon Night (InOMN)

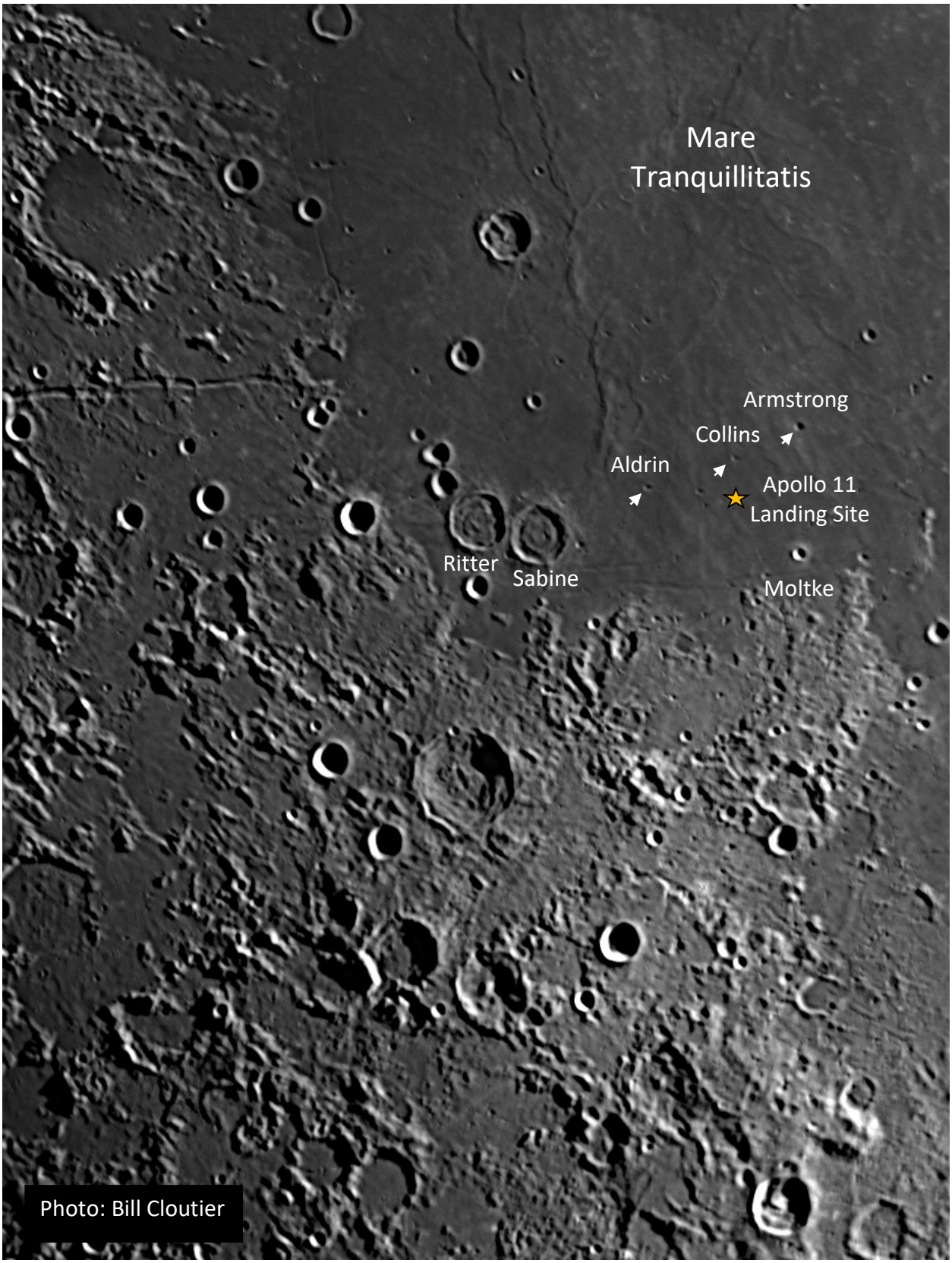
This year InOMN is being celebrated on October 1st. The event was first inspired by public outreach activities sponsored by the Lunar Reconnaissance Orbiter (LRO) and Lunar CRater Observation and Sensing Satellite (LCROSS) educational teams at the Goddard Space Flight Center in Greenbelt, Maryland and at the Ames Research Center in Moffett Field, California, in August 2009. In 2010, the Lunar and Planetary Institute and Marshall Space Flight Center joined Goddard and Ames in a world-wide event to raise public awareness of lunar science and exploration.

The Moon will rise at 1:20 PM (EDT) on the 1st and set relatively early at 10:07 PM. At approximately 230,800 miles (372,000 km) from the Earth, 38% of the near-side lunar surface will be illuminated as the Sun sets and twilight deepens. Unfortunately, the Moon will be quite low in the sky, never getting above 21°. However, with clear skies and a good horizon to the south-southwest, the following lunar features will be visible:



1. Craters Aristoteles, with its radial ridges, and Eudoxus are located between Mare Frigoris (Sea of Cold) and Mare Serenitatis (Sea of Serenity)
2. Fractured floor crater Posidonius can be found on the rim of the Serenitatis basin and adjacent to the nearby Serpentine ridge
3. Crater chain (north to south and youngest to oldest) Theophilus, Cyrillus and Catharina punctuate the rim of the Nectaris basin (based on stratigraphy - a branch of geology related to the order and relative position of features and their relationship to the geological time scale)
4. Proclus is a bright crater located just to west of Mare Crisium (Sea of Crises) with its uneven ray pattern likely the result of a low-angle, oblique impact
5. The Apollo 11 landing site can be found just west of the bright crater Moltke and east of the twin craters Ritter and Sabine on the southern shore of Mare Tranquillitatis (Sea of Tranquility)
6. The Altai scarp, which rises 2.2 to 2.5 miles above the plain (3.5 to 4 km), forms the southwestern rim of the Nectaris basin. The escarpment is interrupted by the crater Piccolimini, after which it is more difficult to discern. The Altai scarp defines the third and outermost ring of the impact's bullseye pattern, with the innermost ring flooded with mare lavas (creating Mare Nectaris or the Sea of Nectar). The impact basin, which formed 3.8–3.9 billions year ago, marks the beginning of Nectarian period of the lunar geologic timescale.

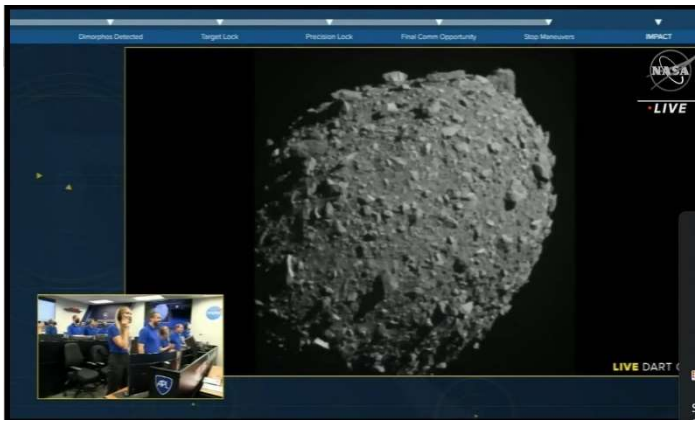
InOMN Highlight:
Apollo 11 Landing Site and Craters Aldrin, Collins and Armstrong



DART Hits Its Mark

On Monday evening, September 26th, NASA's DART spacecraft collided with Didymos' moon, Dimorphos. The collision was a planned demonstration, designed to assess the effectiveness of a kinetic impact in changing the path or deflecting an asteroid from its current trajectory.

Dimorphos is a small asteroid approximately 525 feet or 160 meters wide. It orbits the larger, near-Earth asteroid Didymos (2,560 feet or 780 meters) every 11 hours and 55 minutes. The current separation between the two bodies is 3,870 feet or 1.18 km. DART impacted Dimorphos nearly head-on, which should shorten its orbital period by several minutes.



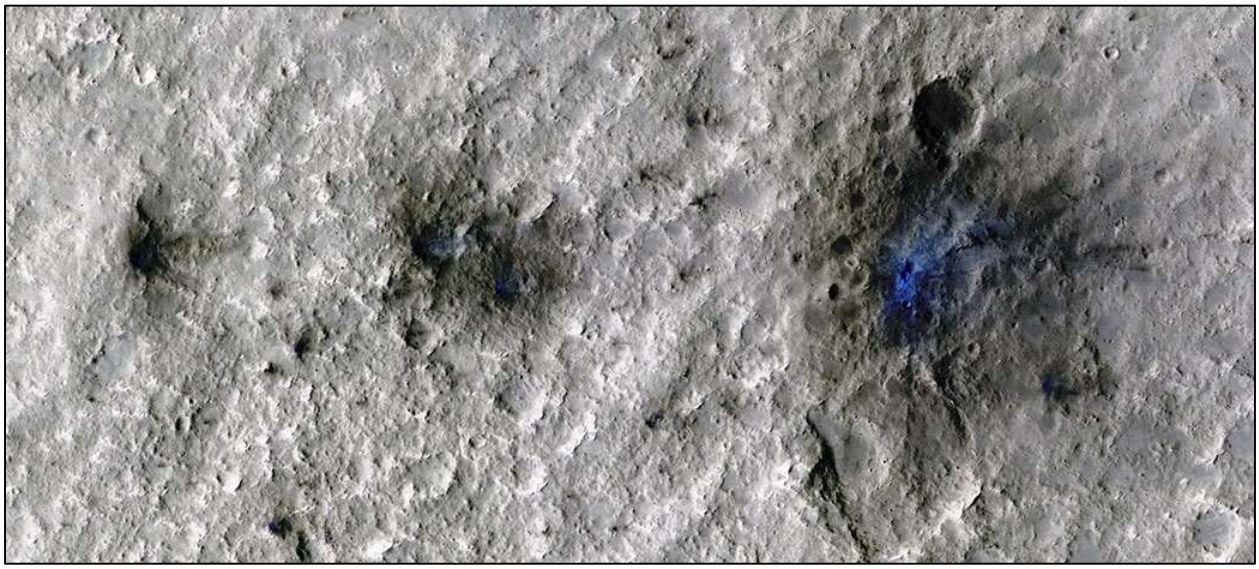
Didymos is close enough at the time of impact that Earth-bound telescopes will be able to measure the change in Dimorphos' orbit. The impact was also recorded by an Italian-built CubeSat (LICIACube) which was released from DART 15 days prior to the collision.

The DART spacecraft carried a high-resolution camera called DRACO (Didymos Reconnaissance and Asteroid Camera for Optical navigation). The camera, DART's lone payload excluding the CubeSat, served multiple purposes including navigation and targeting support, measuring the size and shape of the asteroid target, and impact site determination. Images from DRACO were streamed in real time up to the moment of impact, providing scientists detailed images of Dimorphos' surface.

The European Space Agency's HERA mission will launch to Dimorphos in 2024. The spacecraft will rendezvous will both asteroids in 2026, conducting detailed surveys and characterizing the impact site on the moon (crater size and shape).

Images from DART's DRACO camera as it approached the binary asteroid pair. The top image was transmitted 2 minutes prior to impact and shows both bodies. The middle image is a closeup of the moon Dimorphos. The bottom image of the moon's rocky surface was transmitted just prior to impact.
Credit: NASA TV

InSight Data Used to Locate Fresh Meteoroid Impacts



Enhanced color images of the four meteoroid impacts captured by MRO's HiRISE camera. Dust and soil disturbed by the impacts are shown in blue for enhanced visibility. Credits: NASA/JPL-Caltech/University of Arizona

The seismometer deployed by NASA's InSight lander has detected four separate impact events from meteoroids over the past two years. It is the first time seismic and acoustic waves from impacts have been detected on Mars. Researchers used the Mars Reconnaissance Orbiter's (MRO) black-and-white Context Camera to locate the impact sites, applying InSight data, and then the spacecraft's High-Resolution Imaging Science Experiment camera, or HiRISE, to capture detailed, color images of the resulting crater(s) and ejecta.

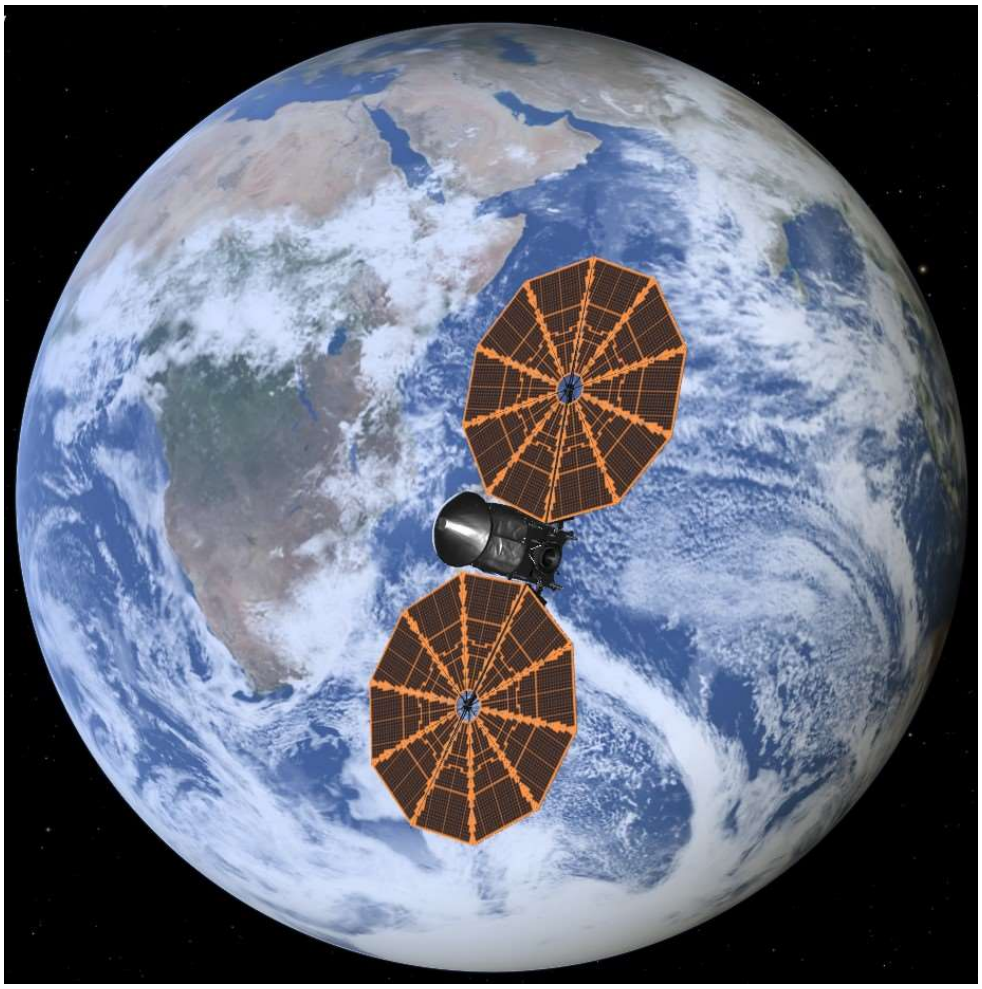
The impact craters, described in a recent paper published in Nature Geoscience, are located between 53 and 180 miles (85 and 290 km) from InSight's location on Elysium Planitia. The first of the four confirmed impacts occurred on September 5, 2021 (shown in the top image). The other three occurred on May 27, 2020, February 18, 2021; and on August 31, 2021, respectively.

While InSight operations have been severely degraded by the accumulation of dust on its solar panels, engineers are hopeful that the lander can deliver a few more months of scientific data from the seismometer.

Lucy Gets an Assist

The twelve-year Lucy mission to Jupiter's Trojan asteroids got off to a rocky start. Shortly after launch on October 16, 2021 there were indications that one of Lucy's two circular solar arrays hadn't fully opened (like a hand fan) and latched. While power production from the 23.9-foot (7.3 meter) diameter array is more than sufficient at its current distance from the Sun (greater than 90%), engineers were concerned about the stability of the array during deep space maneuvers and main engine burns.

Diagnostic testing by Lucy's anomaly response team pointed to a snarled lanyard (designed to pull the array open) as the probable cause. After conducting simulations and ground testing, the mission team commanded the spacecraft to simultaneously engage both the primary and backup solar array deployment motors. After several attempts in May and June, the extra force from the two motors was able to further retract the jammed lanyard and place the array under substantially greater tension. While not latched, the array is now estimated to be between 353° and 357° open (out of 360° total for a fully deployed array) and stable enough for mission operations.

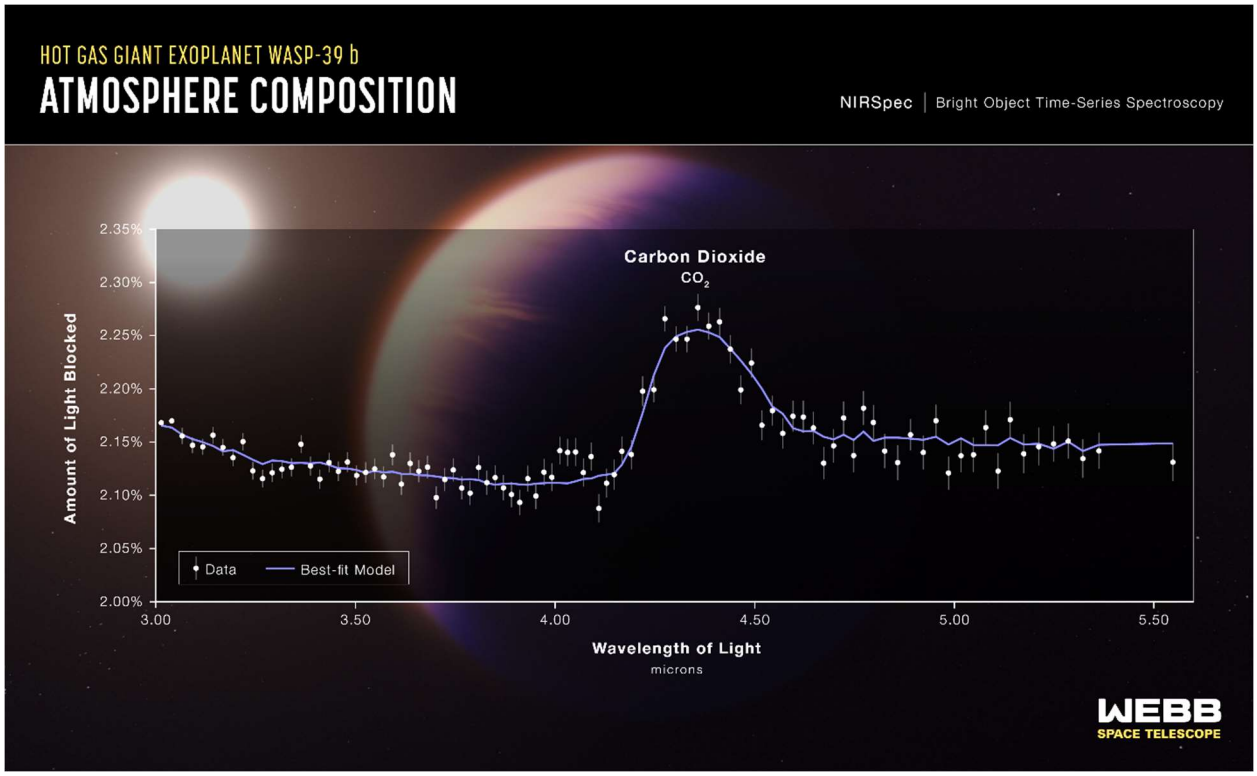


Simulated view of the 2022 flyby

Credit: NASA's *Eyes on the Solar System*

On October 16, 2022, Lucy will fly by Earth (within 220 miles) for a gravity assist that will modify its orbit (boosting its maximum distance from the Sun from 1.16 AU to 2.26 AU) and set the spacecraft up for another encounter with Earth on December 12, 2024. The second gravity assist will propel Lucy out through the Main Asteroid Belt and towards the Trojan asteroids.

Carbon Dioxide in an Exoplanet Atmosphere



A transmission spectrum of the hot gas giant exoplanet WASP-39 b captured by Webb's NIRSpec instrument
Credits: Illustration: NASA, ESA, CSA, and L. Hustak (STScI); Science: The JWST Transiting Exoplanet Community Early Release Science Team

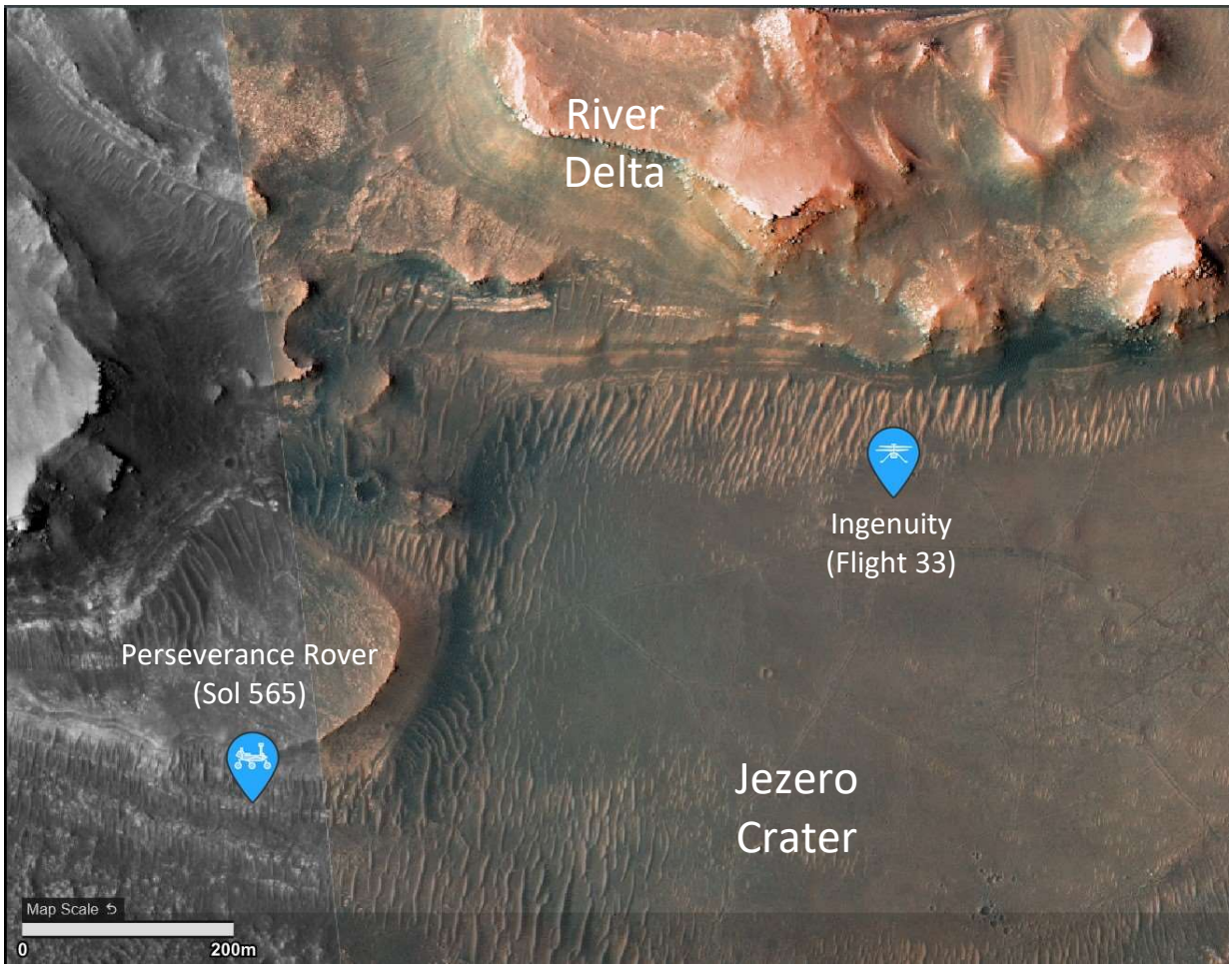
NASA's James Webb Space Telescope has confirmed the presence of carbon dioxide in the atmosphere of a gas giant planet orbiting a Sun-like star 700 light-years away. The exoplanet, WASP-39 b, is larger in diameter than Jupiter but with only one-quarter the mass. It is located extremely close to its host star (about one-eighth the distance between the Sun and Mercury), completing an orbit once every four days. The temperature of WASP-39 b is estimated at about 1,600°F (900°C) based on its proximity to the G-type star. The planet was discovered in 2011 from the dimming of the star as WASP-39 b crossed, or transited, the stellar disk (as viewed from Earth).

Webb's Near-Infrared Spectrograph (NIRSpec) was used to capture the spectrum of the exoplanet's atmosphere during such a transit. The detection of carbon dioxide is a first for a planet located outside our solar system. NASA's Hubble and Spitzer space telescopes had previously detected the presence of water vapor, sodium, and potassium in the atmosphere of WASP-39 b.

The portion of the spectrum analyzed by Webb's NIRSpec instrument can also be used to measure the abundance of other gases, such as water and methane, in the atmospheres of exoplanets, and scientists will be using the instrument to target smaller, rocky worlds in the future. Carbon dioxide, in particular, can be used to give scientists clues to the planet's origin, as well as the relationship of solid versus gaseous material involved in its formation.

Back in the Rarified Air

NASA's Ingenuity helicopter, long past its expiration date, had been grounded since early June with Mars' cold and dusty winter weather at Jezero crater proving a challenge in keeping its batteries charged. Despite the exposure of its electronics to the nighttime temperatures after turning off its heaters to conserve power, the diminutive helicopter was ready to go when the call came in from Earth.



Perseverance's Location: https://mars.nasa.gov/mars2020/mission/where-is-the-rover/

On August 20th, Ingenuity executed a short 33-second hop to shake off the dust and prove its air worthiness. This was followed, on September 6th, by a 56 second flight (No. 31) to reposition the 4-pound (1.8 kg) rotorcraft closer to the ancient river delta being explored by NASA's Perseverance rover. The flight covered about 318 feet (97 meters) of horizontal distance.

The helicopter is expected to be used to scout the rough terrain and provide aerial reconnaissance for the rover's climb to the top of the delta. Ingenuity took to the rarified Martian air again on September 18th (Sol 561). Flight No. 32 covered about 308 feet (94 meters) of horizontal distance as the helicopter moved west and closer to Perseverance.

The helicopter flew again on September 24th, with Flight No. 33 carrying Ingenuity another 364 feet (111 meters) further to the west along the delta front.

MOXIE News

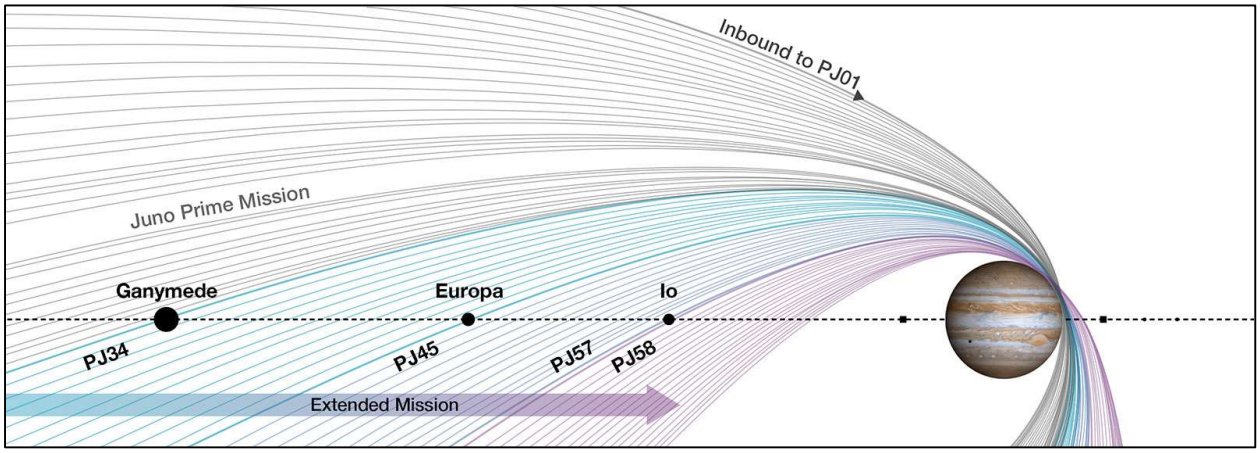
NASA's Mars 2020 Perseverance rover carried two technology demonstrations to the Martian surface: the Ingenuity helicopter and MIT's Mars Oxygen In-Situ Resource Utilization Experiment or MOXIE. The car-battery-sized package was designed to demonstrate a means for extracting oxygen from the carbon-dioxide-rich Martian atmosphere for future crewed missions. Oxygen can be used as propellant and/or breathing air.

Technicians at NASA's Jet Propulsion Laboratory, in Pasadena, California, lower MOXIE into the body of the Perseverance rover prior to launch
Credit: NASA/JPL-Caltech

MOXIE was powered up seven times in 2021, at various times of time of day and night, during different seasons, under extreme temperatures (which can vary by over 100 degrees), and in the wake of a dust storm. In total, the unit was able to generate about 100 minutes of breathable oxygen.

MOXIE is considered a resounding success in that it demonstrated that the process is not only viable, but likely scalable to a size that could support human colonization of the Red Planet (a unit at least 100 times larger would be needed). Engineers plan to expand the testing envelop and push MOXIE's capabilities by running the unit longer and during the Martian spring, when atmospheric density and carbon dioxide levels are at their highest (the density of the Martian atmosphere can vary by a factor of two over a year's time). MOXIE will be monitored for signs of wear and tear during the exercise as there were some design compromises to allow the unit to fit within the body of the rover.

Europa Flyby by Juno

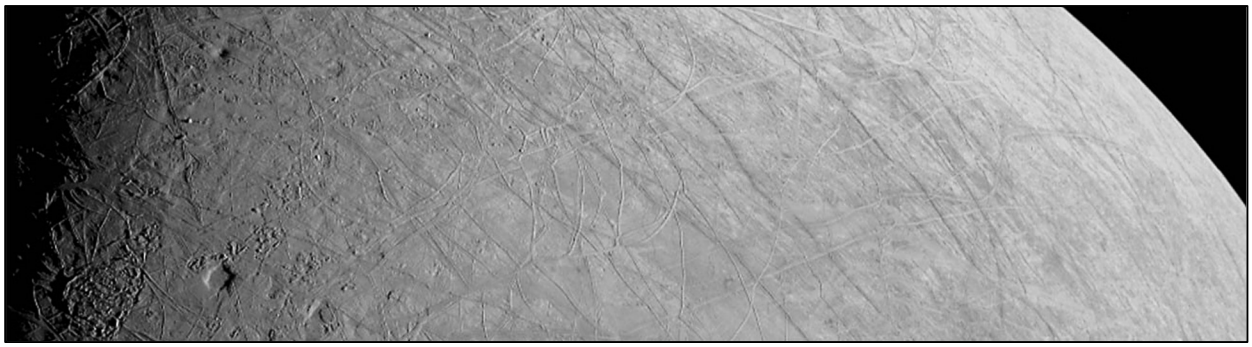


Juno's extended mission includes flybys of the moons Ganymede, Europa, and Io
Credit: NASA/JPL-Caltech/SwRI

NASA's Juno spacecraft, which entered orbit around Jupiter in 2016, is now in an extended mission phase. The spacecraft has completed 45 flybys of the gas giant (called perijoves or points of closest approach). Its last perijove (PJ45) on September 29th included a flyby of Jupiter's moon Europa, which has not been visited in more than 20 years (during the Galileo mission).

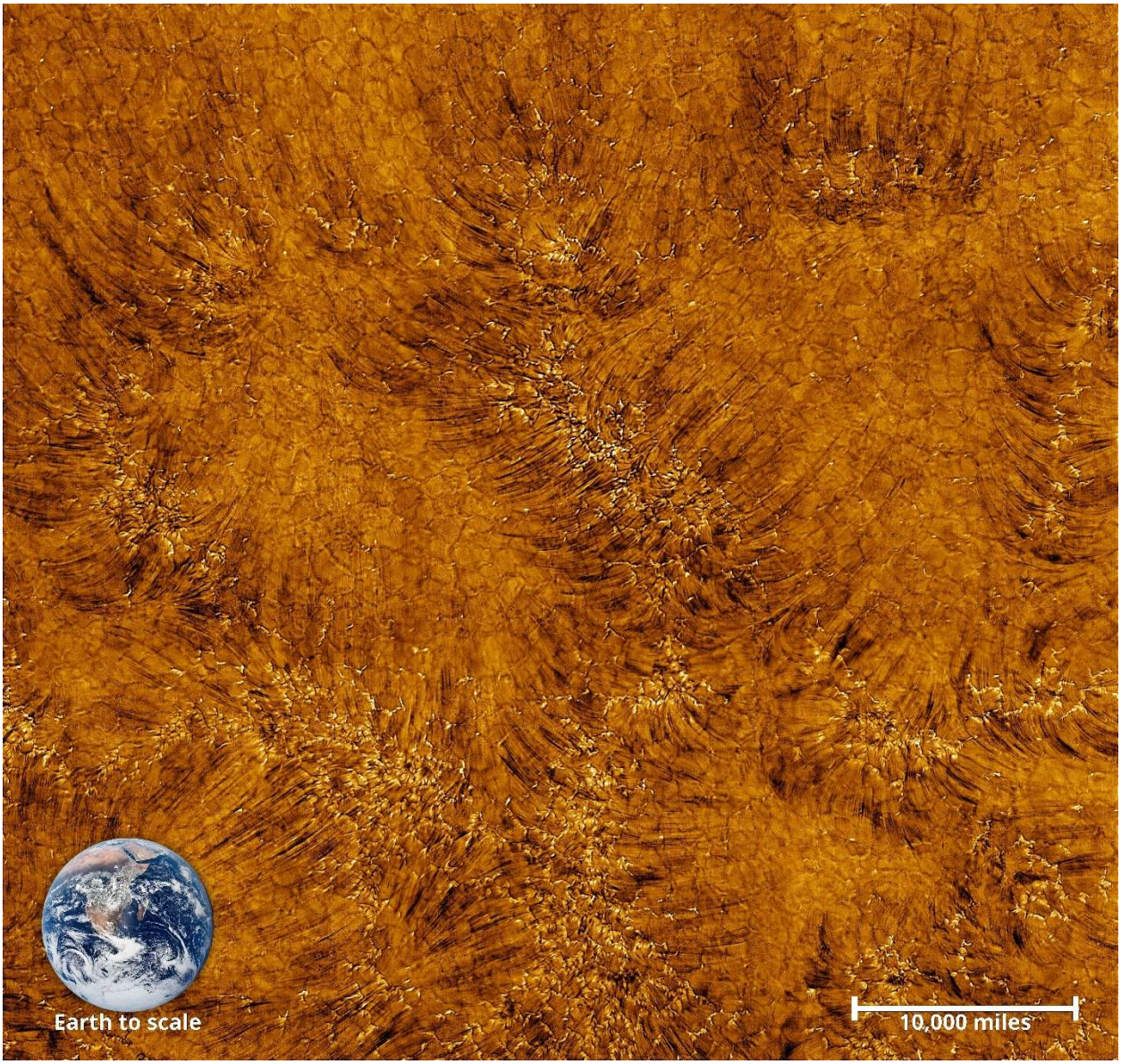
Juno passed within 220 miles (350 km) of Europa's icy surface. In addition to returning detailed images of the moon's surface, Juno's instruments will be able to provide data on Europa's magnetic field and possibly the depth of the icy shell that covers, what is believed to be, an internal ocean. With the Europa Clipper being prepared for launch in 2024, scientists are hopeful that Juno's camera will detect the water vapor plumes that have been spotted in Earth-based observations and map the fractured regions for future investigation.

In addition to NASA's Europa Clipper, the European Space Agency is preparing its Jupiter Icy Moon Explorer, or JUICE, orbiter for a launch window in April 2023. JUICE will make detailed observations of the gas giant with flybys of its three large ocean-bearing moons (Ganymede, Callisto and Europa), before settling into an orbit around Ganymede.



First image of Europa's icy surface released from Juno's Europa flyby on September 29th
Credits: NASA/JPL-Caltech/SWRI/MSSS

Sun's Chromosphere from the World's Largest Solar Telescope



The image released on August 31st in honor of the inauguration ceremony shows the Sun's chromosphere, the lower region of its atmosphere where temperatures can be as high as 13,000° F (7,200°C). It was taken on June 3, 2022 and shows a region 51,300 miles (82,500 km) across at a resolution of 11 miles (18 km). Credit: NSO/AURA/NSF

The National Science Foundation celebrated the inauguration of the world's most powerful solar telescope by releasing an image of the Sun's chromosphere. The Daniel K. Inouye Solar Telescope is located at the summit of the Haleakalā volcano in Maui, Hawaii, and has a 13-foot (4-meter) primary mirror. At a 10,000-foot elevation (3 km), the atmosphere above the mountain is relatively stable; however, the telescope is also equipped with an adaptive optics system which corrects atmospheric seeing and enables diffraction limited imaging and spectroscopy. As a Sun-gazer, the telescope is equipped with a state-of-the-art cooling system that can remove 12 kilowatts of heat energy every second. Without active cooling, the solar telescope would overheat within minutes.

New Mineral Found on Moon

Chinese National Space Administration's (CNSA) Chang'e 5 spacecraft was the fifth mission of the Chinese Lunar Exploration Program and first lunar sample-return mission (and first since Luna 24 in 1976). Launched from the Wenchang Space Launch Center on Hainan Island, China, on November 23, 2020, the lander set down on the Mons Rumker region of Oceanus Procellarum about a week later. The robotic arm on the lander collected a number of samples that were then sealed in a sample return container. The container was placed in an ascent vehicle which rendezvoused with an orbiter for the trip back to Earth.

The sample capsule landed in the Siziwang Banner grassland of northern China on December 17th (local Beijing time) with 3.81 pounds (1.731 kg) of relatively young lunar regolith.

A close up of the Changesite-(Y) crystal
Image credit: Beijing Research Institute of Uranium Geology

In early September (2022), researchers at the Beijing Research Institute of Uranium Geology announced the discovery of a new lunar mineral. The phosphate mineral, in the form of a columnar crystal, was found in the lunar basalt samples collected by Chang'e 5.

Named Changesite–(Y), the discovery is noteworthy in that the mineral contains Helium-3, a light, stable isotope of helium with two protons and one neutron. The isotope, which accumulates in the lunar regolith (soil) from the bombardment of the solar wind, has potential applications as a fuel source for fusion reactors (fusing Helium-3 with deuterium is a cleaner reaction with less waste products).

Although harvesting parts-per-billion concentrations of Helium-3 may not be practical at this time, it does portend a competition for lunar resources. As a result of the discovery, CNSA has approved an additional three Moon missions (orbiters) over the next decade. China is expected a second sample return mission in 2024 with Chang'e 6 targeting the Moon's far side and south pole.

Saturn

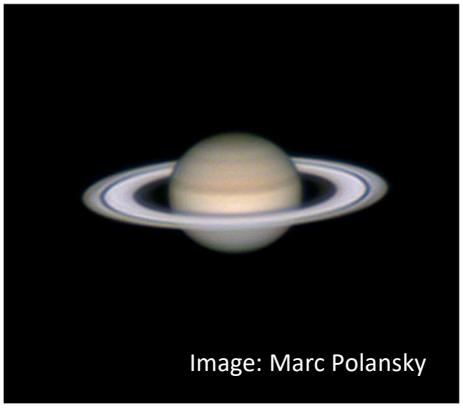


Image: Marc Polansky

Saturn reached Opposition in mid-August when the ringed-world was closest to Earth. Since that time, the distance between the Earth and Saturn has been steadily increasing with Earth's higher orbital velocity. Saturn is still well placed in the evening sky in the constellation Capricornus. The planet's north pole is currently tilted towards the Earth with its rings inclined at an angle of almost 14° to our line of sight. We see the ring tilt or inclination cycle (from our perspective) over Saturn's 29.5-year orbit. The last ring crossing (when the rings disappeared) was in 2009. Since then, the rings opened to a maximum of 27° before starting to close. The rings will disappear in 2025 before the process begins again, starting to open back up again, this time with the southern hemisphere tilted toward Earth.

Jupiter


Image: Marc Polansky

Jupiter reached Opposition on September 26th. The gas giant shines brightly in the eastern sky after sunset (about 24 times brighter than Saturn). The largest planet in the solar system can be found in the constellation Pisces to the east of Saturn.

	Rise and Meridian Transit Times (EDT)			
	October 1		October 30	
Planet	Rise	Transit*	Rise	Transit*
Saturn	4:34 pm	9:36 pm	2:35 pm	7:37 pm
Jupiter	6:25 pm	12:27 am	4:15 pm	10:12 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 Moon Transits

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
Sept 30th	Io	11:50 pm	2:04 am (1st)
1st	Europa	6:50 pm	9:22 pm
2nd	Io	6:18 pm	8:32 pm
8th	Europa	9:25 pm	11:57 pm
9th	Io	8:14 pm	10:28 pm
16th	Io	10:09 pm	12:23 am (17th)
18th	Io	4:38 pm	6:52 pm
25th	Io	6:34 pm	8:47 pm
26th	Europa	3:55 pm	6:25 pm
26th	Ganymede	4:20 pm	7:07 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 8 pm to midnight local time.

Date	Transit Time	Date	Transit Time
3rd	9:32 pm	17th	11:03 pm
5th	11:10 pm	20th	8:33 pm
8th	8:40 pm	22nd	10:11 pm
10th	10:18 pm	24th	11:49 pm
12th	11:56 pm	27th	9:19 pm
15th	9:25 pm	29th	10:57 pm

Space Race History

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

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

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

There were relatively few problems with the spacecraft and most were resolved before Apollo 8 made its historic trip to the Moon in the following December. The service module's main engine, which was required to enter into and leave lunar orbit performed flawlessly, restarting eight times during the mission. The overall performance of the Apollo 7 command and service module was a significant factor in NASA's decision to send Apollo 8 to the Moon after only one low-Earth test flight.

<u>October Nights</u>

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

Sunrise and Sunset (from New Milford, CT)

Sun	Sunrise	Sunset
October 1st (EDT)	06:50	18:35
October 15th	07:05	18:12
October 31st	07:24	17:49

Astronomical and Historical Events

1st International Observe The Moon Night
1st Apollo Asteroid 2018 ER1 near-Earth flyby (0.038 AU)
1st Kuiper Belt Object *120347 Salacia* at Opposition (44.201 AU)
1st History: launch of Chang'e 2 – China's Moon Orbiter (2010)
1st History: NASA created by the National Aeronautics and Space Act (1958)
2nd First Quarter Moon
2nd Atira Asteroid 2021 BS1 closest approach to Earth (0.613 AU)
2nd History: First flyby of Mercury by the BepiColombo spacecraft (2021
2nd History: opening of the Hayden Planetarium (1935)
3rd Scheduled launch of a Crew Dragon (Crew 5), with four astronauts, aboard a SpaceX Falcon 9 rocket from the Kennedy Space Center, Florida to the International Space Station - first Crew Dragon mission to fly a Russian cosmonaut
3rd History: launch of the fifth Mercury flight, piloted by astronaut Walter Schirra (1962)
3rd History: fall of the Zagami Martian meteorite in Katsina Province, Nigeria; the meteorite is classified as a Shergottite and is the largest single individual Mars meteorite ever found at 40 pounds (1962)
3rd History: first successful test launch of the German A-4 rocket (V-2) (1942)
3rd History: fall of the Chassigny Martian meteorite in Haute-Marne province, France; the meteorite is distinctly different from other Martian meteorites (shergottites and nakhilites) and is classified as its own subgroup – "chassignites" (1815)
4th Moon at perigee (closest distance to Earth in its orbit)
4th Apollo Asteroid *65803 Didymos* near-Earth flyby (0.071 AU)
4th History: Japanese lunar probe "Selenological and Engineering Explorer" (SELENE) enters lunar orbit; also known as Kaguya, the spacecraft was designed to study the geologic evolution of the Moon (2007)
4th History: SpaceShipOne rockets to an altitude of almost 70 miles to win the $10 million Ansari X Prize (2004)
4th History: launch of Luna 3; Soviet spacecraft was first to photograph the far side of the Moon (1959)
4th History: launch of Sputnik 1, world's first artificial satellite (1957)
5th Aten Asteroid 2018 VG near-Earth flyby (0.047 AU)
5th Plutino 469372 (2001 QF298) at Opposition (42.625 AU)
5th Kuiper Belt Object 523794 (2015 RR245) at Opposition (60.047 AU)
5th Kuiper Belt Object *541132 Leleakuhonua* at Opposition (76.112 AU)
5th History: Edwin Hubble's discovery of Cepheid Variable Star V1, a special class of variables that can be used measure large cosmic distances (1923)
5th History: launch of the space shuttle Challenger (STS-41-G), crew included astronaut Kathryn Sullivan, first American women to walk in space (1984)

Astronomical and Historical Events

5th History: Robert Goddard born, founding father of modern rocketry (1882)
6th Apollo Asteroid 2021 TJ10 near-Earth flyby (0.050 AU)
6th History: Asteroid 2008 TC3 discovered by astronomers on Mt. Lemmon less than 24 hours before exploding over the Sudan. The McCarthy Observatory submitted one of the last accepted observations. Meteorites from the fall were eventually recovered. (2008)
6th History: launch of the space shuttle Discovery and the solar polar orbiter spacecraft Ulysses (1990)
7th Amor Asteroid 2013 TJ6 near-Earth flyby (0.030 AU)
7th Apollo Asteroid 2006 SG7 near-Earth flyby (0.043 AU)
8th **Second Saturday Stars at the McCarthy Observatory** (starting at 7:00 PM)
8th Mercury at its Greatest Western Elongation (18°) – greatest apparent distance from the Sun in the eastern sky before sunrise
9th Full Moon (Hunter Moon)
9th Draconids Meteor Shower peak (produced by debris from Comet Giacobini-Zinner)
9th History: LCROSS impacts crater Cabeus near the Moon's south pole in search of water (2009)
9th History: Peekskill meteorite fall; 27-pound meteorite hits a 1980 Chevy Malibu sitting in its driveway in Peekskill, NY (1992)
9th History: discovery of Supernova 1604 (Kepler's Nova) (1604)
10th History: inauguration of the Very Large Array, one of the world's premier astronomical radio observatories; located west of Socorro, New Mexico (1980)
10th History: enactment of the Outer Space Treaty: 1) prohibited placement of nuclear and other weapons of mass destruction in orbit, on the Moon or other celestial body and 2) limited the use of the Moon and other celestial bodies to peaceful purposes (1967)
10th History: discovery of Neptune's moon *Triton* by William Lassell (1846)
11th Kuiper Belt Object 308933 (2006 SQ372) at Opposition (30.278 AU)
11th History: NASA's historic 100th space shuttle flight as Discovery carries the Z1 Truss (first piece of the ISS structural backbone) into space (2000)
11th History: Magellan spacecraft burns up in the Venusian atmosphere after completing its mission to map the planet with its imaging radar (1994)
11th History: launch of first manned Apollo mission (Apollo 7) with astronauts Schirra, Eisele and Cunningham (1968)
11th History: launch of WAC Corporal, first man-made object (16-foot rocket) to escape Earth's atmosphere (1945)
12th Kuiper Belt Object 528381 (2008 ST291) at Opposition (61.786 AU)
12th History: launch of Voskhod 1; Soviet spacecraft was first to carry multiple (3) cosmonauts (a pilot, scientist and physician) into space. Due to the cramped conditions the crew flew without spacesuits, ejection seats, or an escape tower (1964)
12th History: first Symposium on Space Flight held at the Hayden Planetarium in New York City; participants included Wernher von Braun, Willy Ley, and Fred L. Whipple; topics included an orbiting astronomical observatory, survival in space, circumlunar flight, a manned orbiting space station, and the question of sovereignty in outer space (1951)
13th Apollo Asteroid *11066 Sigurd* closest approach to Earth (0.414 AU)
13th Aten Asteroid *3362 Khufu* closest approach to Earth (1.499 AU)
13th History: launch of Shenzhou 6, China's second manned spacecraft (2005)

Astronomical and Historical Events (continued)

13th History: launch of Explorer 7; spacecraft measured solar X-rays, energetic particles, and cosmic rays (1959)
13th History: formation of the British Interplanetary Society by Phillip Cleator in Liverpool (1933)
14th Apollo Asteroid 2013 SL20 near-Earth flyby (0.016 AU)
14th History: three main belt asteroids discovered by the McCarthy Observatory while searching for NEOs. 2003 TG10 (its provisional name) was subsequently named after Monty Robson (115449 Robson), the founder and director of the observatory (2003)
14th History: launch of Shenzhou 5, first Chinese manned spacecraft (2003)
14th History: Air Force Captain Chuck Yeager breaks the sound barrier in the Bell X-1 rocket plane (called "Glamorous Glennis" as a tribute to his wife). The plane reached a speed of 700 miles per hour after being launched from the bomb bay of a Boeing B-29 (1947)
15th Amor Asteroid 5620 Jasonwheeler closest approach to Earth (1.212 AU)
15th History: Interstellar Object 1I/2017 U1 (*'Oumuamua*) closest approach to Earth (0.162 AU) (2017)
15th History: launch of the Cassini spacecraft to the planet Saturn (1997)
16th Apollo Asteroid 2020 TO2 near-Earth flyby (0.006 AU)
16th Apollo Asteroid 2020 BD near-Earth flyby (0.031 AU)
16th History: launch of the Lucy spacecraft on 12-year mission and a flyby of seven Trojan asteroids that orbit the Sun in front of and behind Jupiter (2021)
16th History: launch of GOES 1, first weather satellite placed in geosynchronous orbit (1975)
17th Last Quarter Moon
17th Moon at apogee (furthest distance from Earth in its orbit)
17th Kuiper Belt Object 303775 (2005 QU182) at Opposition (53.967 AU)
18th Kuiper Belt Object 19308 (1996 TO66) at Opposition (46.700 AU)
18th Dwarf Planet *136199 Eris* at Opposition (94.820 AU)
18th History: launch of the space shuttle Atlantis (STS-34) and Galileo spacecraft to Jupiter (1989)
18th History: discovery of *Chiron* by Charles Kowal; *Chiron* has the characteristics of both a comet and an asteroid. These types of objects are called Centaurs after a mythological being that are half human/half horse (1977)
18th History: Soviet spacecraft Venera 4 enters the atmosphere of Venus; first probe to analyze the environment (in-situ) of another planet (1967)
18th History: discovery of Asteroid *8 Flora* by John Hind (1847)
19th History: launch of the BepiColombo spacecraft (Mercury orbiters) from the Kourou launch facility in French Guiana. BepiColombo is on a seven-year journey to Mercury carrying orbiters from the European Space Agency and the Japan Aerospace Exploration Agency (2018)
19th History: launch of the IBEX (Interstellar Boundary Explorer) (2008)
19th History: flyby of the planet Venus by the Mariner 5 spacecraft (1967)
19th History: Subrahmanyan Chandrasekhar born; awarded Nobel Prize in Physics (1983) for studies of the structure and evolution of stars; NASA named its premier X-ray observatory the Chandra X-ray telescope in his honor (1910)
20th Atira Asteroid 434326 (2004 JG6) closest approach to Earth (0.699 AU)
20th History: launch of the Soviet spacecraft Zond 8; moon flyby mission (1970)
20th History: discovery of asteroid *577 Rhea* by Max Wolf (1905)

Astronomical and Historical Events (continued)

21st Orionids Meteor Shower peak (produced by debris from Comet Halley)
21st History: NASA's Mars Atmosphere and Volatile Evolution (MAVEN) spacecraft successfully entered orbit around Mars - first spacecraft dedicated to studying the Martian atmosphere and its connection to the Red Planet's climate (2014)
21st History: dedication of the Yerkes Observatory in Williams Bay, Wisconsin; home of the world's largest refractor with its 40-inch objective lens ground and polished by Alvan Clark and Sons (1897)
22nd History: launch of Chandrayaan-1, India's first mission to the Moon (2008)
22nd History: Soviet spacecraft Venera 9 touches down on Venus and transmits first pictures (black and white) of its surface (1975)
22nd History: launch of the Soviet Moon orbiter Luna 12 to take high-resolution photos of the Moon's surface from lunar orbit (1966)
23rd Kuiper Belt Object 202421 (2005 UQ513) at Opposition (46.805 AU)
23rd History: India's Mars Orbiter Mission (MOM) entered orbit around Mars (2014)
23rd History: first time female commanders led orbital missions at the same time: Pamela Melroy commanded space shuttle Discovery (STS-120) to the ISS while Peggy Whitson led the Expedition 16 team aboard the ISS in the installation of a new orbital node (2007)
24th History: launch of Chang'e-1, Chinese lunar orbiter, from the Xichang Satellite Launch Center in the southwestern province of Sichuan (2007)
24th History: Mars Odyssey enters orbit around Mars (2001); science goals included mapping the elemental composition of the surface
24th History: launch of Deep Space 1; first of a series of technology demonstration probes developed by NASA's New Millennium Program; propulsion was provided by a xenon ion engine that operated for a total of 16,265 hours (1998)
24th History: discovery of Saturn's moon Prometheus by Stewart Collins in photos taken by the Voyager 1 probe (1980)
24th History: Over 100 people killed in a launch pad explosion when Air Marshal Mitrofan Nedelin, commander of the USSR's Strategic Rocket Forces, orders workers back to the pad to repair a defective R-16 missile without first unloading the unstable fuel (1960)
24th History: discovery of Uranus' moons *Umbriel* and *Ariel* by William Lassell (1851)
25th New Moon
25th Aten Asteroid 2016 TH94 near-Earth flyby (0.049 AU)
25th Aten Asteroid *3753 Cruithne* closest approach to Earth (0.606 AU)
25th Centaur Object *20461 Dioretsa* at Opposition (32.626 AU)
25th History: launch of the twin Solar Terrestrial Relations Observatories (STEREO A and B); 3-D studies of the Sun and coronal mass ejections (2006)
25th History: Soviet spacecraft Venera 10 touches down on Venus 2,200 km from its twin Venera 9; lands on a flat boulder that was determined to be similar in composition to basalt on Earth (1975)
25th History: discovery of Saturn's moon *Iapetus* by Giovanni Cassini (1671)
26th Scheduled launch of a Russian Progress cargo-carrying spacecraft from the Baikonur Cosmodrome, Kazakhstan to the International Space Station
27th History: first test flight of the Saturn I rocket (1961)
28th Kuiper Belt Object 308379 (2005 RS43) at Opposition (43.475 AU)
28th History: Karl Reinmuth's discovery of Apollo asteroid *69230 Hermes* (1937)

Astronomical and Historical Events (continued)

28th History: first (and last) test flight of the Ares I-X rocket; a two-minute powered suborbital flight (2009)
28th History: launch of Prospero spacecraft, Great Britain's first space launch (1971)
29th Moon at perigee (closest distance to Earth in its orbit)
29th Aten Asteroid 2004 UT1 near-Earth flyby (0.010 AU)
29th Apollo Asteroid *2063 Bacchus* closest approach to Earth (0.221 AU)
29th History: launch of the space shuttle Discovery (STS-95) with astronaut and then U.S. Senator, John Glenn (1998)
29th History: flyby of asteroid *Gaspra* by the Galileo spacecraft on mission to Jupiter (1991)
30th History: discovery of the Los Angeles (Mars) Meteorite (1999)
30th History: launch of Venera 13, Soviet Venus lander; lander survived for 127 minutes on the surface where the temperature was recorded at 855 °F (1981)
30th History: Mercury Theatre broadcasts Orson Welles' adaptation of H.G. Wells "War of the Worlds" (1938)
31st History: Walter Baade's discovery of the first Centaur Object, 944 Hidalgo (1920)
31st History: birthday of Apollo 11 Command Module pilot Michael Collins (1930)
31st History: first rocket engine tests by three young rocketeers that would be the beginning of what would become the Jet Propulsion Laboratory (1936)

Commonly Used Terms

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

References on Distances

- the apparent width of the Moon (and Sun) is approximately one-half a degree (½°), less than the width of your little finger at arm's length which covers approximately one degree (1°); three fingers span approximately five degrees (5°)

- 1 astronomical unit (AU) is the distance from the Sun to the Earth or approximately 93 million miles

International Space Station and Artificial Satellites

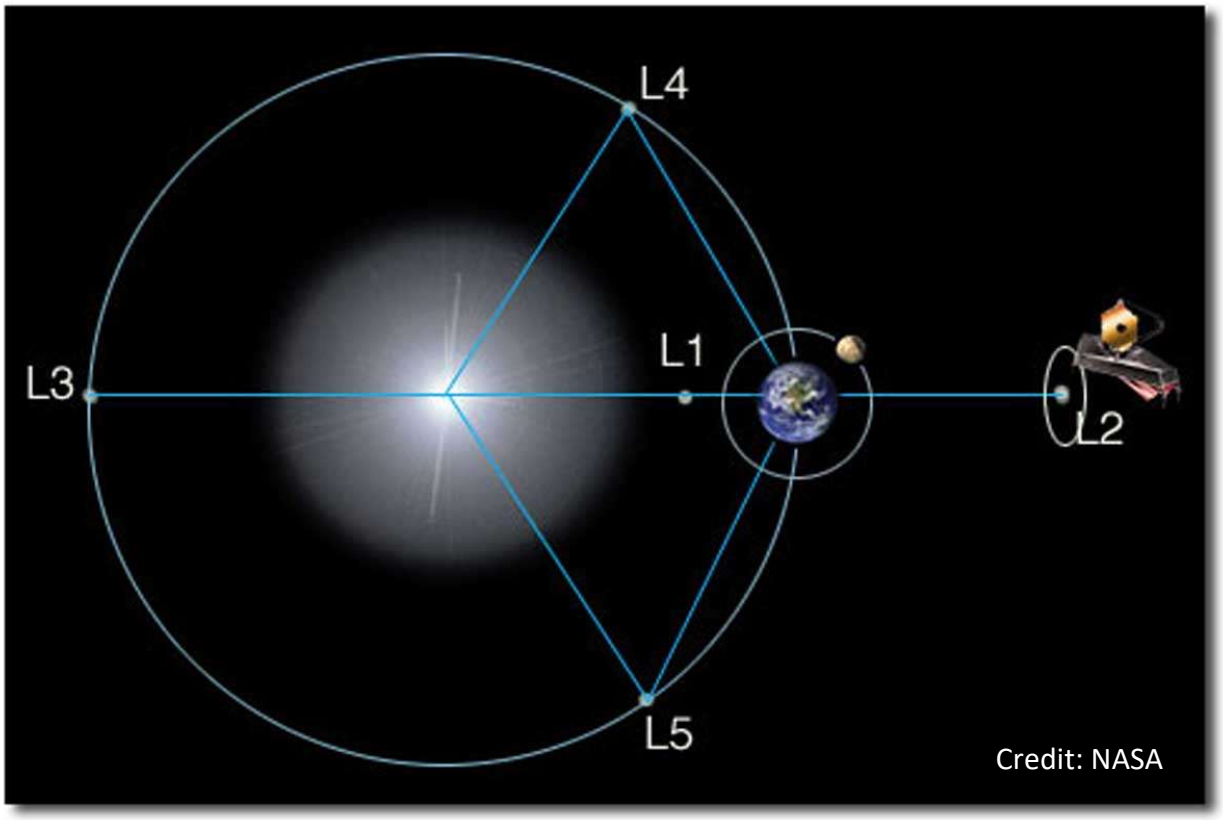
Visit www.heavens-above.com for the times of visibility and detailed star charts for viewing the International Space Station and other man-made objects in low-Earth orbit.

Solar Activity

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

Lagrange Points

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



James Webb Space Telescope

- https://www.jwst.nasa.gov/

NASA's Global Climate Change Resource

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

Mars – Mission Websites

- Mars 2020 (Perseverance rover): https://mars.nasa.gov/mars2020/
- Mars Helicopter (Ingenuity): https://mars.nasa.gov/technology/helicopter/
- Mars Science Laboratory (Curiosity rover): https://mars.nasa.gov/msl/home/
- Mars InSight (lander): https://mars.nasa.gov/insight/

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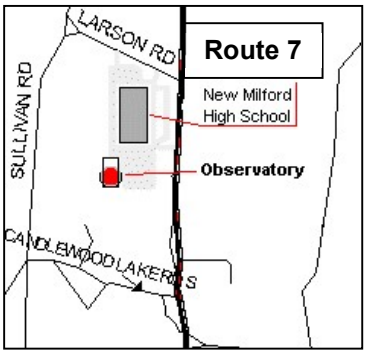

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