# Galactic Observer

## John J. McCarthy Observatory

Volume 17, No. 11 November 2024


Comet C/2023 A3
October Apparition
Photo: Bill Cloutier

# November Astronomy Calendar and Space Exploration Almanac


Built in 1892, the entrance to Building C on the grounds of the Harvard College Observatory in Cambridge, Massachusetts. During his tenure, Edward Pickering (the Director of the observatory from 1877 to his death in 1919) employed more than 80 women at this location to be astronomical computers, analyzing stellar images. Among those who would revolutionize the science of astronomy were Williamina Fleming, Cecilia Payne, Annie Jump Cannon and Henrietta Swan Leavitt.

Photo: Bill Cloutier

## In This Issue

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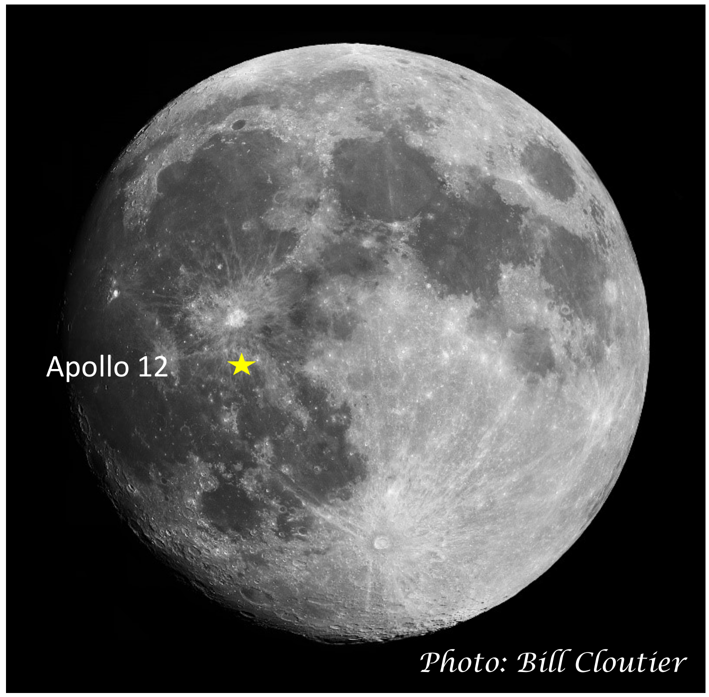
932
McCarthy Observatory
New Milford, CT

"Out the Window on Your Left"

It's been 55 years since Neil Armstrong first stepped onto the Moon's surface and almost 52 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).

On a rainy morning in November 1969, despite being struck by lightning (twice) during the first minute of flight, a Saturn V rocket delivered the crew of Apollo 12 into orbit and on its way for the second successful manned Moon landing.



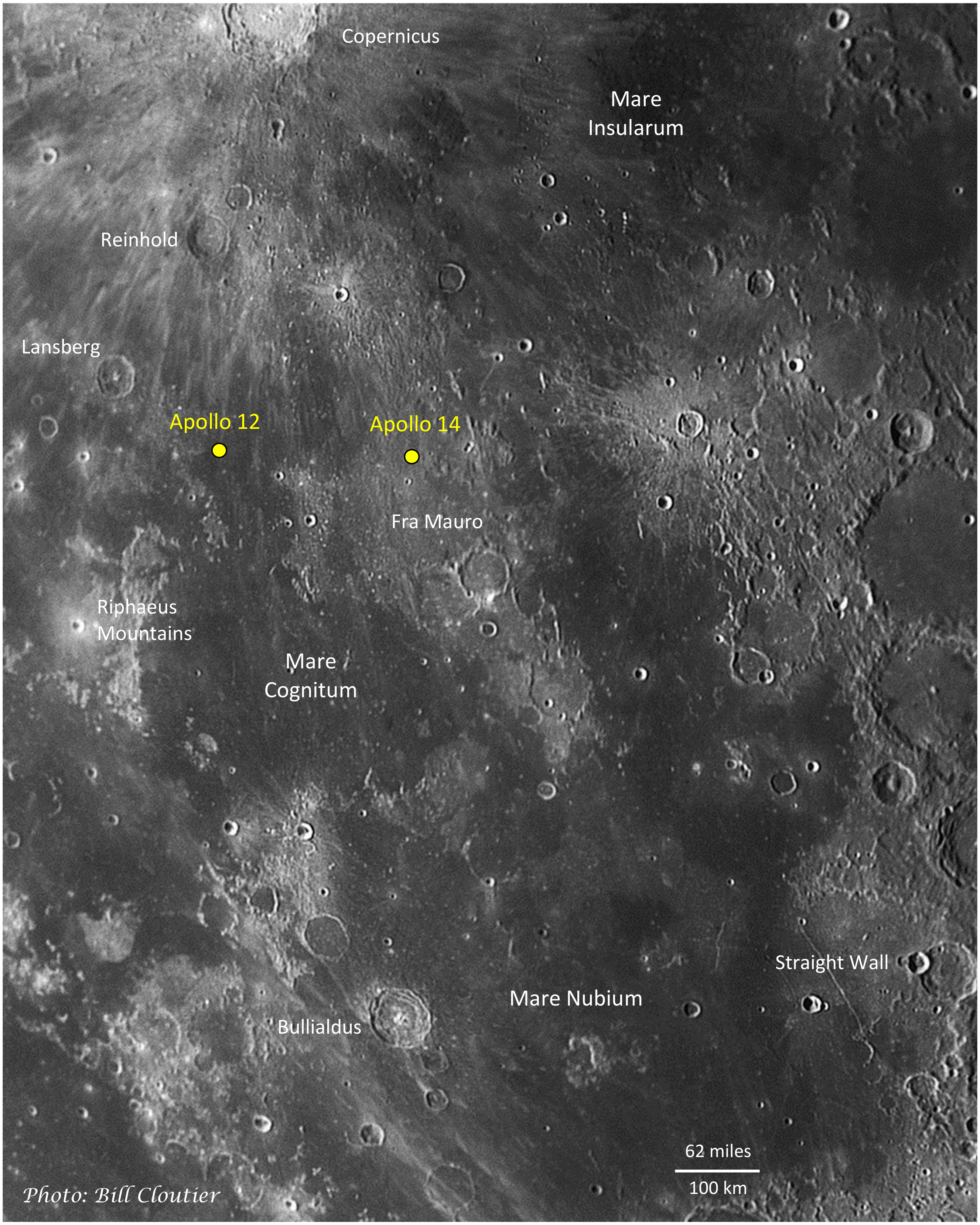

Apollo 12 landed approximately 930 miles (1,500 km) west of the Apollo 11's Tranquility Base. The site was selected for its proximity to Copernicus crater, 250 miles (400 km) to the north, and for the ejecta that was believed to have covered the area from that crater's formation. The location was also home to Surveyor 3, an unmanned robotic spacecraft that landed on the Moon in April 1967.

"Pete" Conrad and Alan Bean executed a pinpoint landing on November 19th, setting down the Lunar Module "Intrepid" 535 feet (163 meters) from the Surveyor spacecraft. To minimize the potential of contaminating the robotic spacecraft by the descent engine exhaust or from dust kicked up by the engine, the landing was required to be at least 500 feet (152 meters) from Surveyor. The Sun was only 6° above the horizon at touchdown, casting long shadows across the volcanic plain and adding sharp relief to the geologic features at the landing site.

The astronauts spent 7 hours and 45 minutes on the surface in two separate excursions, collecting 75 pounds (34 kg) of rock and soil samples, setting up experiments, and removing pieces from Surveyor for further study back on Earth. The most unusual sample collected by the astronauts was a small rock measuring just 2 inches across (5 cm) comprised of potassium (K), rare earth elements (REE), and phosphorus (P). Referred to as KREEP, this material is believed to have formed early in the Moon's history when its magma ocean started to crystalize. An enduring mystery is why KREEP deposits are primarily concentrated on the Moon's nearside.

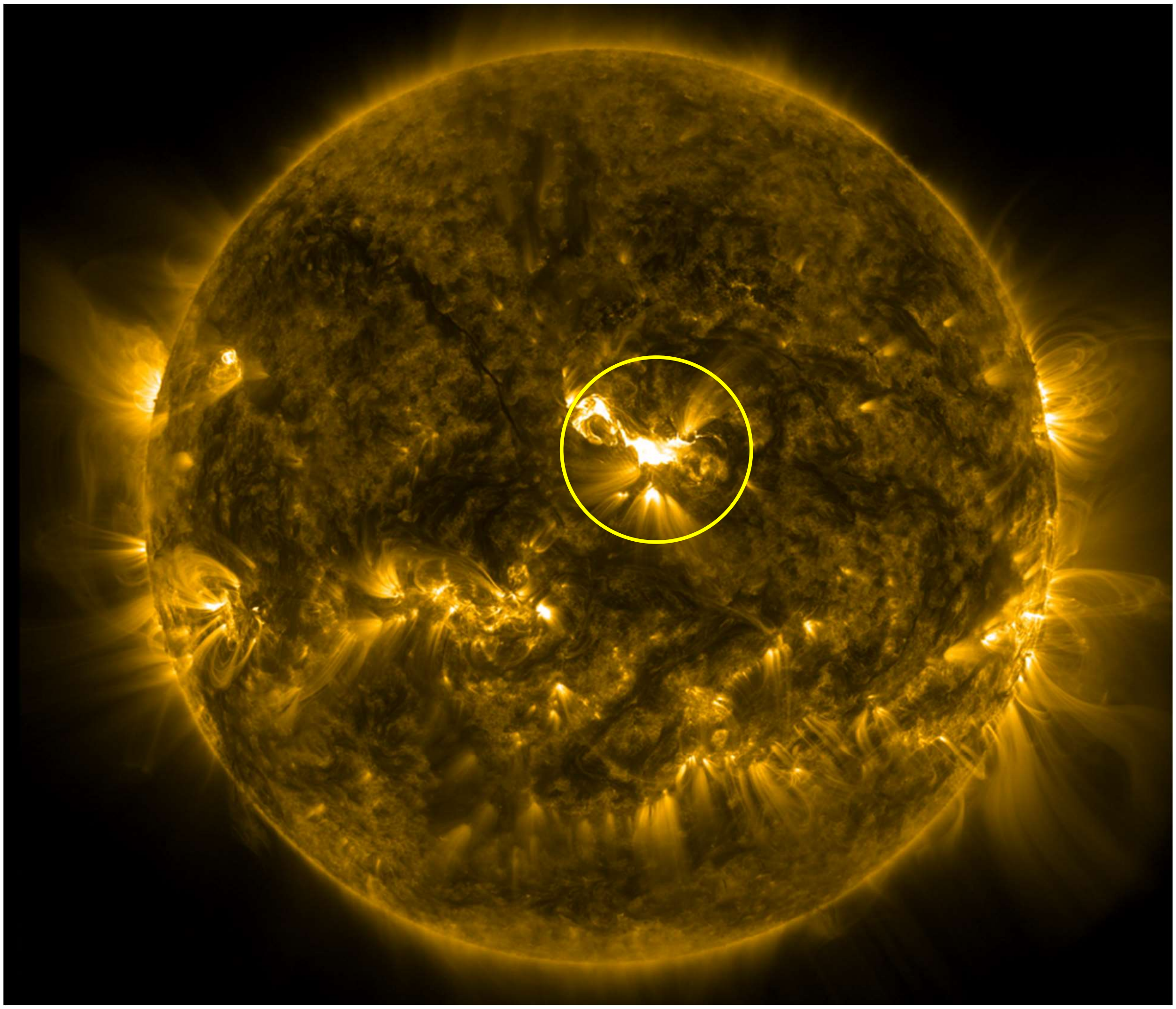
While Conrad and Bean were on the Moon, Command Module Pilot Richard Gordon remained in lunar orbit in the Command Module, the "Yankee Clipper," conducting photographic surveys of potential landing sites. These included the Fra Mauro region, which after the Apollo 13 abort, was redesignated as the target for Apollo 14.

## Apollo 12


Copernicus
Mare
Insularum
Reinhold
Lansberg
Apollo 12
Apollo 14
Fra Mauro
Riphaeus
Mountains
Mare
Cognitum
Straight Wall
Mare Nubium
Bullialdus
62 miles
100 km
Photo: Bill Cloutier

Geomagnetic Solar Storm


Strong auroral activity was seen over the McCarthy Observatory on the night of October 10th despite the interference from parking lot lights and a bright moon



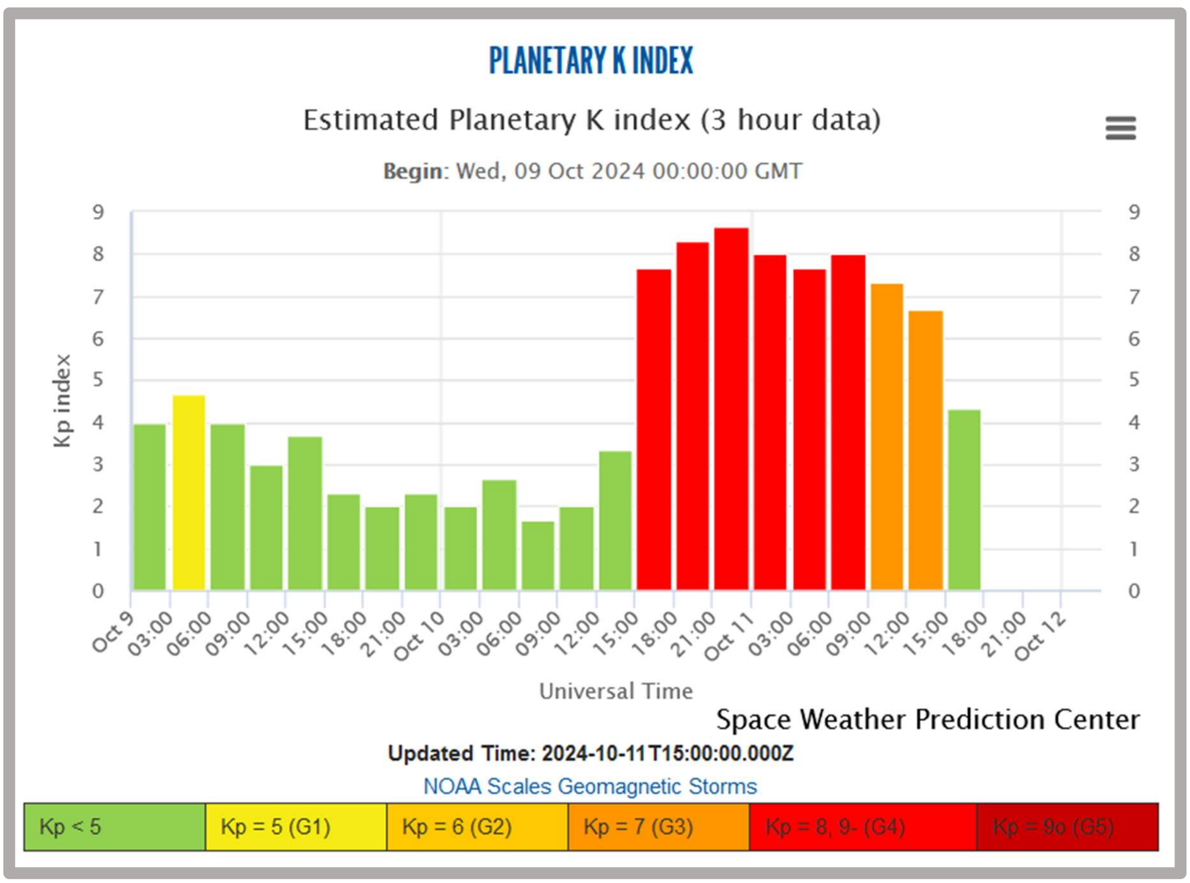
Sun at a wavelength of 171 Ångstroms (17.1 nanometers), a spectral line emitted by iron atoms that have lost 8 electrons at temperatures of 600,000° K
NASA's Solar Dynamics Observatory

On the evening of October 8th a powerful flare erupted from Sunspot AR3848 (circled above). With the sunspot directly facing the Earth, the X1.8-class flare's explosion lasted long enough (more than 5 hours) to lift a massive cloud of plasma out of the Sun's atmosphere and hurl it in Earth's direction.

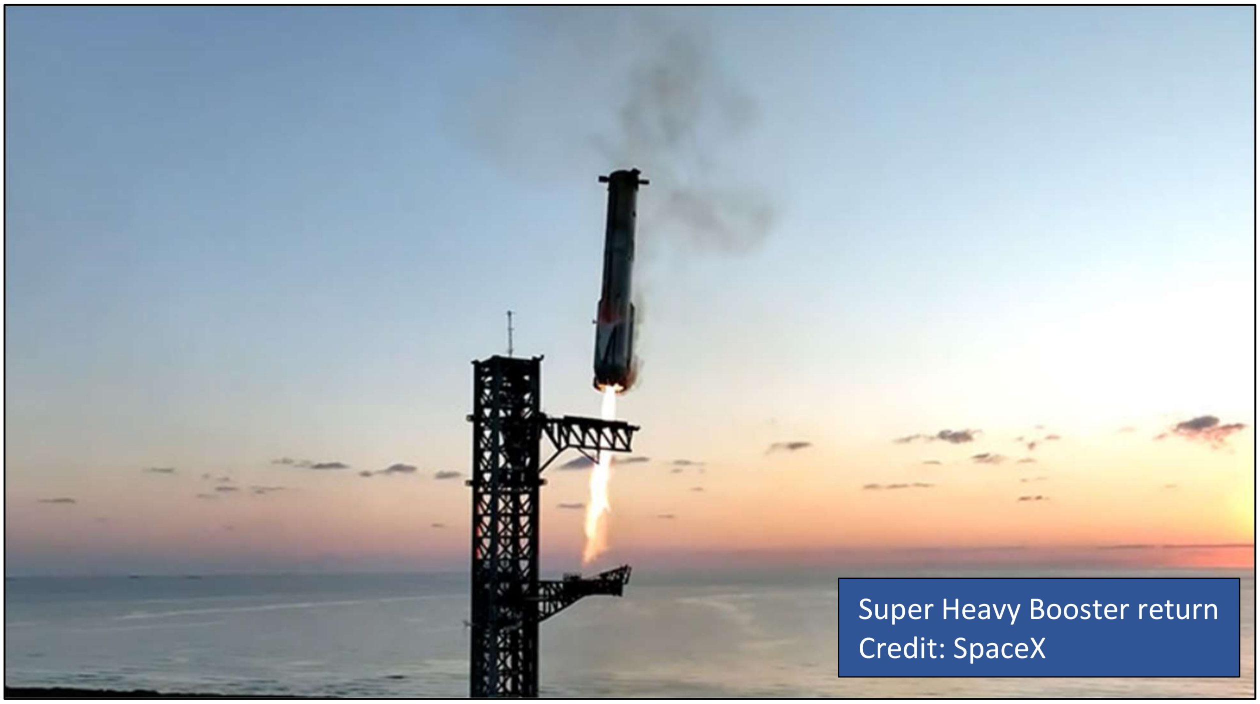
The coronal mass ejection (CME) was first detected by the Deep Space Climate Observatory (DSCOVR). The satellite is located inside Earth's orbit, about a million miles (1.5 million km) from Earth at the L1 Lagrange point.

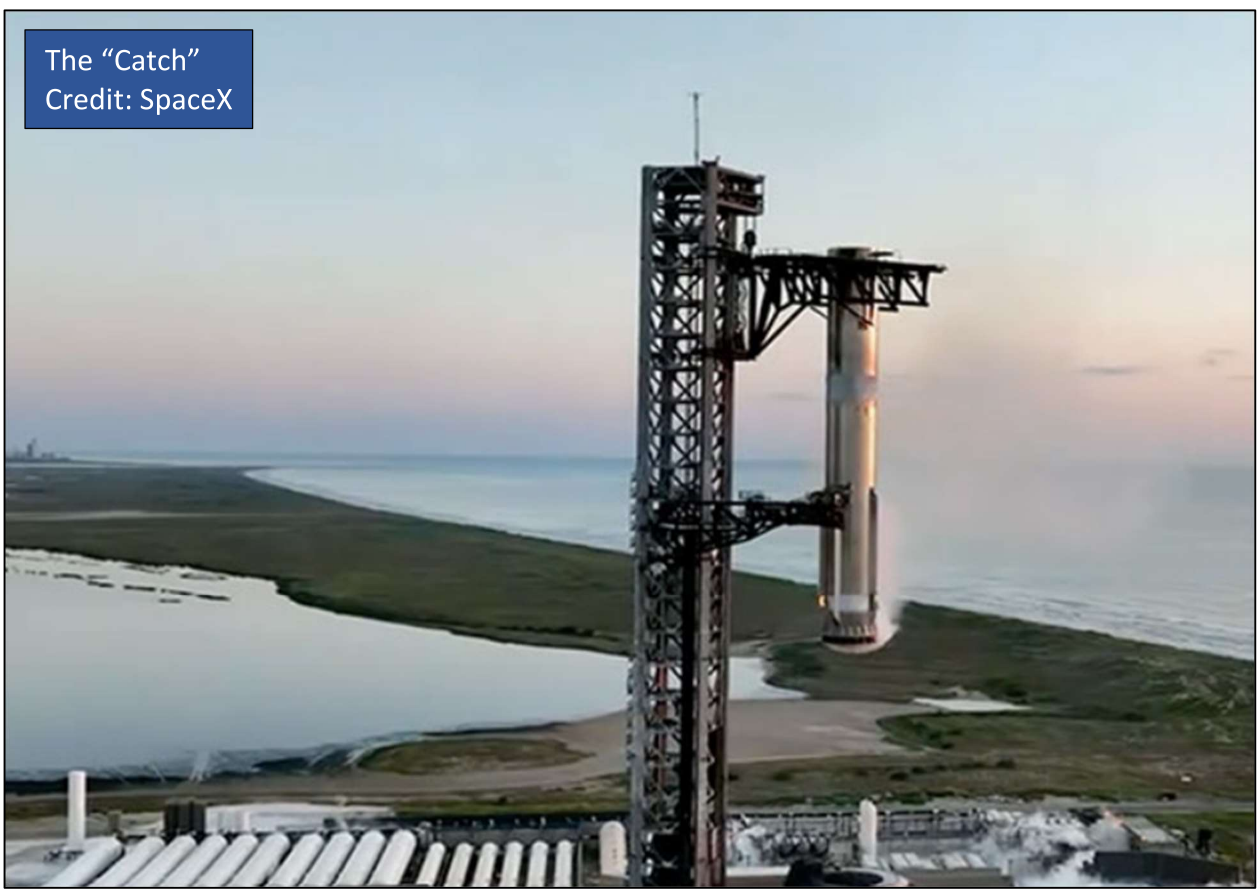
In less than 48 hours, the CME had crossed the 93 million mile gulf between the Sun and Earth. Traveling in excess of 1.3 million miles an hour (600 - 700 kms) upon arrival, the plasma cloud struck our planet on the afternoon of October 10th. By nightfall, a Severe (G4) class geomagnetic storm was underway, highlighted by bright ribbons of red and sheets of green auroral light from electrons colliding with oxygen and nitrogen atoms and molecules in Earth's upper atmosphere.


Auroral Activity from
Geomagnetic Storm
Photo: Bill Cloutier
Photo: Bill Cloutier


PLANETARY K INDEX
Estimated Planetary K index (3 hour data)
Begin: Wed, 09 Oct 2024 00:00:00 GMT
Kp index
0 1 2 3 4 5 6 7 8 9
Oct 9 03:00 06:00 09:00 12:00 15:00 18:00 21:00 Oct 10 03:00 06:00 09:00 12:00 15:00 18:00 21:00 Oct 11 03:00 06:00 09:00 12:00 15:00 18:00 21:00 Oct 12
Universal Time
Space Weather Prediction Center
Updated Time: 2024-10-11T15:00:00.000Z
NOAA Scales Geomagnetic Storms
Kp < 5
Kp = 5 (G1)
Kp = 6 (G2)
Kp = 7 (G3)
Kp = 8, 9- (G4)
Kp = 9o (G5)

Starship Booster Catch


Super Heavy Booster return
Credit: SpaceX


The “Catch”
Credit: SpaceX

On October 13th, SpaceX achieved another first when its Super Heavy Booster returned to the launch site and lowered itself in between two large mechanical arms. The return, just seven minutes after liftoff, was the first time a rocket returned to the same launch pad from which it left. It was also the first time that a rocket has been caught while descending.

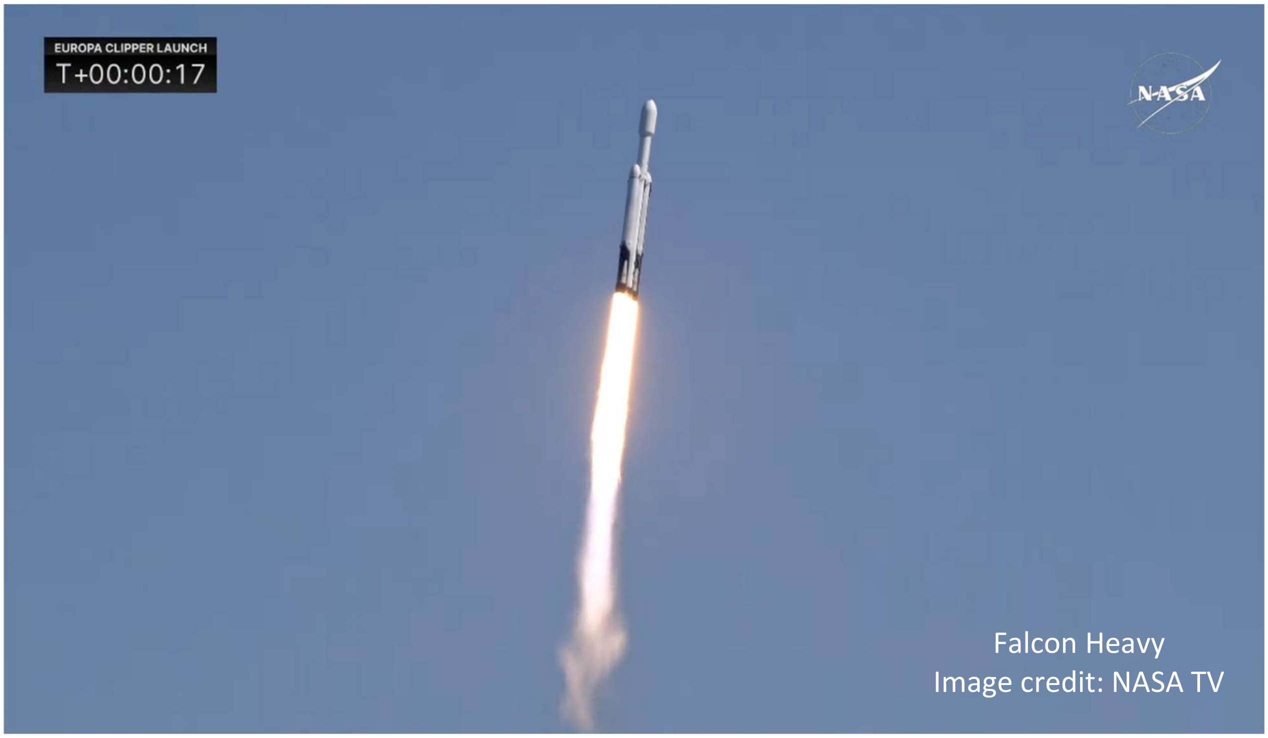
SpaceX's fifth integrated test flight began around 8:25 am EDT when the nearly 400-foot-tall (121 meter) vehicle lifted off from the company's Starbase production and launch facility at Boca Chica, Texas. The Super Heavy Booster's 33 methane-fueled Raptor engines burned for three minutes and 40 seconds before separating and falling away from the Starship spacecraft. Starship, powered by its six Raptors, continued to climb out of the Earth's atmosphere. Halfway around the world, it would later reenter the atmosphere for a controlled splashdown in the Indian Ocean.

The top of the Super Heavy seen resting between the two mechanical arms at the launch site after its nearly seven minute flight and return "catch" Photo: SpaceX

After sending Starship on its way, the Super Heavy Booster flipped around and relit 13 of its 33 engines to reduce velocity for a return to the launch site. Even when not actively firing, the engines on the 233-foot-tall (or 71 meter) booster glowed red from the heat of reentry. While the demonstration was considered a resounding success, there was some warping of the engine nozzles from the heat and aerodynamic forces, and charring of materials in the engine compartment, which SpaceX said would be addressed before future flights.

The "catch" was one of the stated objectives for the demonstration, but only if there were no anomalies in the flight (otherwise the booster would be set down in the Gulf of Mexico as it was in the previous flight). The ability to return the first stage is an important milestone in SpaceX's ambitious pursuit for a fully reusable vehicle. Reusability is also key to SpaceX's role in supporting NASA's Artemis program where multiple boosters will be needed in rapid succession to launch and refuel a modified lunar-landing Starship in Earth orbit.

Europa Clipper's Journey Begins



Falcon Heavy
Image credit: NASA TV

Shortly after noon on October 14th, a SpaceX Falcon Heavy rocket, under the power of 27 Merlin engines, climbed into a clear blue sky over the Kennedy Space Center. Tucked safely inside the second stage fairing was NASA's Europa Clipper spacecraft. Just over an hour after it left the historic Pad 39A, the spacecraft separated from the second stage to begin its five and one-half year journey to Jupiter and its ocean moon Europa.


Spacecraft Separation
Image credit: NASA TV

The Falcon Heavy is configured with a center core booster and two side boosters. Unlike previous launches, the boosters were not recovered with the mission requiring maximum performance to send the spacecraft on its way (the two side boosters had been used a year earlier to send the Psyche spacecraft on its way to a metal asteroid).

Shortly after being released, the spacecraft deployed its massive solar panels. Needed to operate so far from the Sun, each wing measured over 46 feet in length (14.2 meters), with the total span longer than a standard basketball court. Europa Clipper is scheduled to arrive in the Jovian system in April 2030 in a journey that includes a gravity assist from Mars in March 2025 and another one from Earth in December 2026. Once in orbit around Jupiter, the astrobiology mission is expected to conduct 50 flybys of the moon Europa, coming as close as 16 miles (25 km) from its icy surface.

Artemis Radiation Results

The Orion spacecraft used for the Artemis I test flight was equipped with an array of detectors to assess the radiation environment and the heath effects on future astronauts traveling through Earth's radiation belts and into deep space. Instrumentation for measuring radiation inside Orion included NASA's HERA (Hybrid Electronic Radiation Assessor) and Crew Active Dosimeter (for real-time radiation dose data) and the European Space Agency's Active Dosimeter. In addition, the German Aerospace Center provided the Matroshka AstroRad Radiation Experiment. Collaborating with NASA, two life-sized female radiation phantoms (Helga and Zohar) were placed in the spacecraft. The phantoms, constructed with materials that mimic human tissue, bone, and organs, are used in medical studies to replicate the radiation-transport properties of the human body. Each phantom was outfitted with more than 5,600 passive sensors and 34 active radiation detectors, with Zohar also wearing a radiation protection vest.

After launch on November 16, 2022, Orion first crossed the inner (proton-dominated) radiation belt, spending about 30 minutes in the zone of energetic charged particles. Thirty minutes after exiting the inner belt, the spacecraft entered the outer (electron-dominated) radiation belt. The transit of the outer belt took two hours. Once clear of the belts, the primary source of radiation was Galactic Cosmic Rays (GCRs are high-energy particles originated from outside the solar system). Orion passed by the Moon twice in its 25-day mission before re-entering the Earth's atmosphere over the South Pole (avoiding the densest areas of the toroidal-shaped radiation belts).

Helga and Zohar on the flight deck of the Orion spacecraft (NASA test mannequin in orange) Credit: Nature (2024). DOI: 10.1038/s41586-024-07927-7

Recently released results indicate that the spacecraft design exceeded minimum safety levels for future missions. Inside the spacecraft, dose rates varied by a factor of four from the areas with the most shielding to the least. However, the heavily shielded Orion spacecraft offered good protection from belt radiation.

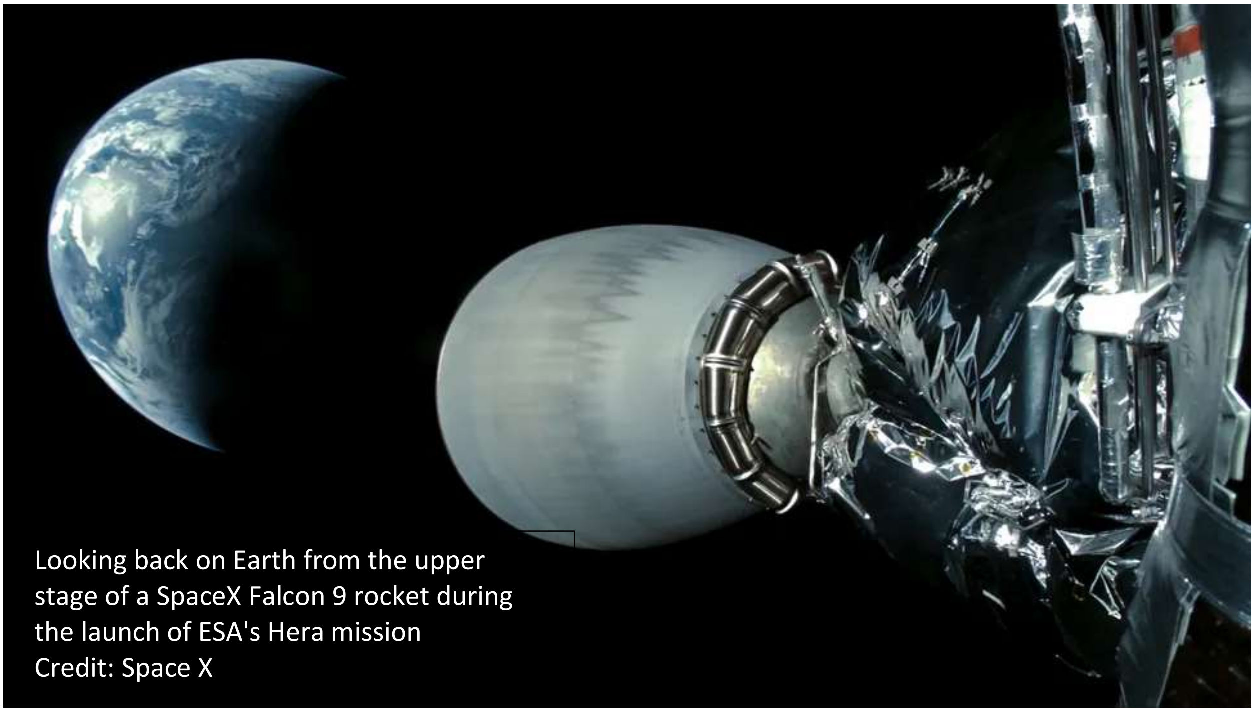
In addition to directing astronauts to the more heavily shielded areas of the spacecraft during a radiation storm, researchers also found that the spacecraft's orientation could provide an additional reduction in dose, particularly in environments like the radiation belts where the charged particles display directionality (following the magnetic field lines). For example, during the crossing of the inner Van Allen belt, the spacecraft performed a 90-degree turn. The orientation placed the heavily shielded long axis of the spacecraft and the Interim Cryogenic Propulsion Stage against the steam of particles. This reduced the radiation levels inside the spacecraft by up to 50%. Overall, the spacecraft's shielding did not provide the same level of protection again GCRs, although the Moon's rocky composition did provide a noticeable reduction in cosmic radiation when the spacecraft was in close proximity.

An Oort Cloud Caller

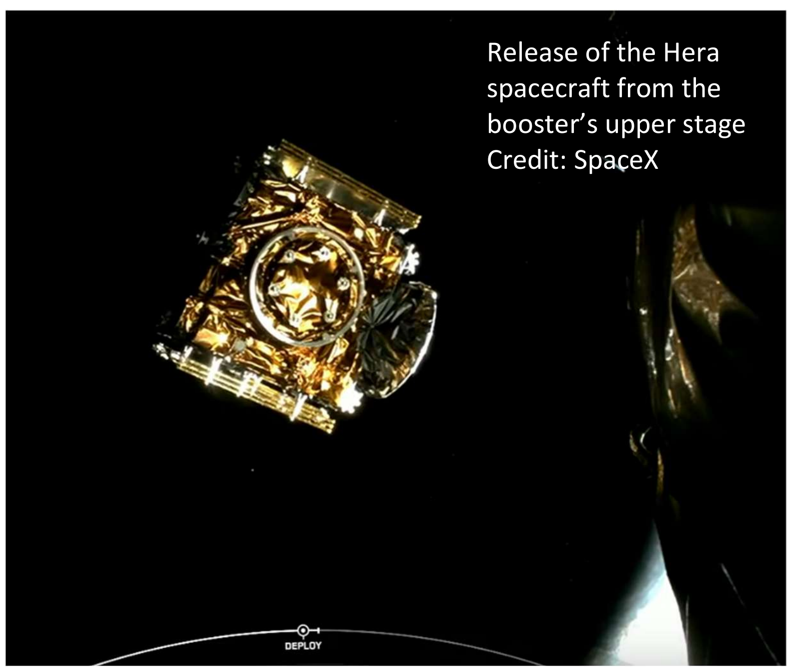

Comet C/2023 A3 was discovered by the Asteroid Terrestrial-impact Last Alert System (ATLAS) in February 2023 and also independently observed a few weeks before in January at the Tsuchinshan Chinese Observatory. The comet was officially named in honor of both observatories. The comet from the distant Oort Cloud survived its close encounter with the Sun (perihelion) in late September, first appearing in the evening sky during the second week of October. Despite interference from a nearly full Moon, Tsuchinshan-ATLAS was bright enough to be seen without optical aid for several days shortly after sunset. Unfortunately, its visit to the inner solar system was fleeting and likely a one-time event. Based on the latest data, the comet will be ejected from the solar system, never to return.

## There and Back Again

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



Looking back on Earth from the upper stage of a SpaceX Falcon 9 rocket during the launch of ESA's Hera mission
Credit: Space X




Release of the Hera spacecraft from the booster's upper stage
Credit: SpaceX

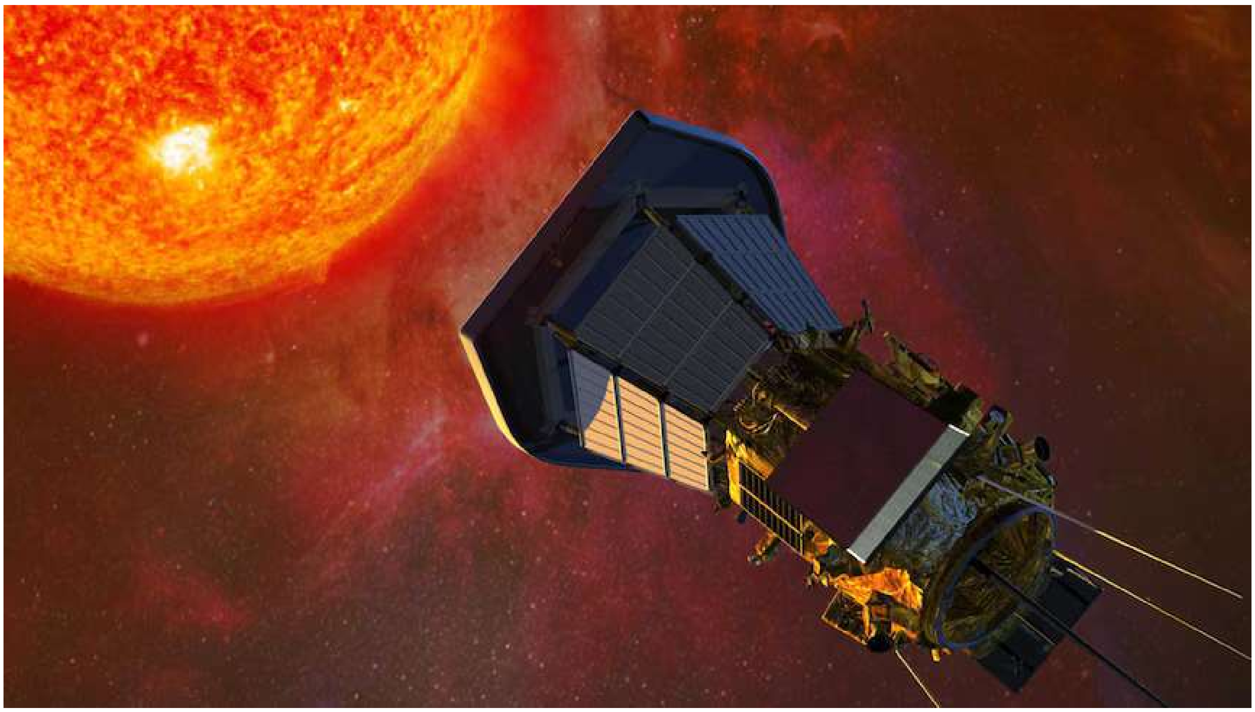
On October 7th, a SpaceX rocket launched the Hera mission from the Kennedy Space Center. The European Space Agency's spacecraft is destined for the Didymos/ Dimorphos binary.

DART and Hera were conceived as part of an international "Asteroid Impact Deflection Assessment" collaboration. Hera will enter into an orbit around the system's barycenter (the common center of gravity in the binary system) in early 2027. The orbit will bring the spacecraft within 12 – 18 miles (20 - 30 km) of Dimorphos' surface for a detailed post-impact survey of the pair, including high-resolution visual, laser and radio science mapping of the moon.

Final Venus Assist for the Parker Solar Probe

The Parker Solar Probe, launched in 2018 from the Cape Canaveral Air Force Station, is designed to study the Sun's outer atmosphere (corona) and trace the flow of energy from the Sun's interior to better understand why the corona is significantly hotter than the Sun's surface (photosphere). Since first arriving inside the orbit of Mercury, the probe has been using the gravity of Venus to modify its orbit, bringing it ever closer to the Sun.

On November 6th, the Parker Solar Probe will perform its 7th and final Venus flyby setting the spacecraft up for its closest encounter yet with the Sun on December 24th. At its closest, the probe will be traveling at approximately 430,000 mph (700,000 kph) - fast enough to get from Philadelphia to Washington, D.C., in one second.

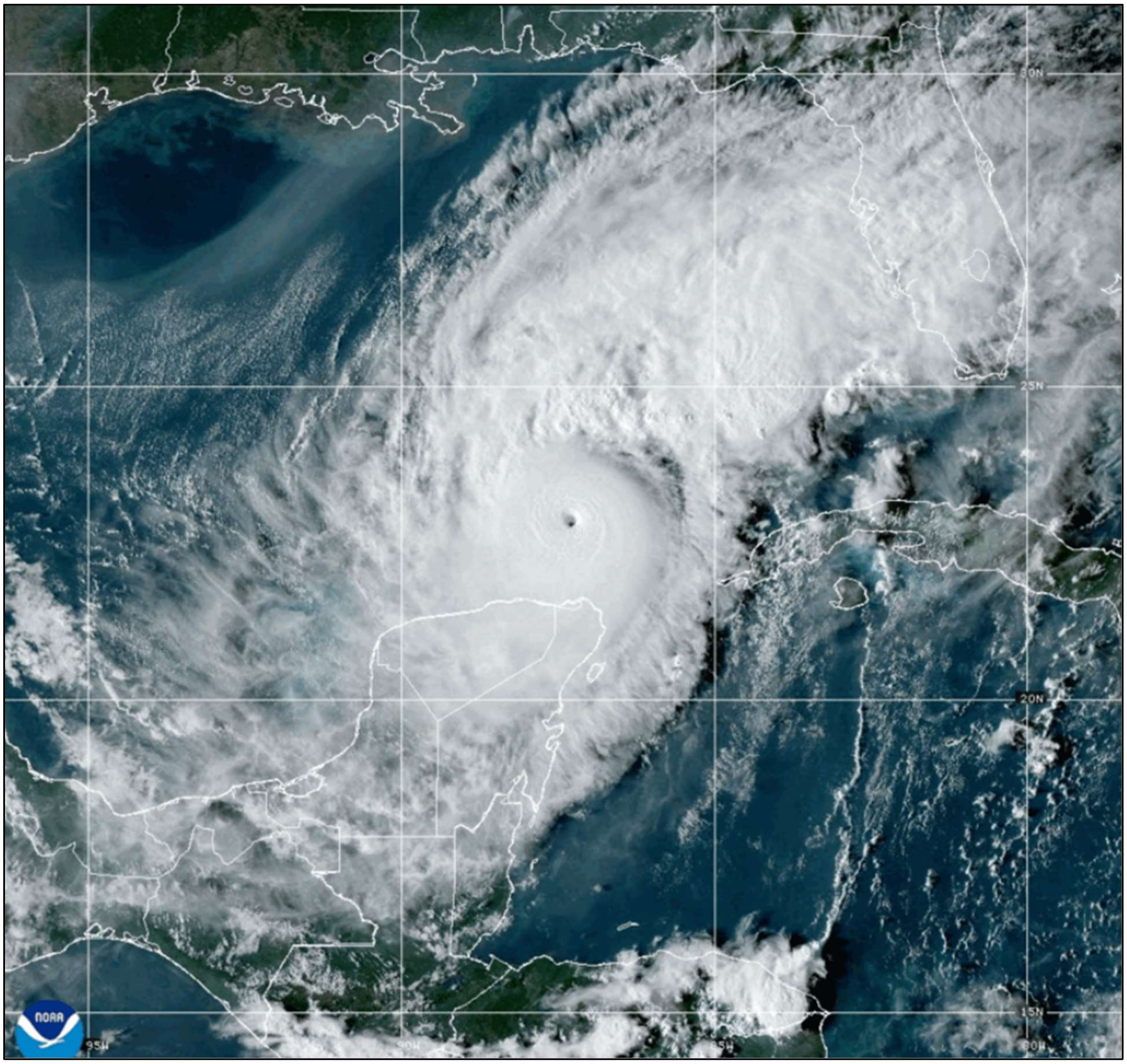


Artist's concept of the Parker Solar Probe spacecraft approaching the Sun
Credit: Johns Hopkins University Applied Physics Laboratory

In the final three flybys of the seven year prime mission, the spacecraft will have completed 24 orbits around the Sun and come as close as 3.9 million miles (6.2 million km) to its surface, about 10 times closer than the planet Mercury. Even at that distance, the Parker Solar Probe is flying through the outermost part of the Sun's atmosphere. Its instruments are protected from the intense heat (reaching nearly 2,500°F or 1,377°C) by a 4.5-inch-thick (11.43 cm) carbon-composite shield.

The Sun washes the solar system in an outflow of plasma with an embedded magnetic field, reaching out more than 10 billion miles (6 billion km). It creates space weather than can erode a planet's atmosphere and adversely affect the sensitive technology of an advanced civilization. The Parker Solar Probe has advanced our understanding of how the solar winds interacts with the Sun's magnetic field, causing it at times to bend back on itself; how the Sun transfers energy to the solar wind; and how the solar wind transitions from rotating with the Sun to flowing radially outward throughout the solar system.

Looking After Spaceship Earth



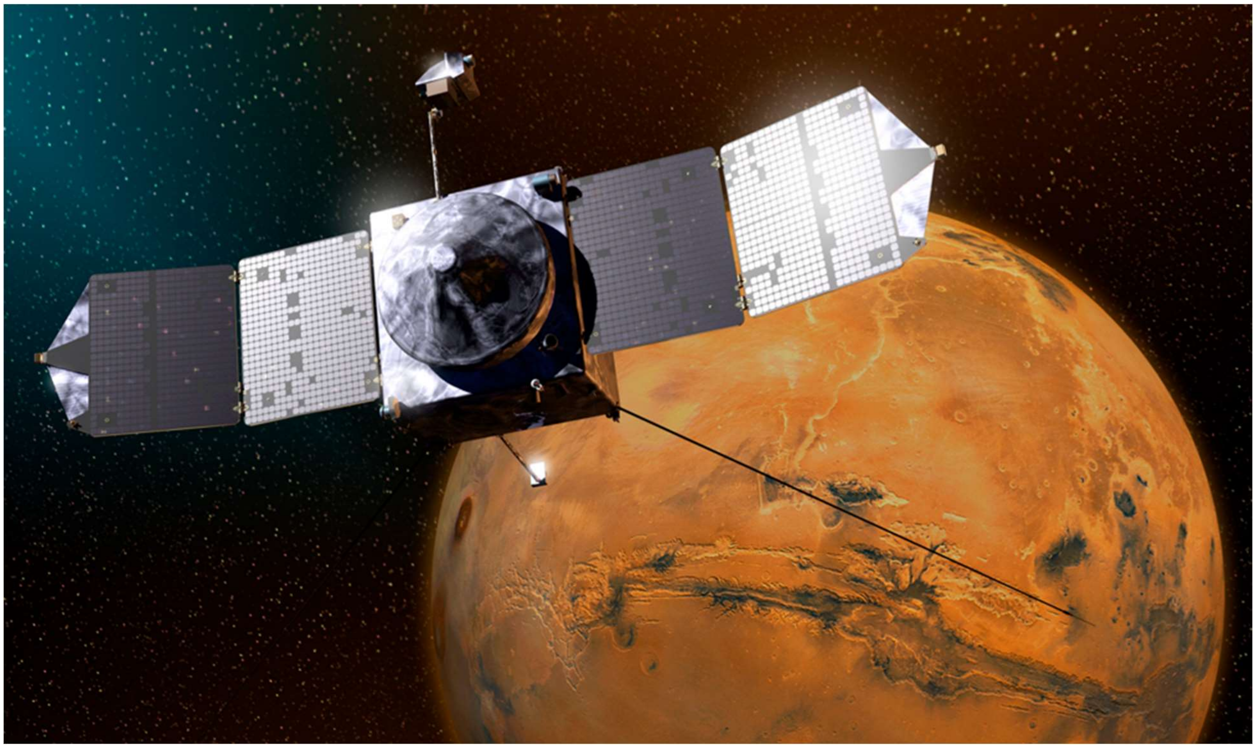
Hurricane Milton from NOAA's Geostationary Operational Environmental Satellite, GOES-16

NASA does much more than explore the universe around us, it also monitors the planet on which we live. The Applied Sciences Program is part of the Earth Science Division of the NASA Science Mission Directorate. It is charged with finding practical applications for the data collected by NASA's fleet of Earth-observing satellites and space-based instruments so as to improve life on Earth.

The Program develops, launches and operates NASA's fleet of satellites, develops and tests scientific technologies, supports research that advances knowledge of Earth, and encourages innovative and practical uses of Earth observations and scientific knowledge. The information gathered is used in weather forecasting, aviation, climate observations and modeling, famine early warning, monitoring ocean current and surface conditions, agricultural planning, emergency planning and response, and natural hazard monitoring/disaster recovery.

MAVEN Celebrates 10

Ten years ago, MAVEN (Mars Atmospheric and Volatile EvolutioN) spacecraft entered orbit around Mars. Since then, the spacecraft has been studying the planet's upper atmosphere in an effort to explain how a world, that scientists believe was wet and warm billions of years ago, evolved into the cold and arid landscape we see today.



Artist conception of the MAVEN spacecraft in orbit around the Red Planet
Credit NASA/GSFC

MAVEN has discovered that the Sun's solar wind (a stream of electrically charged protons and electrons) has been stripping away Mars atmosphere though a process called sputtering. The solar ions enter the atmosphere at such a high velocity that they can knock the Martian gas molecules free. The erosion increases significantly during solar storms.

Researchers estimate that 65% of the argon that was original present in the atmosphere has been lost by sputtering. The collisions can also create planet wide auroras, unlike on Earth where auroral activity is generally confined to the polar regions.

Mars doesn't generate is own magnetic field, but the magnetized solar wind traveling at about a million miles an hour can induce a magnetosphere and, in doing so, generate a system of electrical currents in the planet's upper atmosphere. These currents, which MAVEN has mapped, can accelerate the charged particles in the atmosphere, strengthening the sputtering effect.

MAVEN has also discovered a connection between the planet's global dust storms and the loss of atmosphere and water. Dust storms warm the atmosphere. This heating can propel water molecules far higher into the atmosphere than normal which can lead to their loss to space.

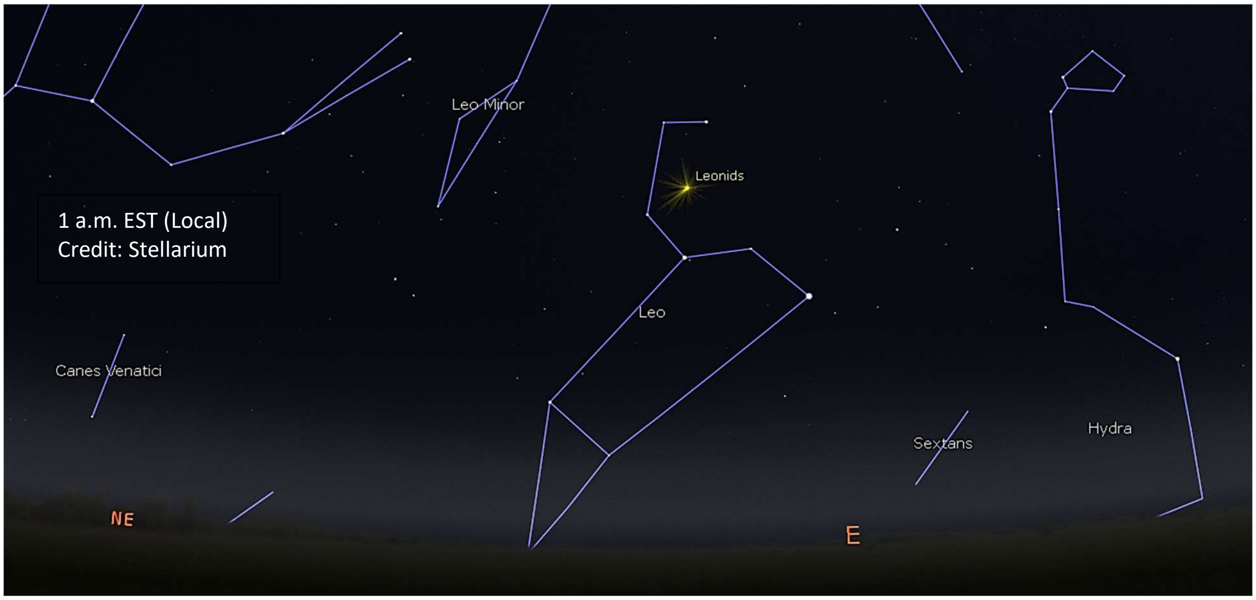
Leonid Meteor Shower

Almost everyone has seen a 'shooting star;' but not everyone knows what they are, where they come from and how best to view them. For those of you that remember that chilly November night in 2001 when the stars fell like rain, a meteor shower or meteor storm is truly unforgettable. As with that night, all you need are a comfortable chair and a warm blanket to enjoy the show.

Meteor showers occur when the Earth passes through a cloud of debris left behind by a comet (or an asteroid). As a comet nears the Sun, the volatile gases warm and erupt along with trapped particles of rock and dust. Pushed away from the comet by the solar wind, this material forms the comet's tail. Each time a comet crosses the Earth's orbit it leaves behind a small cloud of debris. When the Earth passes through these clouds, the debris quickly heats up in the atmosphere, creating streaks of light across the night sky. The point in the sky where the meteors appear to originate is called the radiant. Meteor showers are identified by the constellation in which the radiant appears. As such, if you trace the path of the meteors in the early morning of November 17$^{th}$, you will notice that most seem to originate from a point in the constellation Leo, hence the name Leonids.

Why does the same meteor shower excite one year and disappoint the next? While comets are responsible for seeding Earth's orbit with the makings of a meteor shower, most comets are not frequent visitors to the inner solar system. Comet Tempel-Tuttle (the source of the Leonid meteors) crosses Earth's orbit once every 33 years. The resulting cloud is about 10 Earth diameters across and continues to drift along the comet's path. Most years the Earth misses these clouds altogether. In those years the meteor shower is sparse. Other years, as in 2001, the Earth can interact with several clouds of debris from Comet Tempel-Tuttle. If the debris fields are dense (containing a lot of rock and dust) the show can be spectacular. However, as debris clouds age they stretch out and become less dense. The resulting encounter produces fewer and fewer meteors.

What can we expect this year? Typically, the shower produces an average of 15-20 meteors per hour during the peak period from a dark site. This year the shower peak happens only two days after a Full Moon. The interference from moonlight should wash out the shower's weaker meteors with only the brightest visible through the glare.



## 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. We see the ring tilt change (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


Jupiter reaches Opposition this year on December 7th. By midmonth, the gas giant shines brightly in the eastern sky after sunset (almost 13 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 | | | |
|---|---|---|---|---|
| | November 1 (EDT) | | November 30 (EST) | |
| Planet | Rise | Transit* | Rise | Transit* |
| Saturn | 3:35 pm | 9:06 pm | 12:41 pm | 6:12 pm |
| Jupiter | 7:56 pm | 3:24 am | 4:49 pm | 12:16 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. Due to the current alignment of Jupiter's and Earth's orbits, Callisto won't be transiting across the gas giant's disk until 2025.

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 |
|---|---|---|---|
| | | | |
| 1st | Io | 7:58 pm | 10:08 pm |
| 2nd | Ganymede | 10:39 pm | 12:44 am (3rd) |
| 3rd | Europa | 10:30 pm | 1:02 am (4th) |
| 8th | Io | 8:51 pm | 11:03 pm |
| 15th | Io | 10:45 pm | 12:57 am (16th) |
| 21st | Europa | 5:00 pm | 7:32 pm |
| 24th | Io | 7:08 pm | 9:20 pm |
| 28th | Europa | 7:36 pm | 10:09 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 |
|---|---|---|---|
| | | | |
| 1st | 10:34 pm | 15th | 11:04 pm |
| 3rd | 11:12 pm | 18th | 8:33 pm |
| 4th | 7:03 pm | 20th | 10:11 pm |
| 6th | 8:41 pm | 22nd | 11:49 pm |
| 8th | 10:19 pm | 23rd | 7:40 pm |
| 10th | 11:57 pm | 25th | 9:18 pm |
| 11th | 7:48 pm | 27th | 10:56 pm |
| 13th | 9:26 pm | | |

November Nights

The late Harvard University astronomer Harlow Shapley was born in November 1885. One of his many accomplishments was accurately measuring the distance to globular star clusters and their position around the Milky Way Galaxy. While warm summer nights are usually reserved for hunting globulars, the autumnal sky contains several impressive clusters including M15 in Pegasus and M2 in Aquarius. M30 in Capricorn is also visible in the southwest sky in the evening.

On the eastern side of the Great Square of Pegasus is the constellation Andromeda. Within this constellation and visible to the unaided eye on a dark night is the Andromeda Galaxy (M31), a massive pinwheel of 500 billion suns. Larger than the Milky Way, the Andromeda Galaxy is currently rushing towards us at 75 miles per second. Fortunately, it is approximately 2½ million light years (14.7 million trillion miles) distant, so it will be some time before the two galaxies merge. Visible through a telescope are Andromeda's two companion galaxies, M32 and M110.

While M32 can be mistaken for a bright star due to its close proximity to the core of the Andromeda Galaxy, M110 is a bit easier, being further away and larger than M32.

Located not far from M31 is the Triangulum or Pinwheel Galaxy (M33). Smaller and less massive than the Milky Way, this galaxy can be a challenge to see on less-than-ideal nights, due to its low surface brightness. However, through a large telescope on a dark, steady night, the view looking face-on at this giant pinwheel can be spectacular. The large spiral arms of M33 are filled with star-forming regions that almost appear to be gliding through space.

Sunrise and Sunset (from New Milford, CT)

| Sun | Sunrise | Sunset |
|---|---|---|
| November 1st (EDT) | 07:27 | 17:46 |
| November 15th (EST) | 06:43 | 16:33 |
| November 30th | 07:00 | 16:24 |

Astronomical and Historical Events

1st New Moon
1st Close approach of Aten class asteroid and Near-Earth Object (NEO) 2016 VA
1st History: launch of the Wind spacecraft, designed to monitor the solar wind (1994)
1st History: opening of the Arecibo Observatory (radio telescope) in Arecibo, Puerto Rico (1963)
2nd History: flyby of Asteroid *5535 Annefrank* by the Stardust spacecraft (2002)
2nd History: first light at the 100-inch telescope on Mount Wilson (1917)
3rd End of Daylight Saving Time - set clocks back one hour at 2 a.m.
3rd Close approach of Apollo class asteroid and NEO 2024 TX13
3rd Close approach of Aten class asteroid and NEO 2023 VS
3rd Taurids Meteor Shower peak (associated with the comet *Encke*)
3rd History: launch of Mariner 10 to Venus and Mercury; first mission to use the gravitational pull of one planet (Venus) to reach another (Mercury) (1973)
3rd History: launch of Sputnik 2 and a dog named Laika (1957)
4th History: Deep Impact's closest approach to the nucleus of Comet 103P/Hartley 2 (2010)
4th History: launch of the Soviet Venus lander Venera 14 (1981)
5th History: Parker Solar Probe's first close encounter with the Sun's corona (0.17 AU) (2018)
5th History: launch of India's Mars Orbiter Mission (MOM) from the Satish Dhawan Space Centre (2013)
5th History: Chinese spacecraft Chang'e 1 enters orbit around Moon (2007)
6th History: launch of Lunar Orbiter 2, Apollo landing site survey mission (1966)
7th History: launch of Mars Global Surveyor (1996)
7th History: launch of Surveyor 6 moon lander (landed two days later)
7th History: French astronomer Pierre Gassendi first to observe a transit of the planet Mercury across the Sun's disk (1631)
7th History: a 300-pound stony meteorite falls in a wheat field outside the walled town of Ensisheim in Alsace (now part of France) (1492)

Astronomical and Historical Events (continued)

8th History: launch of the ill-fated Phobos-Grunt spacecraft from the Baikonur Cosmodrome in Kazakhstan. Destined for the Martian moon Phobos, the spacecraft never left Earth orbit and eventually re-entered the atmosphere. (2011)
8th History: meteorite hits a house in Wethersfield, Connecticut (1982)
8th History: launch of Pioneer 9 into solar orbit (1968)
8th History: launch of Little Joe rocket, qualifying flight for the Mercury spacecraft (1960)
8th History: Edmund Halley born, English astronomer who calculated the orbit and predicted the return of the comet now called Comet Halley (1656)
**9th Second Saturday Stars – Open House at the McCarthy Observatory (7:00 pm)**
9th First Quarter Moon
9th History: launch of the Venus Express spacecraft; ESA Venus orbiter (2005)
9th History: launch of OFO-1 (Orbiting Frog Otolith) - two bullfrogs launched in an experiment to monitor the adaptability of the inner ear to sustained weightlessness (1970)
9th History: launch of the first Saturn V rocket, Apollo 4 (1967)
10th History: launch of Luna 17, Soviet Moon rover mission (1970)
10th History: launch of USSR spacecraft Zond 6; Moon orbit and return (1968)
10th History: Waseda Meteorite Fall; hits house in Japan (1823)
11th Close approach of Aten class asteroid and NEO 2019 WB7
11th History: launch of Gemini 12 with astronauts James Lovell and Edwin Aldrin (1966)
11th History: Tycho Brahe discovers a new star in the constellation Cassiopeia shining as bright as Jupiter; later determined to be a supernova - SN1572 (1572)
12th Close approach of Apollo class asteroid and NEO 2020 UL3
12th Close approach of Aten class asteroid and NEO 2020 AB2
12th History: Philae lander (Rosetta mission) touches down on Comet 67P/*Churyumov-Gerasimenko* (2014)
12th History: launch of STS-2, second flight of the Space Shuttle Columbia (1981)
12th History: flyby of Saturn by the Voyager 1 spacecraft (1980)
12th History: Seth Nicholson born, American astronomer who discovered four of Jupiter’s moons, a Trojan asteroid, and computed orbits of several comets and of Pluto (1891)
13th History: launch of HEAO-2, the second of NASA's three High Energy Astrophysical Observatories; renamed Einstein after launch, it was the first fully imaging X-ray space telescope (1978)
14th Moon at perigee (closest distance to Earth)
14th Close approach of Apollo class asteroid and NEO 2019 VU5
14th Close approach of Aten class asteroid and NEO 2019 VL5
14th History: dedication of the New Milford Solar System Scale Model (2009)
14th History: Mariner 9 arrives at Mars; first spacecraft to orbit another planet (1971)
14th History: launch of Apollo 12, with astronauts Pete Conrad, Richard Gordon and Alan Bean to the moon’s Ocean of Storms and near the robotic explorer Surveyor 3 (1969)
14th History: discovery of the Great Comet of 1680 or Kirch’s Comet by Gottfried Kirch (1680)
15th Full Moon (Beaver Moon)
15th History: launch of SpaceX’s Crew-1 from the Kennedy Space Center, Florida, to the International Space Station
15th History: William Herschel born, German-English astronomer, credited with the discovery of Uranus, two of its moons, two of Saturn’s moons and catalogued the heavens (1738)

Astronomical and Historical Events (continued)

15th History: ESA's spacecraft SMART-1 enters lunar orbit; first ESA Small Mission for Advanced Research in Technology; travelled to the Moon using solar-electric propulsion and carrying a battery of miniaturized instruments (2004)
15th History: the only orbital launch of the Russian space shuttle Buran; the unmanned shuttle orbited the Earth twice before landing (1988)
15th History: launch of Intasat, Spain's first satellite (1974)
16th Uranus at Opposition
16th History: launch of Artemis 1, an unmanned Moon mission, from the Kennedy Space Center aboard NASA's Space Launch System (2022)
16th History: discovery of the Asteroid *21 Lutetia* by Hermann Goldschmid (1852)
17th Leonids Meteor Shower peak (associated with the comet Tempel-Tuttle)
17th History: Surveyor 6 performs a "hop" maneuver, moving approximately 8 feet (2.5 meters) from its original landing area and enabling scientists to validate surface properties. This lunar "hop" was the first powered takeoff from the lunar surface. It also provided NASA a view of the original landing site and a baseline for acquiring stereoscopic images of its surroundings. (1967)
17th History: launch of Soyuz 20, a 90-day, long duration mission that carried a biological payload (tortoises) that docked with the Salyut 4 space station. The tortoises returned to Earth in good health (1975)
17th History: Soviet lunar lander Luna 17 deploys first rover - Lunokhod 1 (built by the Kharkov state bicycle plant); operated for 11 months, photographing and mapping the lunar surface and analyzing the regolith (1970)
18th Close approach of Atira class, Potentially Hazardous Asteroid (PHA) and NEO 2023 WK3
18th History: launch of the Mars Atmosphere and Volatile EvolutioN (MAVEN) spacecraft (Mars Orbiter) from the Cape Canaveral Air Force Station (2013)
18th History: launch of the COBE spacecraft; observed diffuse cosmic background radiation (1989)
19th Close approach of Apollo class asteroid and NEO 2012 KO11
20th Close approach of Apollo class asteroid and NEO 2020 VX4
20th History: the Japan Aerospace Exploration Agency's Hayabusa spacecraft lands on Asteroid 25143 *Itokawa* for sample collection (2005) (JST)
20th History: launch of the Swift spacecraft; first-of-its-kind multi-wavelength observatory dedicated to the study of gamma-ray bursts (2004)
21st History: launch of Sentinel 6-Michael Freilich, a joint mission between the European Space Agency, NASA, NOAA, CNES and Eumetsat - continuing the work done by the Jason series of satellites on monitoring sea level.
22nd Last Quarter Moon
23rd History: launch of the Double Asteroid Redirection Test (DART) spacecraft from the Vandenberg Space Force Base, California – targeting the moon of the asteroid Didymos (2021)
23rd History: launch of the Chang'e 5 spacecraft - China's first lunar sample return (2020)
23rd History: launch of the European Space Agency's first satellite, Meteosat 1 (1977)
23rd History: launch of Tiros II weather satellite (1960)
24th Close approach of Aten class asteroid and NEO 2009 WB105

Astronomical and Historical Events (continued)

- 24th History: launch of the Russian Prichal nodal module (docking port) to the International Space Station (2021)
- 24th History: first observations of a transit of Venus (1639)
- 25th History: Albert Einstein publishes his General Theory of Relativity (1915)
- 25th History: William Dawes discovers Saturn's C Ring (1850)
- 26th Moon at apogee (furthest distance from Earth)
- 26th Close approach of Aten class asteroid and NEO 2006 WB
- 26th History: landing of NASA's InSight spacecraft on Mars' western Elysium Planitia (2018)
- 26th History: Mars Cube One 1 & 2, Mars flyby (launched with InSight to monitor landing) (2018)
- 26th History: launch of the Mars Science Laboratory (MSL) aboard an Atlas 5 rocket from the Cape Canaveral Air Force Station (2011)
- 26th History: discovery of Mars meteorites SAU 005 and SAU 008 (1999)
- 26th History: launch of France's first satellite, Asterix 1 (1965)
- 26th History: launch of Explorer 18; studied charged particles and magnetic fields in and around the Earth – Moon (1963)
- 26th History: discovery of the Orion Nebula by French astronomer Nicolas-Claude Fabri de Peiresc (1610)
- 27th History: Soviet spacecraft Mars 2 arrives at Mars; lander crashes, becoming first human artifact to impact the surface of Mars (1971)
- 28th History: launch of Algeria's first satellite, Alsat 1 (2002)
- 28th History: discovery of first Pulsar by Jocelyn Bell and Antony Hewish (1967)
- 28th History: launch of Mariner 4; first spacecraft to obtain and transmit close range images of Mars (1964)
- 29th Close approach of Aten class asteroid and NEO 2018 DC4
- 29th History: discovery of Y000593 Mars meteorite in Antarctica (2000)
- 29th History: launch of Australia's first satellite, Wresat 1 (1967)
- 29th History: launch of Mercury 5 with Enos the chimpanzee (1961)
- 30th Close approach of Apollo class asteroid and NEO 2019 JN2
- 30th History first telescopic observations of the Moon by Galileo Galilei (1609)

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

<u>Commonly Used Terms</u> (continued)

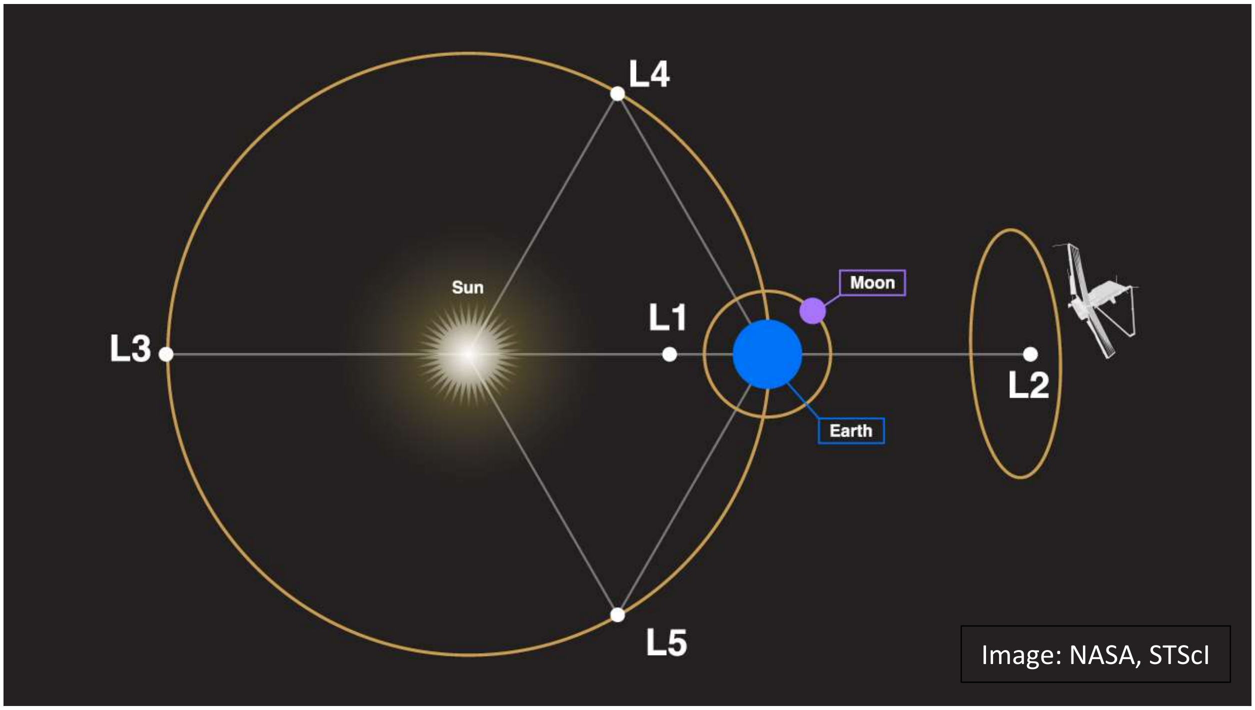
- Opposition: celestial bodies on opposite sides of the sky, typically as viewed from Earth
- Plutino: an asteroid-sized body that orbits the Sun in a 2:3 resonance with Neptune
- Trojan: asteroids orbiting in the 4th and 5th Lagrange points (leading and trailing) of major planets in the Solar System

<u>References on Distances</u>

- 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

<u>Lagrange Points</u>

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



James Webb Space Telescope

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

Euclid Space Telescope

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

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

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.

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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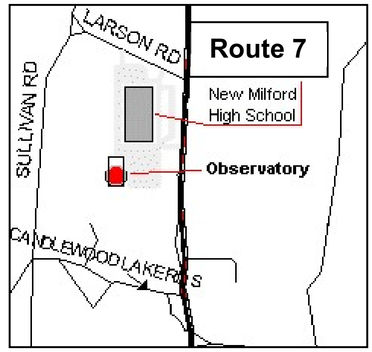


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