Galactic Observer

John J. McCarthy Observatory

Volume 15, No. 12

December 2022

James Webb Space Telescope's near-infrared-light view of the "The Pillars of Creation," a star-forming region within the Eagle Nebula, which lies 6,500 light-years away

Credits: NASA, ESA, CSA, STScI; Joseph DePasquale (STScI), Anton M. Koekemoer (STScI), Alyssa Pagan (STScI)

December Astronomy Calendar and Space Exploration Almanac

The Full Beaver Moon captured shortly after it entered the upper half of the Earth's shadow (umbra) in the early morning hours of November 8th. The Total Lunar Eclipse began at 5:16 AM EST and ended 85 minutes later as the Moon set below the western horizon. The northern limb of the Moon, closest to the outer edge of the umbra, was noticeably brighter as compared to its southwestern limb deep in the shadow. The one-second exposure was taken through a C-11 telescope at prime focus with a Nikon D7200.

In This Issue

Page

932
McCarthy Observatory
New Milford, CT

"Out the Window on Your Left"

It's been 50 years since Gene Cernan left the last boot print on the Moon's surface. As a nation founded on exploration and the conquest of new frontiers, today's commitment to return to the moon has been as fleeting as the funding. But what if the average citizen had the means to visit our only natural satellite; what would they see out the window of their spacecraft as they entered orbit around the Moon? This column may provide some thoughts to ponder when planning your visit (if only in your imagination).

For lunar observers, the Sun rises on the Taurus-Littrow valley early in the morning on the 28th of December. A narrow breach in the rim of the Serenitatis Basin, the valley is enclosed on three sides by large, blunt peaks - the South, North, and East Massifs. On December 11, 1972, the valley was the destination of the Apollo 17, the final lunar mission of the Apollo program.

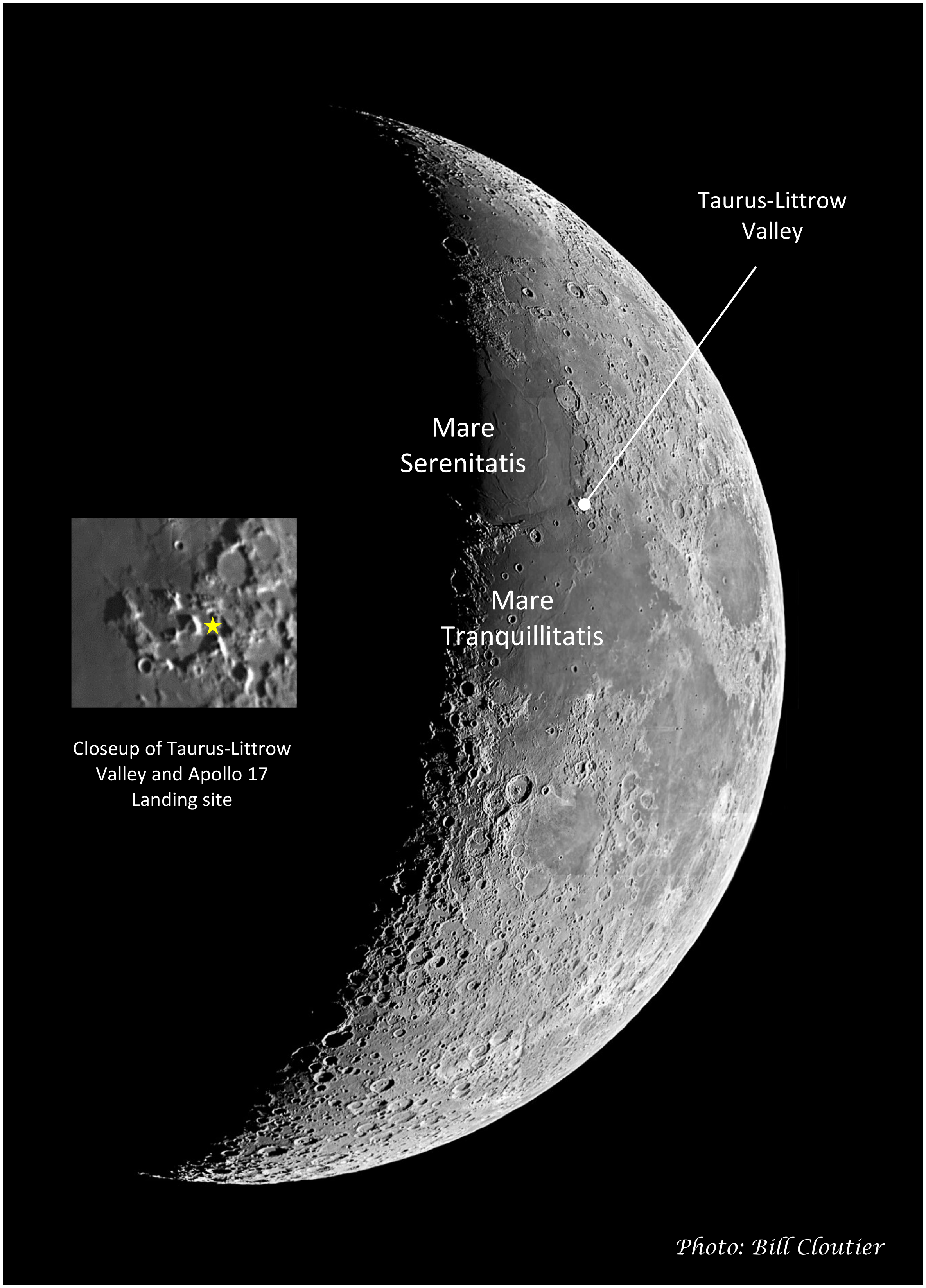
Multiple sites were considered for the last mission, offering diversity of terrains, history and geology. Taurus-Littrow provided the explorers, including astronaut-geologist Harrison Schmitt, an opportunity to visit craters on the valley floor with dark halos. The lunar module set down near one such crater, called "Shorty."

It was on the rim of Shorty that Schmitt discovered a deposit of "orange soil." The substance was later determined to be volcanic glass, likely created in a volcanic vent or fire fountain. The glass formed 3.64 billion years ago from material that had melted several hundred miles below the surface. The glass erupted onto the surface, was then buried, and later excavated by impacts.

Scientist-astronaut Harrison Schmitt stands next to a huge, split lunar boulder during the third Apollo 17 extravehicular activity at the Taurus-Littrow landing site. The Lunar Roving Vehicle can be seen in the background.
Image Credit: NASA/Eugene Cernan

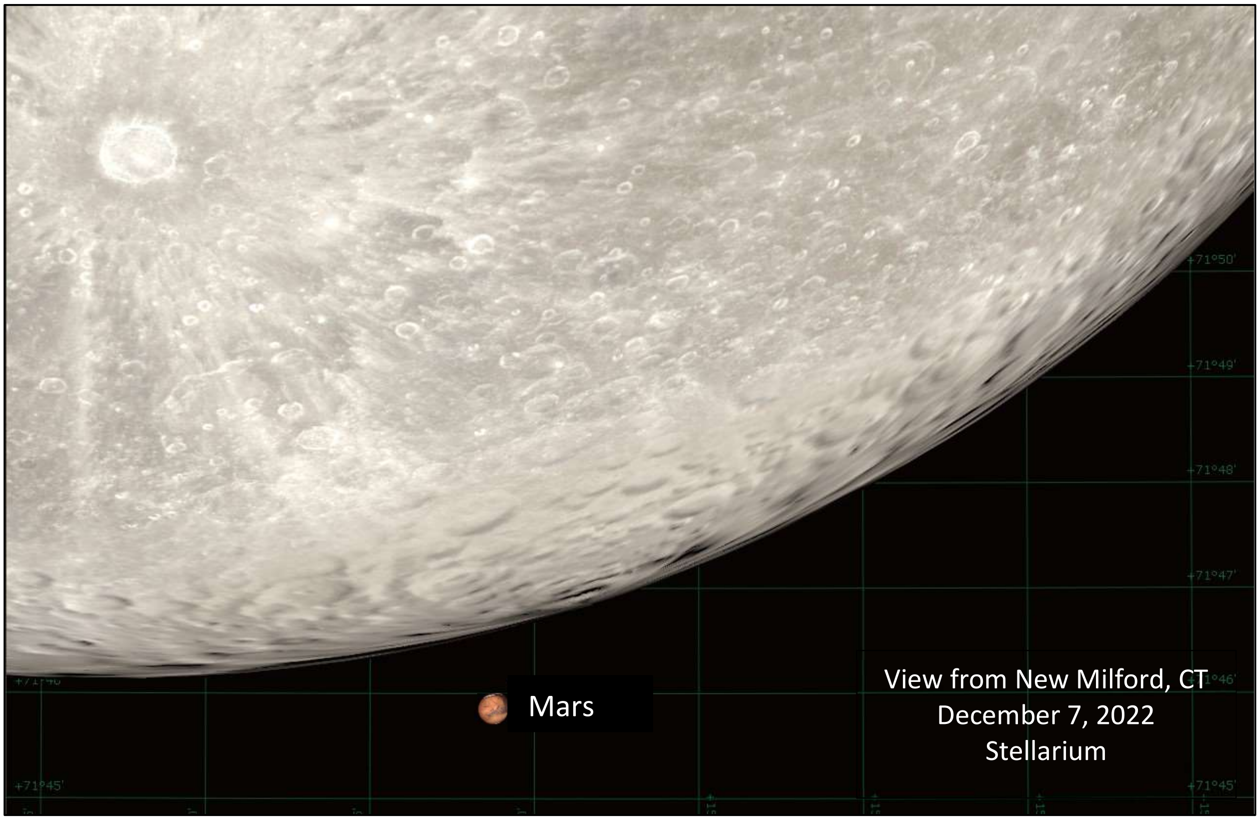
The Apollo 17 mission featured the most extensive lunar exploration of the program, with three moonwalks, each lasting more than seven hours. The crew collected the oldest known, unshocked lunar rock (at least 4.2 billion years old) - suggesting that the Moon had, at one time, a magnetic field generated by a dynamo at its core. The astronauts took more than 2,000 photographs and collected about 243 pounds (110 kg) of soil and rock samples at 22 different sites.

<u>Taurus Littrow</u>



Closeup of Taurus-Littrow Valley and Apollo 17 Landing site

Close Encounter



For observers in parts of the Americas, Europe and Northern Africa, the Moon will pass in front of Mars on the night of December 7th/8th, creating a lunar occultation. From western Connecticut, no occultation will be visible, as Mars will appear to glide along the southern limb of the Moon, with closest approach around 11 PM on the 7th. A short drive to western Massachusetts or central New York will be required to view the occultation and the brief disappearance of Mars.

Moon-Bound

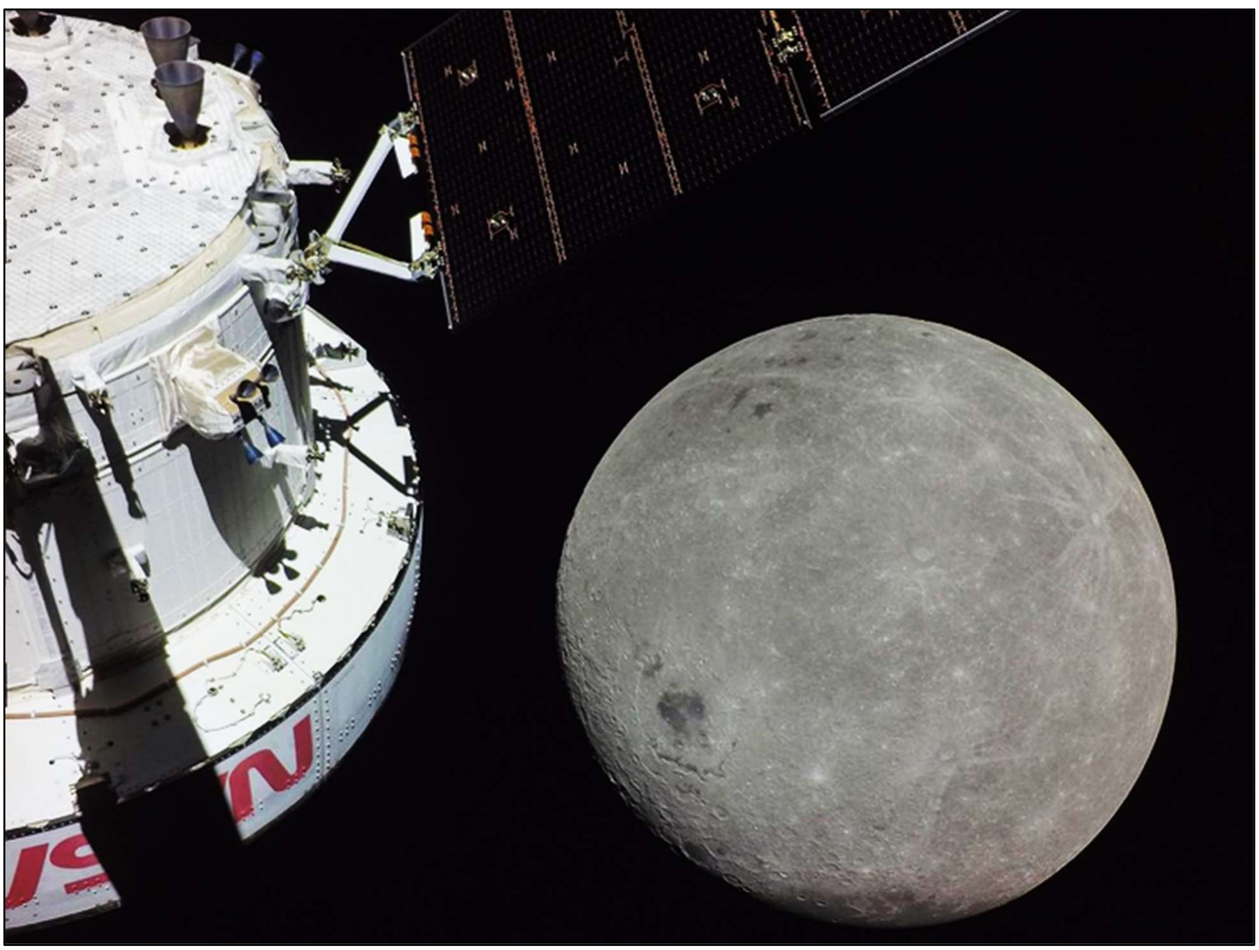
NASA's Space Launch System rocket lifted off in the early morning hours of November 16th, successfully placing the Orion spacecraft into a parking orbit around the Earth. About 1.5 hours later, the engine on the rocket's upper stage ignited, sending the spacecraft towards the Moon. The launch, from the Kennedy Space Center in Florida, was NASA's third launch attempt after leaky liquid hydrogen connections and two hurricanes prevented the agency's most powerful rocket from leaving the pad.

The third attempt was not without its challenges as NASA had to send a specially trained team of technicians out to the pad when, after the rocket was fully fueled, a valve on the hydrogen replenishment line started to leak. The seepage was stopped after the team was able to torque down the packing nuts on the valve. The countdown was interrupted again when the U.S. Space Force's Eastern Range had difficulty accessing data from its tracking radar. Replacement of a faulty ethernet switch resolved the issue and allowed the countdown to proceed to a 1:47am EST liftoff from Pad 39B.

Orion separated from its upper stage during the outbound coast to the Moon. The spacecraft, powered by its European Space Agency-provided service module, flew by the Moon on November 21st, on its way to a distant retrograde orbit, more than 50,000 miles (80,500 km) beyond the Moon. The highly-stable orbit allowed NASA to test the spacecraft in a deep-space environment for an extended time period.

The test flight (designated "Artemis I") is scheduled to conclude with a high-speed return to Earth on December 11th, with splashdown in the Pacific Ocean.

View of Earth (above) and the far side of the Moon (below) as seen on the outboard journey from a camera mounted on the end of one of the Orion spacecraft's solar panels. Images credit: NASA

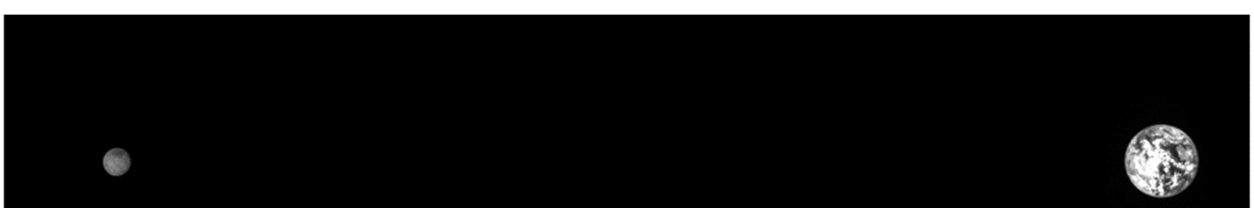


Korean Moon Probe

South Korea launched is first Moon mission, "Danuri," officially known as the Korean Pathfinder Lunar Orbiter on August 5th. The spacecraft employed a low-energy, fuel-efficient ballistic lunar transfer trajectory (in these transfer orbits, the Sun's gravity is used to raise perigee and adjust inclination), to reach the Moon by mid-December.

Artist conception of Danuri mapping the permanent shadowed regions of the Moon
Credit: Korea Aerospace Research Institute (KARI)

Danuri will train its five scientific instruments on the Moon for at least a year after entering an orbit roughly 62 miles or 100 km above the lunar surface. The spacecraft is equipped with two Korean-built cameras, a magnetometer, a gamma-ray spectrometer, and a NASA-provided camera (called "ShadowCam"). Danuri's instruments will enable scientists to map the mineral composition of the Moon's crust, measure the magnetic fields of localized features called "swirls," and "illuminate" the permanently shadowed regions that are suspected to contain water ice (ShadowCam is 200 time more sensitive than the comparable instrument on NASA's Lunar Reconnaissance Orbiter – using scattered sunlight to "see" into these voids).

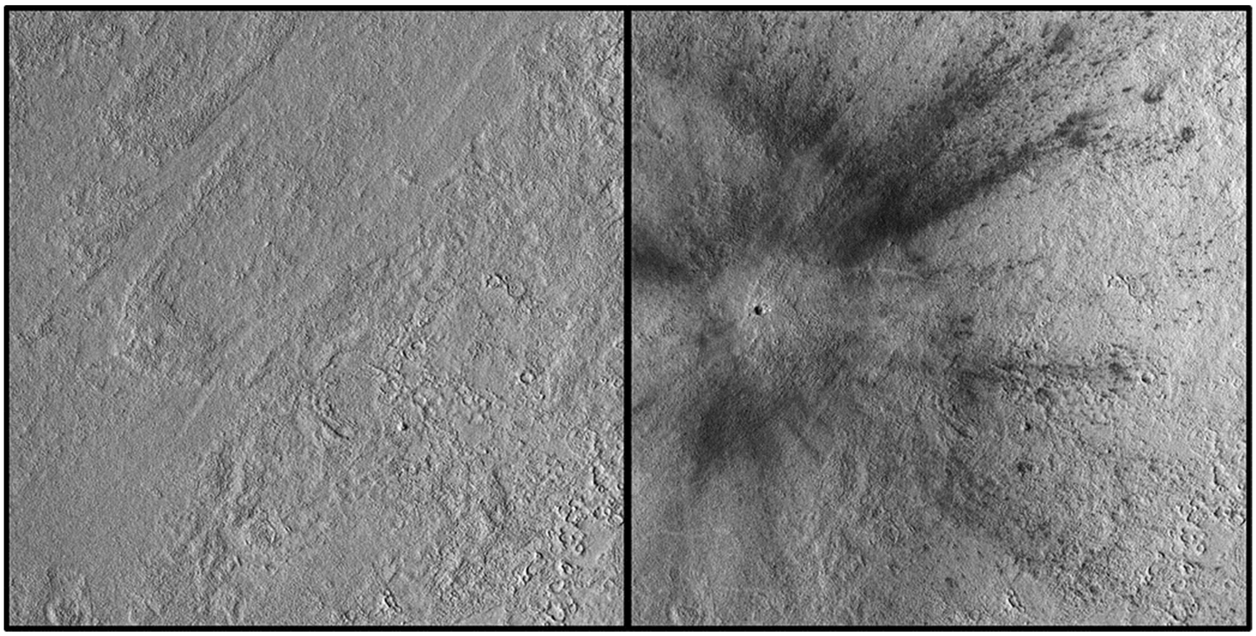


An image of the Earth and the Moon captured by Danuri
Source: KARI

Team Work

NASA's InSight lander recorded a powerful magnitude 4 marsquake from a suspected impact on December 24, 2021. Since landing in November 2018, InSight had detected more than 1,300 marsquakes, but this was the first detected that produced surface waves – a type of seismic wave that ripples along the top of a planet's crust. Scientists were then able to use the Mars Reconnaissance Orbiter's (MRO) Context Camera, which produces daily maps of the entire planet for weather-monitoring purposes, to pinpoint the epicenter of the quake (impact crater).

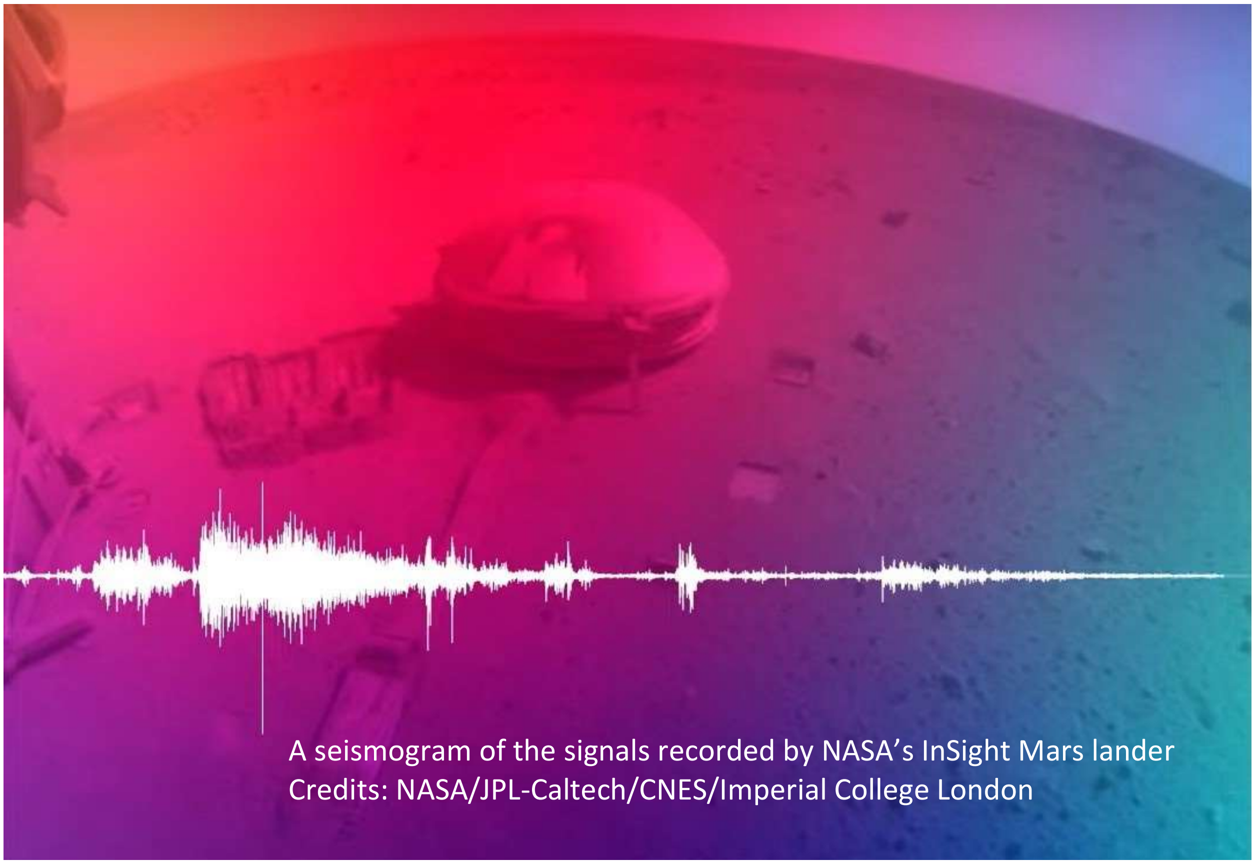
MRO's images revealed a fresh impact crater, roughly 492 feet (150 meters) across and 70 feet (21 meters) deep, surrounded by boulder-size chunks of ice, and located about 2,200 miles (3,500 km) from InSight. The pre-impact meteoroid is estimated to have been between 16 to 39 feet (5 to 12 meters) across. The discovery of ice so close to the Martian equator could be significant in the planning for the future manned exploration of the planet.



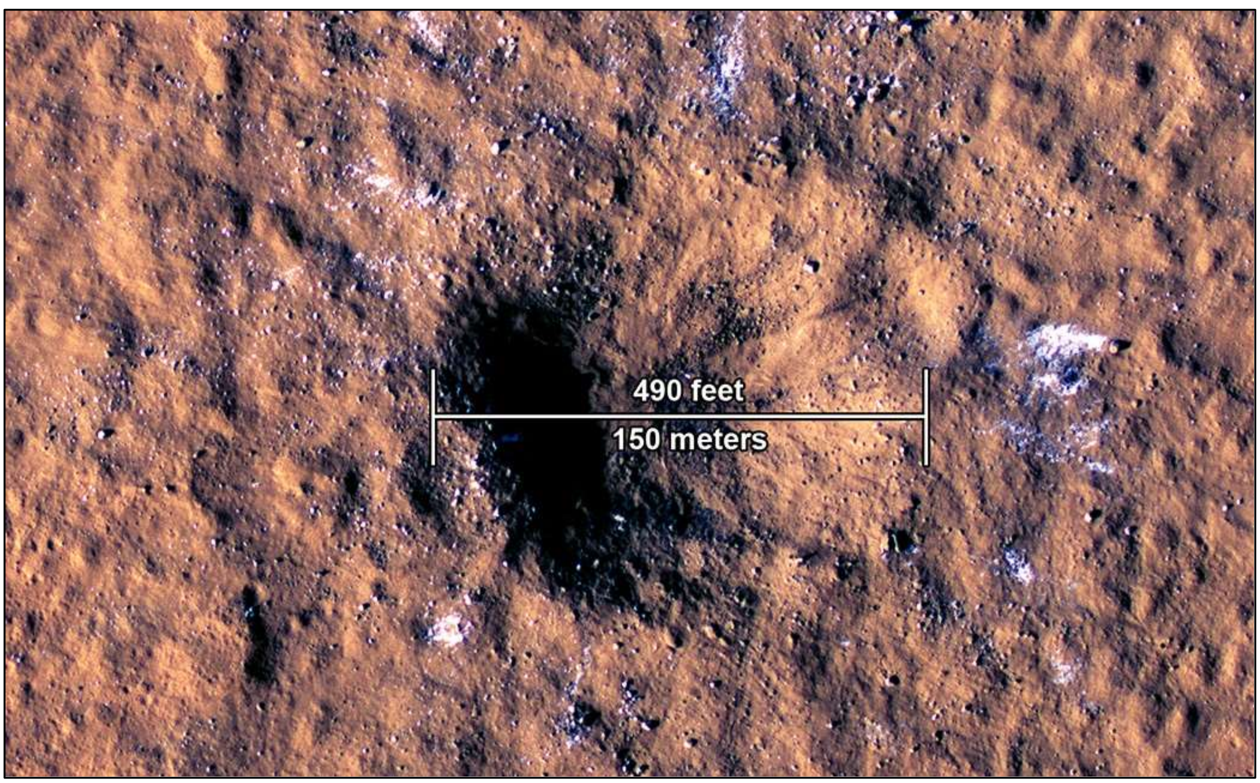
Before and after images of the meteoroid impact crater on Mars' Amazonis Planitia
Credits: NASA/JPL-Caltech/MSSS

Until the Christmas Eve marsquake, InSight's seismometer had only detected seismic body waves. These vibrations have provided scientists a great deal of information about the interior of the planet, including the size, depth, and composition of mantle and core, but very little about the surface layer. While a single data point from the surface wave was welcome, its value was limited in characterizing the entire planet's crust. However, in reviewing older data, researchers found other quakes with a similar signature, including one recorded in September 2021. This event was eventually traced to a fresh impact crater located about 4,700 miles (7,500 km) from the lander.

The InSight mission is coming to an end. Dust accumulation on its solar panels has reduced the lander's power production to levels that prevent fulltime operation of its instruments. In addition, regional dust storms have resulted in the temporary suspension of surface activities and, although intermittent operations have resumed, engineers estimate that the lander only has enough power for a few more weeks.



A seismogram of the signals recorded by NASA's InSight Mars lander
Credits: NASA/JPL-Caltech/CNES/Imperial College London

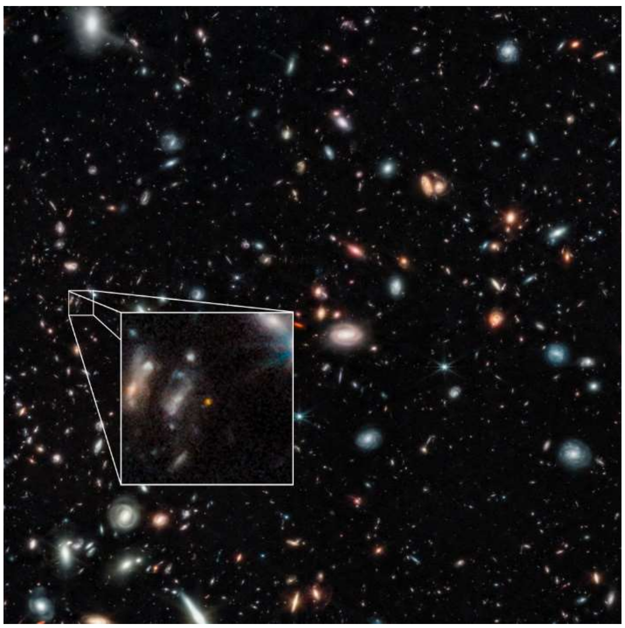


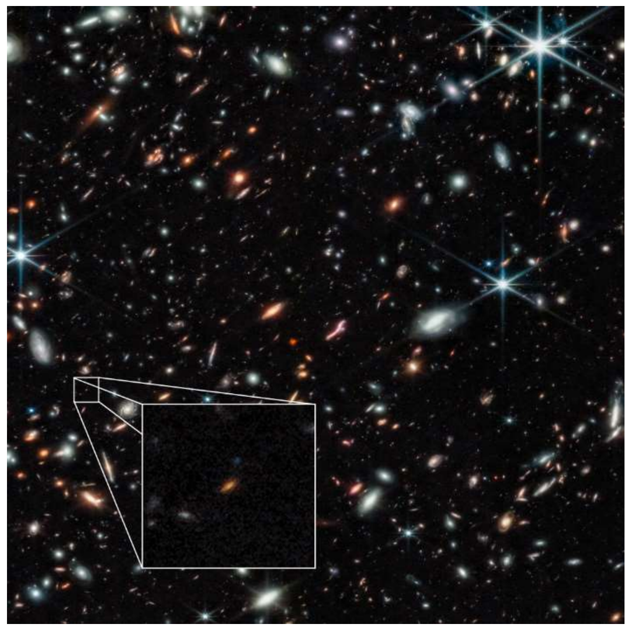
The impact crater formed by the Christmas Eve meteoroid strike in the Amazonis Planitia region. Credits: NASA/JPL-Caltech/University of Arizona

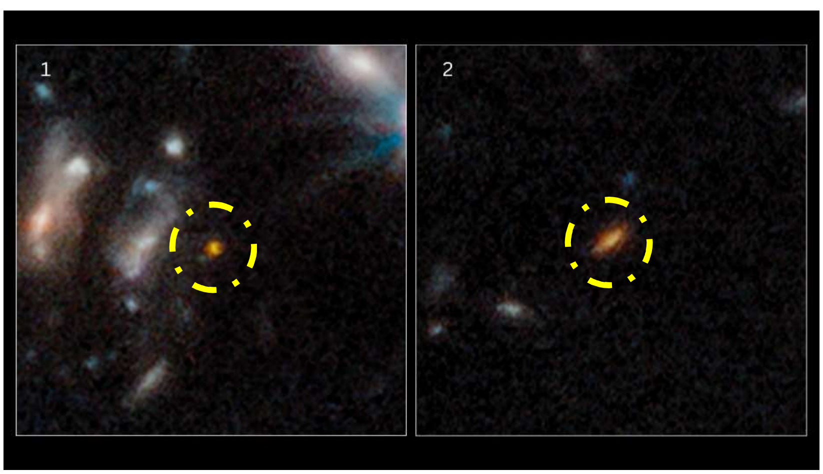
Webb Plus One Year

The James Webb Space Telescope was launched on Christmas Day 2021. After a six month commissioning and calibration period, science operations have quickly ramped up along with a number of discoveries. Among the revelations was the appearance of galaxies in a time period thought to have been much too early in the universe's evolution for such constructs.

Researchers are confident that they have found at least two galaxies in the very early universe. These stellar islands, in the constellation Sculptor, are believed to have existed 350 and 450 million years after the Big Bang (images on the left to right, respectively). The proto-galaxies are small and compact, but they do infer that the constituent stars formed as early as 100 million years after the Big Bang. Follow-up observations will be needed with Webb's spectrographs to confirm the ages and reconcile the observations with the current cosmological models of the universe.







Credits: Science: NASA, ESA, CSA, Tommaso Treu (UCLA); Image Processing: Zolt G. Levay (STScI)

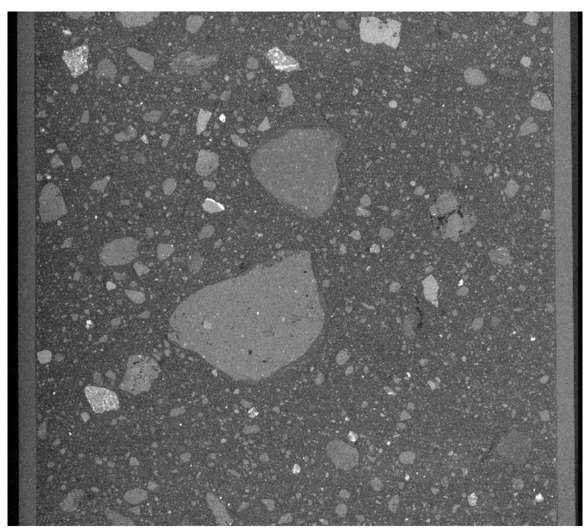
The two galaxies were found in the outer regions of an image of the giant galaxy cluster Abell 2744, also known as Pandora's Cluster, located about 3.5 billion light years from Earth. The two protogalaxies are not associated with the cluster, but located billions of light years behind it. The mass of the galaxy cluster, estimated at 4 trillion suns, is distorting spacetime, as if by a lens. As a consequence, the dim light of these two protogalaxies has been magnified by the gravitational lensing.

Apollo 17 Samples Opened

At the conclusion of the Apollo 17 mission in 1972, NASA set aside a portion of the rock samples collected by astronauts Eugene Cernan and Harrison Schmitt for future study. The agency was counting on future innovations in technology and new techniques, not even envisioned at the time, to maximize the scientific return.

Apollo 17 lunar core sample 73001 being removed from its drive tube by technicians
Credits: NASA/Robert Markowitz

Now, 50 years later, the samples are being removed from storage and brought back into the laboratory. Sample 73001 was collected by geologist-astronaut "Jack" Schmitt from a landslide deposit in the Moon's Taurus-Littrow Valley. Schmitt hammered a drive tube (a cylindrical sample collection device) into the regolith. The lower half of the tube was vacuum-sealed on the Moon and then stored in a second protective outer vacuum tube at the Johnson Space Center's Lunar Laboratory Sample Facility. (The drive tube was comprised of two 14-inch, or 35-cm, sections, driven one on top of another – the upper half, which was left unsealed, was opened in 2019).

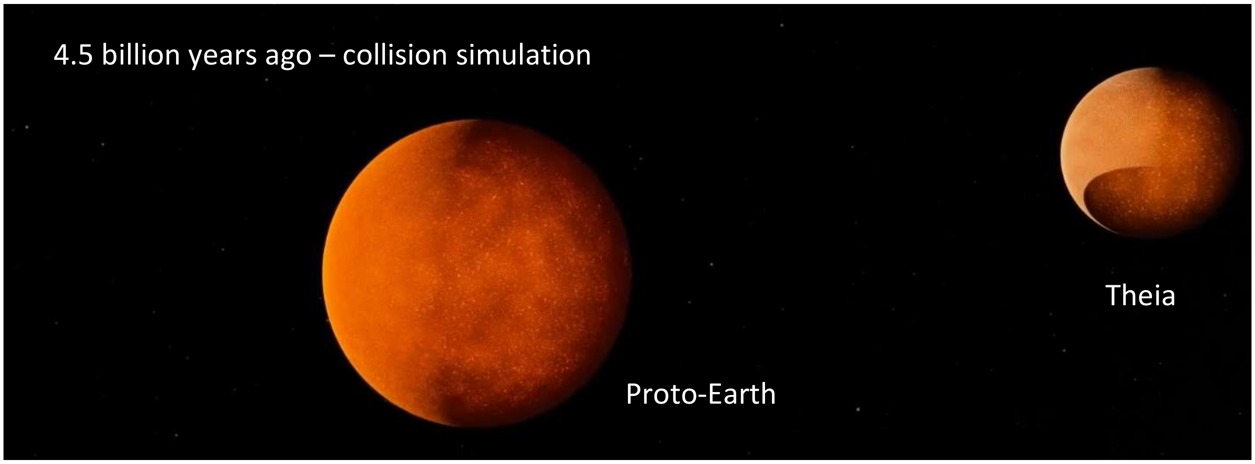


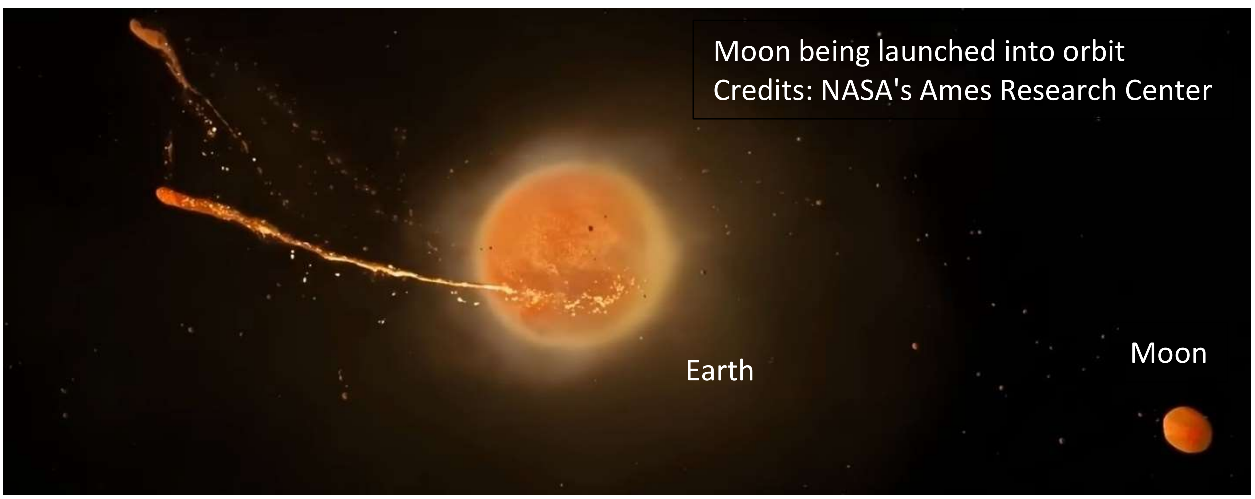
X-ray computed tomography image of core sample 73001
Credits: The University of Texas at Austin Jackson School of Geosciences

Prior to removing the core, technicians x-rayed the contents and pierced the tube to collect any gas or other volatiles that may have been trapped within the rock and soil. Processing will help scientists to prepare for the samples to be returned by Artemis.

New Lunar Formation Simulation

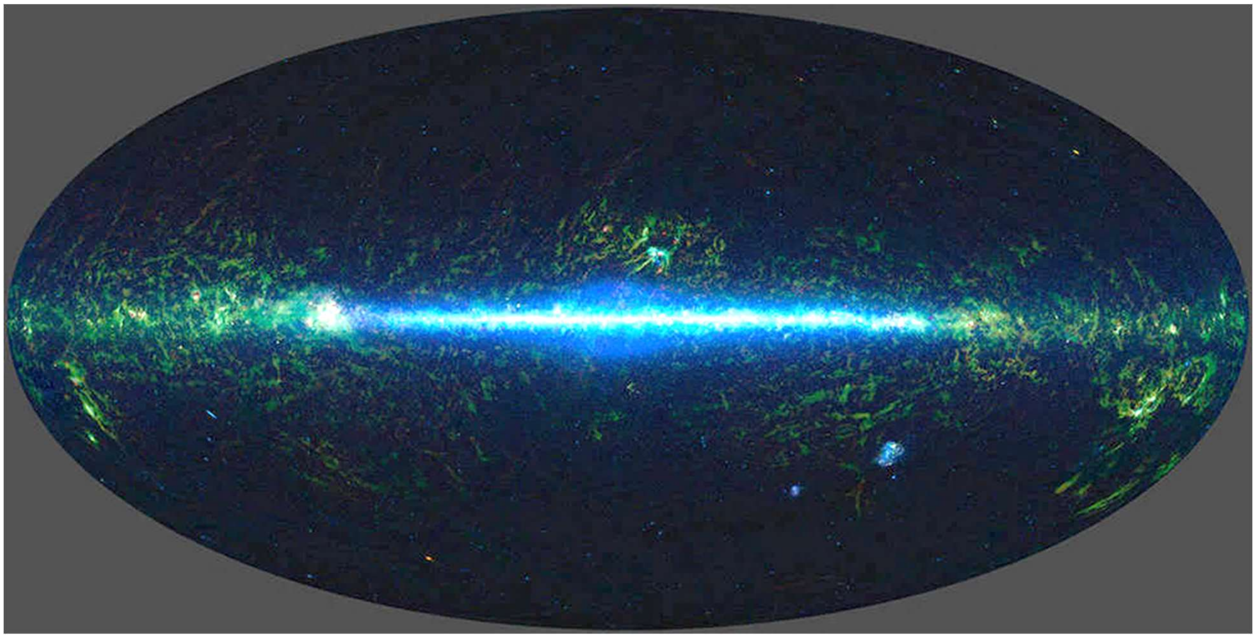
In the most detailed and highest resolution simulation yet of the suspected collision of a Mars-sized protoplanet (called "Theia") and the proto-Earth show that the Moon may have formed in only hours rather than months or years. The full simulation is available at: https://www.nasa.gov/feature/ames/lunar-origins-simulations





Universe in Motion

The Wide-field Infrared Survey Explorer (WISE) spacecraft was launched in 2009. With cryogenically-cooled detectors, its instruments scanned the sky for distant, cool and faint objects not visible to the human eye. While the WISE mission concluded in 2011 after the coolant was exhausted, several of its instruments were still functional. The spacecraft was subsequently repurposed in 2013 to find and study asteroids and other near-Earth objects (NEOs), with the mission and the spacecraft renamed NEOWISE.



Mosaic composed of images taken by the Wide-field Infrared Survey Explorer (WISE) as part of WISE's 2012 All-Sky Data Release
Credits: NASA/JPL-Caltech/UCLA

The original mission (WISE) acquired images from the entire sky every six months. When stitched together, they created a map that showed the location and brightness of hundreds of millions of objects. Notwithstanding its new directive, NEOWISE has continued to generate these suites of images, with the 19th and 20th all-sky maps to be released in March 2023. The additional NEOWISE maps have enabled astronomers to create a decade-long, time-lapse movie of the sky, and bringing to light the motion of objects, such as brown dwarfs, fluctuations in the brightness or positions of objects like stars and black holes, or changes in star-forming regions.

WISE images revealed some 200 brown dwarf stars within 65 light-years of our Sun (a population of stars significantly larger than a Jupiter-size planet, but without sufficient mass for elements such as hydrogen to fuse within their cores). Nearby brown dwarfs, because of their proximity to Earth, appear to move faster across the sky than more distant background stars. The time-lapse movie has revealed an additional 60 brown dwarfs from their motion and doubled the number of known Y-dwarfs, the coldest brown dwarfs.

While the original sky maps provided a wealth of information, for example, revealing millions of supermassive black holes at the centers of distant galaxies, the ability to monitor changes in the sky over a long period, known as time-domain astronomy, has been a bonanza.

Testing the Next Generation of Heat Shield

The need to deliver larger payloads to off-world destinations (or return them to Earth) has spurred the development of re-entry/heat shield technology that can tolerate higher heat loads. Over the past ten years, NASA has been working on a concept, depicted by science fiction author Arthur C. Clarke in his 1982 sequel to 2001: A Space Odyssey, for slowing down spacecraft or cargo and created an inflatable heat shield.

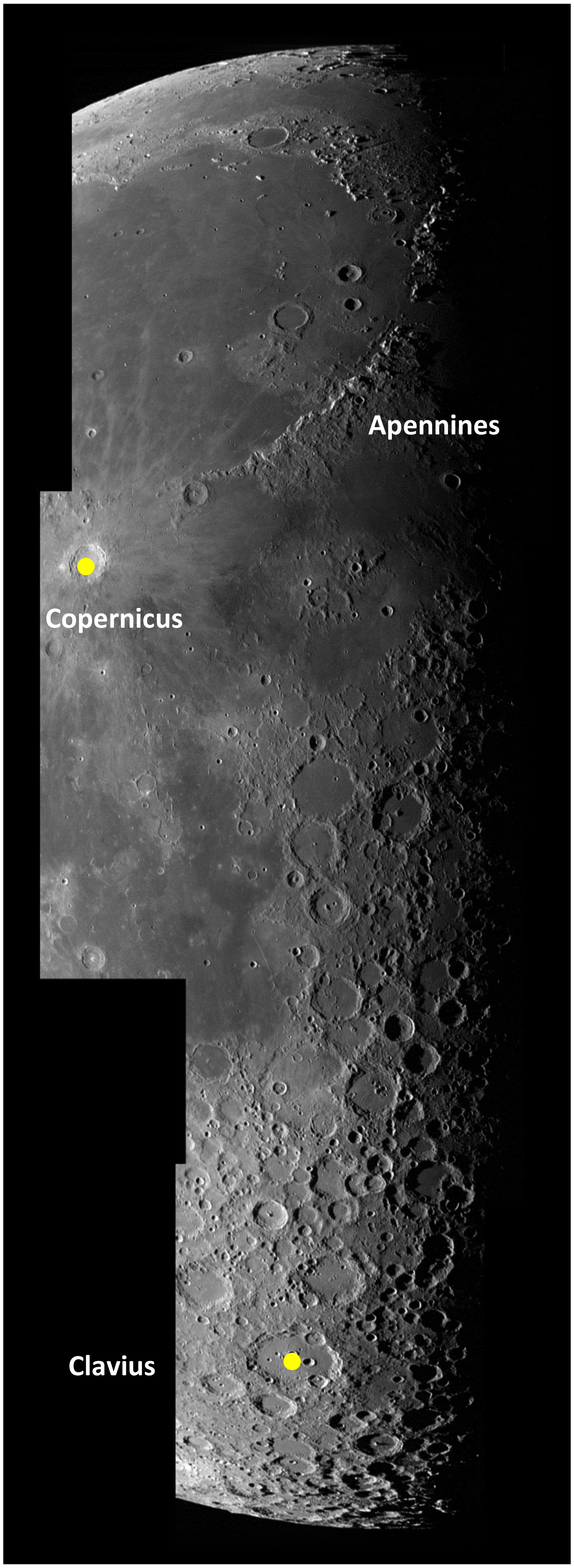
In November, NASA launched its Low-Earth Orbit Flight Test of an Inflatable Decelerator (LOFTID) aboard a United Launch Alliance Atlas V rocket, alongside NOAA's Joint Polar Satellite System-2, for an atmospheric re-entry demonstration. Once released, LOFTID inflated to its full 19.7 feet (6 meters) diameter and entered the Earth's atmosphere at nearly 18,000 miles per hour, or 29,000 kph.

Aft view of LOFTID from the upper stage of Atlas V rocket after deployment and inflation, and subsequent recovery after splashdown (insert) Credit: NASA/Greg Swanson

The pressurized, concentric rings that created the rigid aeroshell structure are made from braided synthetic fibers with a strength 15 times stronger than steel. On the forward facing side, exposed to the heat of reentry, the rings are covered with layers of ceramic fiber cloth than can withstand temperatures in excess of 2,900°F (1,600°C).

This was the first orbital test of the blunt body design after two previous suborbital trials. From the preliminary examination of the vehicle, the payload on the aft side of the heat shield appeared to have been well-protected. Atmospheric drag slowed the vehicle down to just 80 miles per hour (129/kph) before onboard parachutes were deployed for a splashdown in the Pacific Ocean. The concept could be used in future missions to places like Mars, that have a thin, but substantive atmosphere, to deaccelerate and protect large and sensitive payloads.

Lucy Looks to the Moon



NASA's Lucy mission will be the first to explore the Jupiter Trojan asteroids, a population of minor planets that share an orbit with Jupiter. The two groups of Trojans are located 60° in front of and behind the gas giant (Lagrange Points 4 and 5).

The twelve-year mission includes three Earth flybys/gravitational assists - the first was successfully executed about a year after launch. At closest approach, the October flyby took the spacecraft within 224 miles (360 km) of Earth – closer than the International Space Station.

Lucy will visit 8 different asteroids (including one main belt), scanning their surfaces for impact craters as a means of gaining a better understanding of events in the early solar system. During the October flyby, the Lucy team used the Moon to test the sensitivity and resolution of its camera to detect small impact features.

The lunar images, used to create the mosaic (left), were taken about 8 hours after the spacecraft flew by the Earth, at a distance of approximately 140,000 miles (230,000 km) from the Moon. The team will compare Lucy's images with those taken by other spacecraft, for example, NASA's Lunar Reconnaissance Orbiter, to calibrate the spacecraft's instruments and be better prepared to interpret the images acquired once it arrives in the vicinity of Jupiter.

The mosaic, comprised of 5 separate exposures, was taken with L'LORRI (Lucy LOng Range Reconnaissance Imager). It shows the terminator region of a last quarter Moon. The lunar Apennine mountains, an arc forming the eastern rim of the Imbrium basin, are identifiable near the top of the image, the bright crater Copernicus along the left edge, and the ancient crater Clavius in the southern highlands along the bottom. Credit: NASA/Goddard/SwRI/JHU-APL/Tod R. Lauer (NOIRLab)

Space Shuttle Challenger

A film crew searching the ocean floor off the coast of Florida for World War II-era aircraft wreckage, for a HISTORY Channel documentary, came across a much more recent and historic find. Divers found, what appears to be, a significant piece (at least 15 by 15 feet or 4.5 by 4.5 meters) of the space shuttle Challenger.

The space shuttle Challenger broke apart 73 seconds into flight on January 28, 1986, after seals in one of the two solid rocket boosters failed. The entire STS-51L crew, including "Teacher-in-Space" Christa McAuliffe were lost in the accident. After a seven month search and salvage operation, 167 pieces of the orbiter, weighing 118 tons, were recovered, representing about 47 percent of the shuttle Challenger (the search covered more than 486 square nautical miles or 1,666 sq km of ocean floor in depths ranging from 10 to over 1,200 feet or 3 to 365 meters).

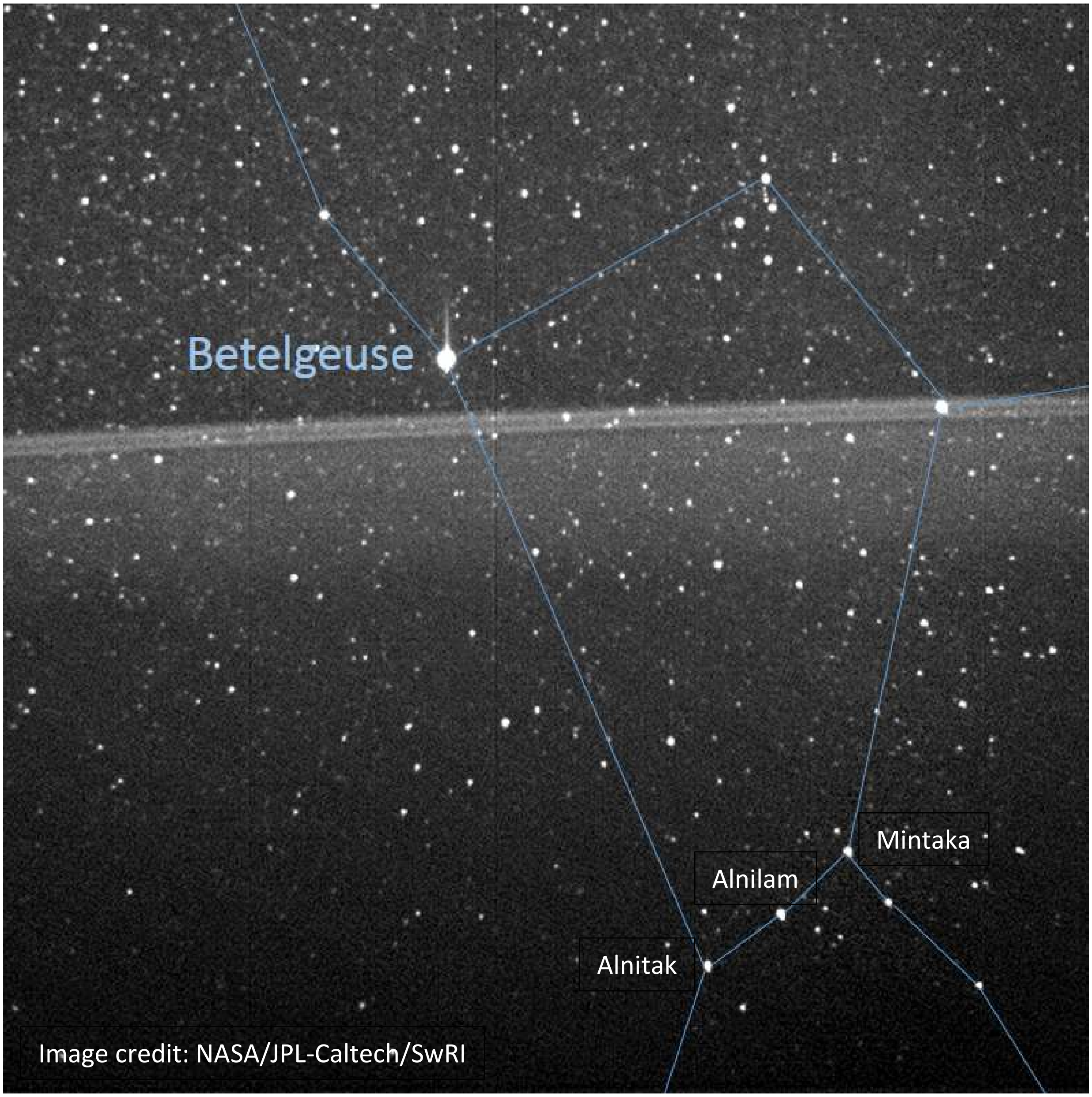
Marine biologist Mike Barnette and wreck diver Jimmy Gadomski explore a large segment of the Challenger Space Shuttle, which exploded in 1986. The HISTORY® Channel

The film crew notified NASA and, after reviewing the film, confirmed that the debris is from the Challenger (based upon the overall construction and presence of the heat shield tiles).

All of the debris from the fallen space shuttle Challenger remains U.S. government property and for now, this piece of the orbiter will remain where it was found. Debris from prior recovery efforts are currently stored in two Minuteman missile silos at the Cape Canaveral Air Force Station (now Space Force Station). The silos are considered interim storage sites and not permanent burial locations. NASA is now considering what actions might be taken with this new discovery.

In 2015, NASA placed a large section of space shuttle Challenger's fuselage on public display at the Kennedy Space Center Visitor Complex as part of the "Forever Remembered" memorial to both the Challenger and Columbia orbiters.

Jupiter's Rings (Insider's View)



Jupiter, Uranus and Neptune all have ring systems, but none that match the grandeur of Saturn's. Jupiter's ring system, much smaller and fainter than Saturn's, was only discovered in 1979 during a flyby of NASA's Voyager 1 spacecraft. The ring system has three major constituents: a pair of very faint outer rings called the gossamer rings; a wide, flat main ring; and a thick inner ring called the halo. They are believed to have been created from the dust thrown off from collisions and/or impacts on Jupiter's smaller moons.

Now, thanks to the Juno spacecraft, which entered into a polar orbit around Jupiter in 2016 to study the gas giant, we have a view from inside the rings. Juno's insider image, which it took with its star-tracking navigation camera from a distance of 40,000 miles (64,000 km), includes background stars in the constellation Orion, including Betelgeuse and the three bright belt stars.

World's Largest Solar Telescope Array

Ring of radio antennas during construction in China
Credit: Liu Zhongjun/China News Service/Getty

China has completed construction of the world's largest solar radio telescope on the edge of the Tibetan Plateau. The Daocheng Solar Radio Telescope (DSRT), is an assembly of more than 300 parabolic antennas, arranged in a circle almost 2 miles (3 km) in circumference.

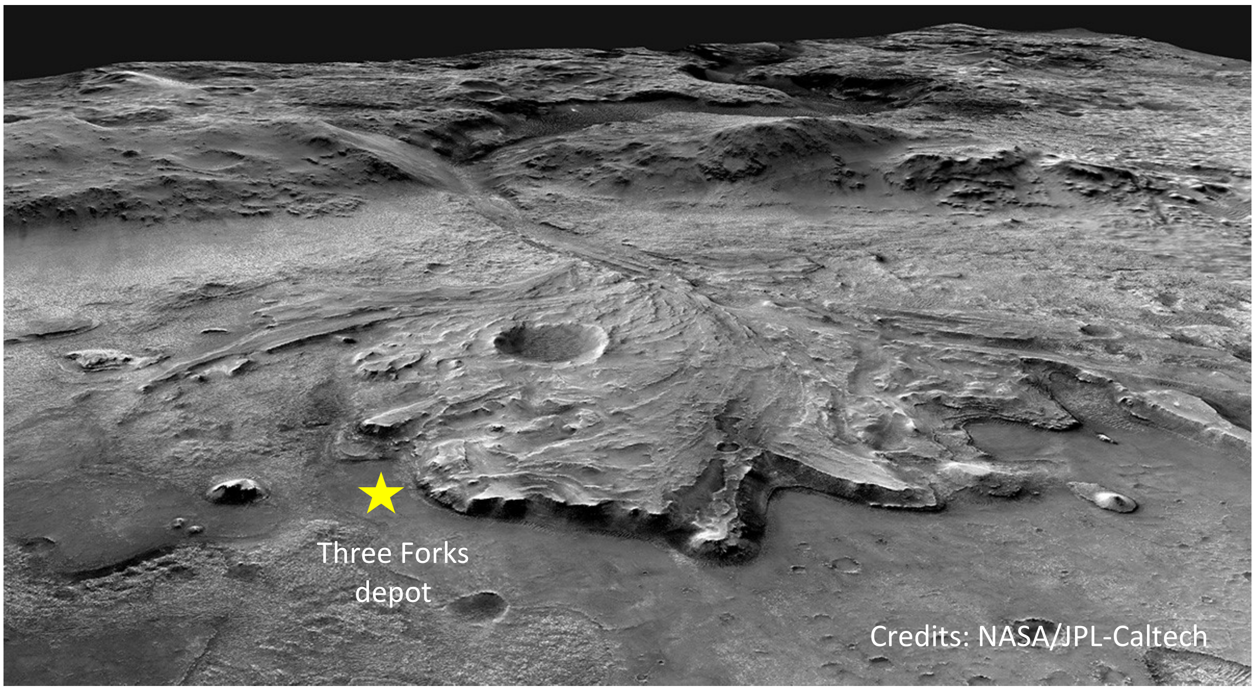
DSRT will allow researchers to monitor the Sun's upper atmosphere for energetic events, such as solar flares and coronal mass ejections (CMEs), and determine how they affect the space around Earth. The solar telescope will complement the four Sun-gazing satellites launched by China in the past two years.

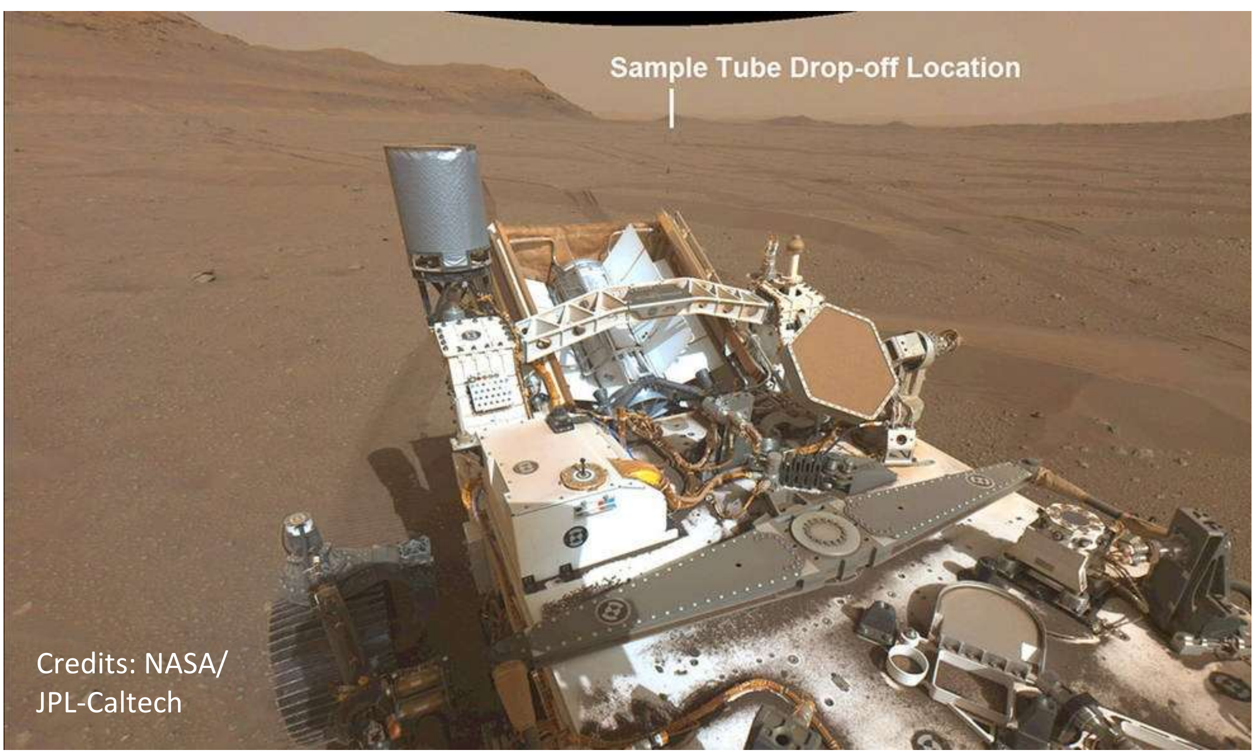
DSRT is just one of the astronomical facilities recently constructed by China. In 2016, construction was completed on the world's largest single-dish radio telescope. China is also building a new optical telescope in Sichuan that is expected to be completed in 2026.

Five-Hundred-Meter Aperture (1,600 feet) Spherical Telescope (FAST) in Guizhou, China
Photo: Xinhua

Sample Cache

NASA and its partner ESA (European Space Agency) have agreed upon the location of the first sample depot for a select group of samples collected by the Perseverance rover for eventual return to Earth. The location, at "Three Forks," is in an area within Jezero Crater near the base of an ancient river delta. The sample depot is a contingency cache for retrieval in the event that the rover isn't operational when the sample return hardware arrives, sometime around 2031. Perseverance will keep a duplicate set of samples onboard.





Phobos Under Stress

Phobos
Credit: NASA/JPL-Caltech/U of A

Phobos is the larger of Mars' two moons and orbits considerably closer to the Red Planet than its companion. Currently at a distance of only 3,600 miles (6,000 km), Mars' tidal forces are slowly pulling Phobos even closer. At the current rate, Phobos will begin to break up sometime in the next 20 to 40 million years. Mars will then join the rest of the outer planets with its own ring.

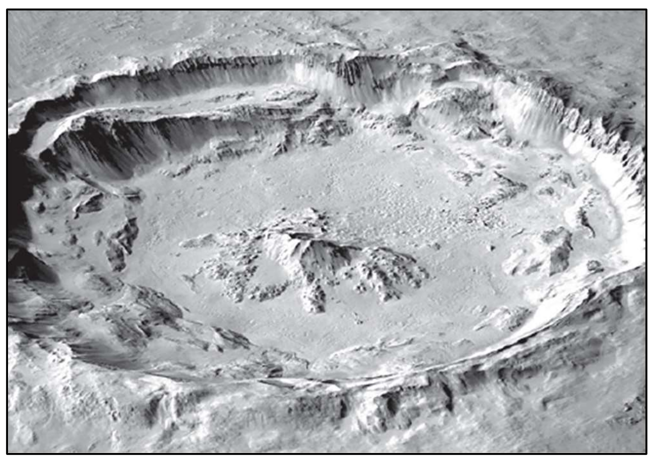
The 13.7-mile diameter (22-km) moon may already be exhibiting outward signs of stress. Running across its surface are parallel, linear features (not present on the smaller and outer moon Deimos). In a new paper published in The Planetary Science Journal, researchers describe a model that can explain the formation of these grooves by the presence of subsurface canyons – created as the moon starts to self-destruct. Weaker material on the surface, dust and rock, drains down into the parallel fissures, creating the linear surface features. Japan's upcoming Martian Moons eXploration (MMX) mission, scheduled for launch in the mid-2020s, will include a sample return that could confirm the surface properties of the moon and offer additional insight into its interior.

Shergottites – Meteorites from Mars

Meteorites that have been determined to have come from Mars (gases trapped inside these extraterrestrial rocks are in the exact proportions as gases in the Martian atmosphere, as measured by the Viking landers) are generally one of three types or families of achondrites, with Shergottites being the most numerous (more than 80% of all Martian meteorites). Shergottites are further categorized into three subgroups in accordance with their relative abundance of light, rare-earth elements such as Lanthanum, Cesium, and Praseodymium.

Meteorites from Mars (or the Moon) are comprised of material excavated from the surface as a result of a relatively energetic impact (powerful enough to eject the material into space). Once in space, the material is subject to the gravitational forces of nearby bodies and can migrate far from its point of origin, for example, until it comes under the influence of another body like Earth. Shergotty, the first member of the family, was an 11-pound (5 kg) meteorite that was seen to fall at Sherghati, in the Gaya district, Bihar, India on August 25, 1865.

The time a rocky body spends in space can be measured by its exposure to cosmic radiation. Scientists noticed that a number of "depleted shergottites" had similar ejection ages (around 1.1 million years), suggesting a common impact event and location. In searching for that point of origin, Australian researchers at Curtin University compiled a database of 90 million impact craters, while also considering the surface geology, age of the terrain around the craters, crystallization ages of the meteoritic material, and the chemical and mineralogical properties of the depleted shergottites.

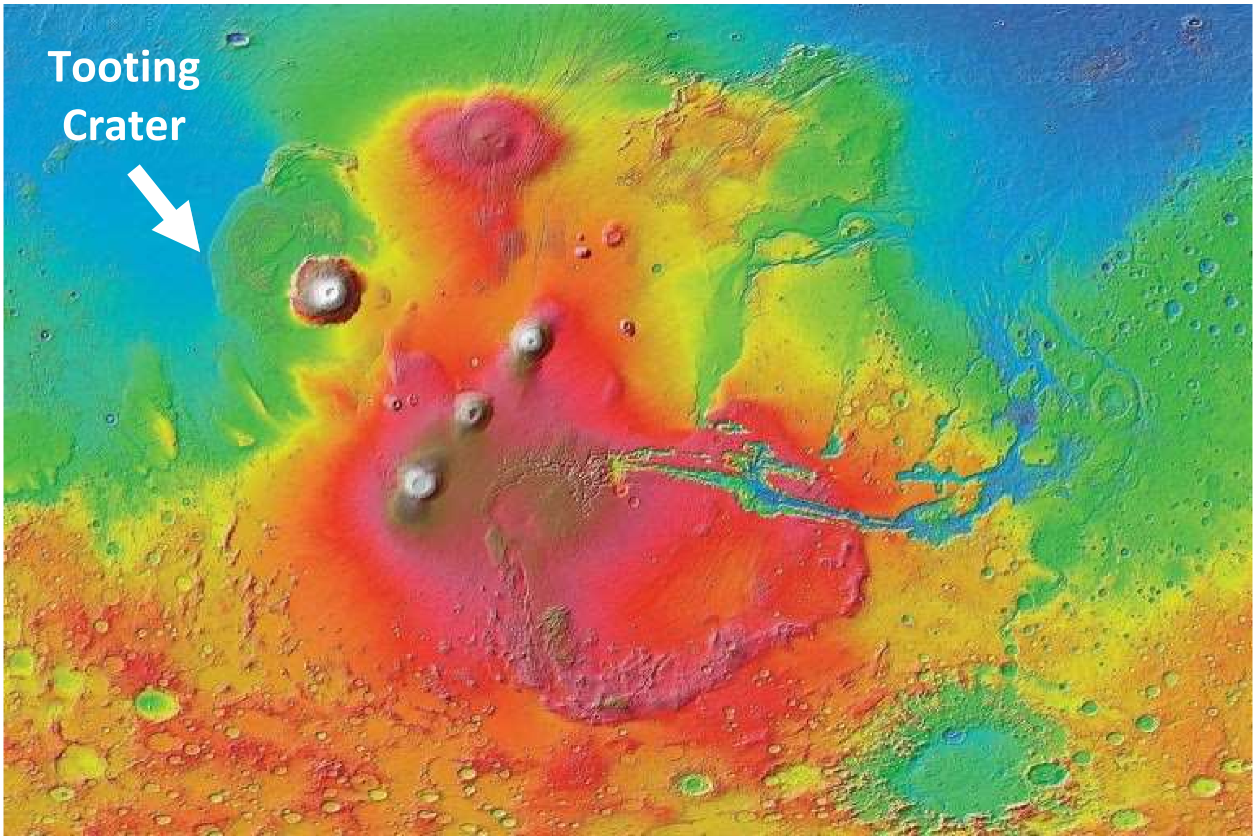


Tooting crater
Credit: NASA

The crater-modeling algorithm identified Tooting crater as the most likely source of the depleted shergottites ejected 1.1 million years ago. The 17-mile (27.2 km) diameter crater is located in the Tharsis volcanic province, not far from the solar system's largest volcano, Olympus Mons. Its age is estimated to be about 1 million years, with the age of the surrounding surface estimated at 308 ± 41 million years.

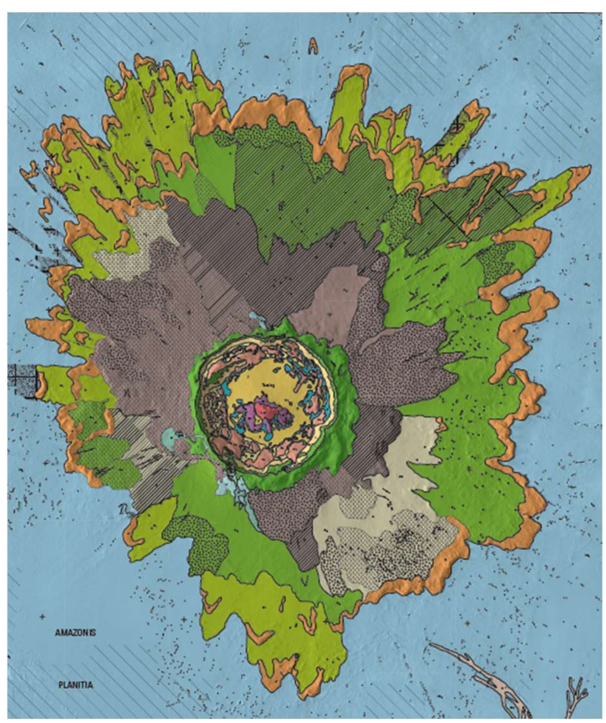
The McCarthy Observatory has an extensive collection of meteoritic specimens, including historic finds and falls, as well as meteorites from both Mars and the Moon.

The collection includes a meteorite classified as a depleted shergottite – Dar al Gani 476 (image of the 0.866 gram part slice on left). The meteorite was found in Libya in 1998. Radiogenic analysis indicates that the basalt crystalized about 475 million years ago, was exposed to cosmic rays for 1 million years, and lay on the sands of the Sahara for 40-80 thousand years.



Colorized elevation map of Mars showing the location of Tooting crater. The crater is near the Martian Tharsis, an expansive volcanic plateau centered near the equator and home to Mars' massive shield volcanoes, including Olympus Mons to the southeast of the crater. Image: NASA/JPL-Caltech/ Arizona State University

Tooting crater is located on the flat lava flows of Amazonis Planitia. The crater is believed to have been created by an oblique impact from the southwest based upon the uneven radial distribution of impact ejecta and secondary craters. The image on the right identifies the various layers and types of ejecta material found in and around the crater from data collected by the Mars Reconnaissance Orbiter's THEMIS camera.



Geologic Map of Tooting Crater, Amazonis Planitia Region of Mars prepared on behalf of the Planetary Geology and Geophysics Program, Solar System Exploration Division, Office of Space Science, National Aeronautics and Space Administration

Apollo 8 – Lookback

1968 was a year of turmoil. The United States was entangled in a war that even the Secretary of Defense concluded could not be won and he resigned from office. The My Lai massacre was one of many atrocities of the Vietnam War perpetrated by both sides during this year. Major U.S. cities were the target of race riots and anti-war protests. Chicago police violently clashed with protesters at the Democratic National Convention and civil rights leader Martin Luther King and presidential candidate Robert Kennedy were assassinated in 1968. To many Americans, the only heartening event in this otherwise horrific year was the reading from the Book of Genesis by the crew of Apollo 8 as they orbited the Moon on Christmas Eve.

The race to beat the Soviets to the Moon took a dramatic turn in 1968 and saw the United States take its first lead by year's end. Apollo 7 was launched in October 1968 into Earth orbit. A week or so later, the Soviets launched two Soyuz space craft into Earth orbit (one manned and one unmanned for a planned rendezvous). In November, another unmanned Zond flew around the Moon and photographed the unseen far side. The United States expected that the Soviets would attempt another moon shot in early December when the launch window for the Baikonur space center in Kazakhstan reopened (a Zond stood poised on the launching pad). Curiously, the opportunity passed without any activity. Cosmonaut Alexei Leonov would later attribute the Soviet's loss of initiative and resolve to the premature death of Sergei Korolev, the "Chief Designer" of the Soviet space program as well as the design complexities of their Moon rocket (the N1).

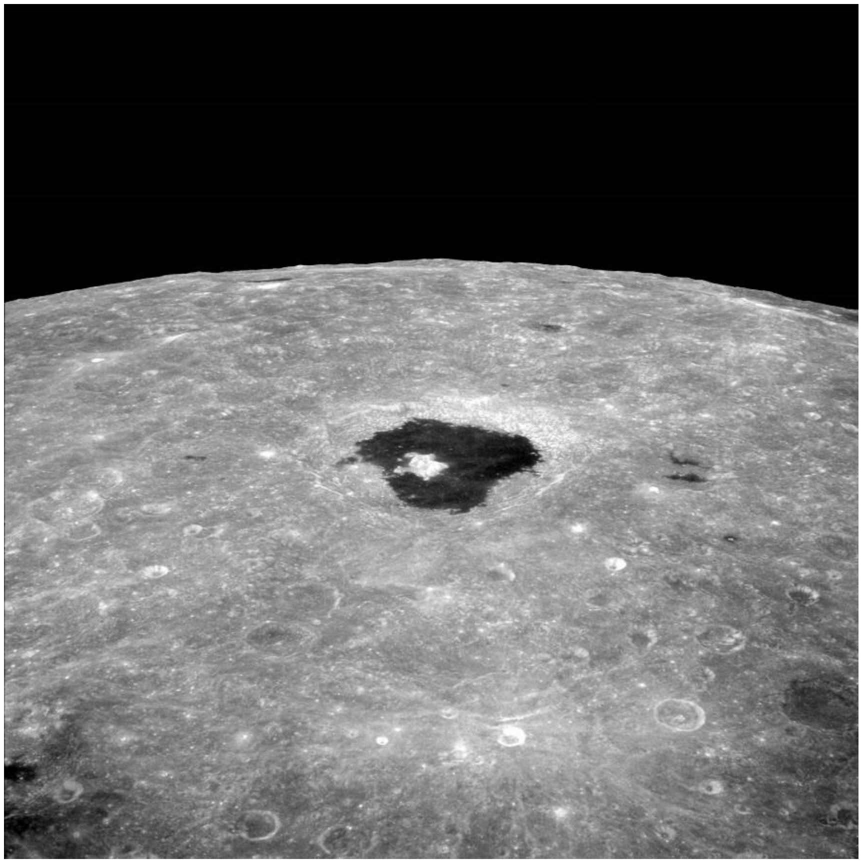
While Apollo 7 had been a successful maiden voyage of the completely redesigned command module (after the Apollo 1 fire), the United States had yet to leave Earth orbit. NASA's original plan was to launch a series of increasingly complex missions to near-Earth orbit before attempting a lunar excursion. Development of the lunar lander was behind schedule and violent vibrations in the Saturn rocket's main stage needed to be corrected before NASA felt confident of sending men to the Moon. However, the apparent progress by the Soviets threatened to upstage the United States once again. It was a proposal by a quiet engineering genius, George Low, (Manager of the Apollo Spacecraft Program Office) to send the Apollo 8 command module alone into lunar orbit that would ultimately place the United States in a position to achieve President Kennedy's goal to land a man on the Moon and safely return him to Earth by the end of the decade.

Apollo 8 was launched on December 21st under the command of Frank Borman with astronauts William Anders and Jim Lovell (Lovell replaced Michael Collins on the original team; Collins, who required back surgery, would go on to be the Command Module Pilot for Apollo 11). The launch was scheduled so that the crew would arrive at the Moon as the Sun was rising on the Sea of Tranquility. With the Sun low in the sky, the astronauts could photograph potential landing sites and resolve surface detail that would otherwise be washed out in the glare from a higher Sun.

The crew of Apollo 8 was the first to ride the three stage Saturn V rocket, with the explosive energy of an atomic bomb (the Saturn V had only been launched twice before – both unmanned). The night before the launch, the astronauts were visited by Charles Lindbergh. During the visit, it was discussed that the engines on the Saturn V would burn 10 times the amount of fuel every second that Lindbergh had used to fly nonstop from New York to Paris.

The Apollo 8 astronauts were also the first humans to leave Earth orbit and pass through the Van

Allen radiation belts that extend up to 15,000 miles from Earth. To accomplish the mission, Apollo 8 had to cross the 240,000-mile void between the Earth and the Moon with sufficient precision so as to intercept the Moon (traveling at 2,300 miles an hour through space) just 69 miles above the lunar surface. By successfully doing so, the astronauts were the first humans to witness the rising of the Earth above the Moon's horizon (Earthrise). They would also be the first to return to Earth and reenter the atmosphere at a speed of 25,000 miles an hour.



Apollo 8's view of Tsiolkovsky crater with its lava covered floor on the Moon's far side. Credit: NASA

The highlight of the mission, to many, was the broadcast from the Apollo 8 command module during the ninth orbit of the Moon. After a brief introduction of the crew and their general impressions of the lunar landscape, William Anders said that the crew had a message for all those on Earth. The astronauts took turns reading from the book of Genesis, the story of creation. Frank Borman closed the broadcast with: "And from the crew of Apollo 8, we close with: Good night, Good luck, a Merry Christmas, and God bless all of you, all you on the good Earth." It is estimated that a quarter of Earth's population saw the Christmas Eve transmission.

In order to safely return to Earth, the main engine had to be restarted on the far side of the Moon (out of contact with the Earth). If successful, Apollo 8 would reappear from behind the Moon at a predetermined time. As predicted, the spacecraft re-emerged on time, and when voice contact was regained, astronaut Jim Lovell would announce: "Please be informed, there is a Santa Claus." It was Christmas Day. Apollo 8 would return safely to the Earth two days later, splashing down in the Pacific Ocean shortly before sunrise. The astronauts and the capsule were recovered by the aircraft carrier USS Yorktown.

Following the success of Apollo 8, the Soviet Moon program fell further behind with catastrophically unsuccessful launches of their N1 booster in February and again in July of 1969. An unmanned, sample return mission attempted to upstage the Apollo 11 landing, but Luna 15 crashed into Mare Crisium shortly before Armstrong and Aldrin were scheduled to lift off from the Moon. The Soviets officially cancelled their Moon program in the early 1970s.

Purchasing a Telescope

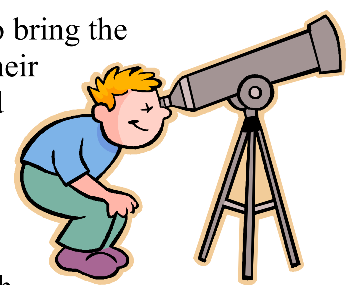
During the holidays it's not uncommon to see parents and grandparents carrying around a telescope that they just picked up at the mall or warehouse store for their budding astronomer. Unfortunately, too many of these thoughtful gifts end up in a basement or attic after one or two uses. All too often, telescope manufacturers prey on consumer's expectations, which are often out of line with the capabilities of the product, resulting in frustration and disillusionment. However, even a crudely constructed telescope can be coaxed to produce acceptable images, if the observer understands the limitations of his or her instrument.

There is no perfect telescope for everyone. An inexpensive, mass-produced telescope that gets carted out of the house and set up every clear night, stimulates the users' imagination and encourages them to push the instrument's capabilities to its limits is far more valuable than the most highly crafted optical masterpiece that spends its nights in a closet.

There are several types of telescopes available to the general consumer. Each has advantages and disadvantages, and with a little education, a consumer can find a telescope that fits his or her needs and lifestyle. Again, if you don't use it, a telescope is about as useful as a garden gnome and not as cute.

Types of Telescopes

There are three basic types of telescopes: refractors, reflectors and compound or catadioptric telescopes.



Refractors have been around for 400 years and use a series of lenses to bring the light rays from distant objects to focus. They are highly regarded for their unobstructed and high-contrast images. The optical tubes are sealed and generally more rugged than other designs. As such, the optics rarely need to be adjusted (realigned) which makes the refractor a good choice as a travel telescope. Refractors are an excellent choice for planetary and lunar viewing and for double stars, but generally do not have the large light gathering capacity needed for faint objects such as nebula and galaxies. The disadvantages of refractors include: the potential for different wavelengths of light to diverge from a common focus as they pass through the glass (producing color "fringing" around bright objects), the position of the eyepiece at the rear of the optical tube (requiring the telescope to be mounted fairly high off the ground for comfortable viewing), the closed tube that can take some time to cool down, and the price (highest cost per inch of aperture of the basic telescopes designs).

Reflectors have been around for almost as long as refractors, but use mirrors instead of lenses to bring light to the observer's eye. A large mirror located at the closed end of the optical tube reflects light back up the tube to a smaller mirror mounted near the open end and out to an eyepiece. Mirrors are much easier and less expensive to manufacture than lenses with only an optical curve required on the front of the mirror. With mirrors, the light never passes through the glass, so there is no divergence of the light rays. However, since the optical tube is open to the atmosphere, mirrors will require periodic cleaning, adjustment and, eventually, recoating. Reflectors offer the best value, particularly for larger apertures.

The most popular compound or catadioptric telescopes combine a large, rear spherical mirror with a front corrector lens to create a very compact optical tube. Companies such as Meade and Celestron built their businesses on the Schmidt-Cassegrain design. While generally more expensive than reflectors, the compound telescope offers a very portable alterative for large aperture telescopes. Disadvantages include cool down time (since the optical tubes are sealed), and a relatively large secondary mirror that degrades the image of high contrast objects (planets or the Moon). The front corrector plate is also susceptible to dew formation although this can be managed with a dew shield or corrector plate heater.

There are several terms that are used in the sales promotion of telescopes. Some of the common ones are discussed below:

Aperture

Aperture refers to the size of the largest lens or mirror in the telescope, for example, the primary mirror in an 8-inch reflector is 8-inches in diameter. As a general rule, bigger is better, as light gathering and resolution increase with the size of the optics. However, as with everything else, there are other considerations that limit the practical size of a particular instrument. Alvan Clark & Sons figured the 40-inch lens for the Yerkes Observatory's refractor, delivering the lens in 1897. More than 100 years later, it is still the world's largest working refractor. Why? The weight of the glass and the complexities in supporting a large lens by its edge and the absorption of light passing through the glass were factors; however, the refractor was ultimately done in by Sir Isaac Newton when he built the first reflecting telescope in 1668. Mirrors, unlike lenses, can be completely supported from the back. Since light does not pass through the glass, reflected images do not suffer from "chromatic aberration." Today single mirrors are routinely produced with diameters exceeding 28 feet and telescopes are constructed combining multiple mirrors to achieve even larger light gathering capabilities. So what size is good for you? Before you answer, you may want to consider:

- Are you planning on setting up your telescope in a permanent installation, e.g., backyard observatory, or will you be moving it in and out of your home every time you plan on observing? If the latter, then weight, portability and ease of set up are important considerations. Due to its size and weight, my telescope saw very little use until I invested in a wheeled platform that allows me to easily roll the fully assembled telescope in and out of my garage in minutes.

- Are you planning on taking your telescope on the road, with you on vacation or planning to travel some distance to find truly dark skies or observe a "once in a lifetime event?" Whether by train, plane or automobile, care must be taken to protect your telescope and ensure that it arrives at its destination in working order (mechanically and optically). If this is important to you, a smaller and simpler design such as a refractor may be a good choice.

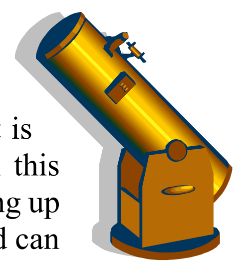
- What are you interested in looking at? Spectacular views of the Sun, Moon and planets can be acquired with a relatively modest instrument. However, if your passion is hunting down the more elusive and distant residents of the Milky Way Galaxy or exploring other galaxies far, far, away, it will require a much larger aperture to capture those meager photons.

Magnification

Magnification is likely the most overrated measure of a telescope's capabilities. Magnification is a function of the eyepiece placed in the path of the incoming light and in front of the observer's eye; the observer can change the magnification by simply selecting a different eyepiece. As such, it shouldn't be a criterion in selecting a telescope.

The limiting useful magnification is approximately 50 times the diameter of the objective lens or primary mirror. For example, a small refracting telescope with a 4-inch objective lens can be pushed to a magnification of 200 times; however, only under the best observing conditions and, in general, only on bright objects such as the Moon and planets. Most astronomers prefer the views that lower magnification provides with a wider field and brighter image. So, the next time you are captured by the stunning views of the universe on the packaging of a modest instrument, remember that the potential of most telescopes is rarely realized, particularly if you reside in the light polluted skies of the northeast. A higher power eyepiece magnifies not only the telescope's intended target but also the side-effects of living under 20 miles of Earth's atmosphere.

Mounts



While generally not at the top of the list as far as features, the telescope's mounting system and construction is key to its ease of use and the stability of the image. A poorly designed mount or one with flimsy construction can be just as frustrating to deal with as poor optics. An altitude-azimuth or alt-az mount is the simplest type of telescope mount and generally the easiest to set up. In this arrangement, the mount allows the telescope to move left and right while pivoting up and down. It is commonly found on Dobsonian* telescopes, is user friendly and can be mechanized to track celestial objects across the sky.

Another common mount design is the equatorial mount. In this design, one axis is aligned with the celestial pole, requiring only the movement around this axis to follow objects across the sky. It is the easiest configuration for tracking and is generally preferred for astrophotography. Some alt-az mounts can be converted to an equatorial configuration with the addition of an "equatorial wedge." Equatorial mounts, however, can be heavier than their alt-az counterparts.

Go-To

Essentially a computer controlled pointing system, "go-to" allows the user to select an object from a data base and command the drive motors on the mount to move the telescope to the object's location in the sky. This presupposes that the telescope user has properly set up the telescope and successfully navigated through the alignment process (a process by which the telescope's computer determines where it's pointed, the local time, and its position on the Earth). Most "go-

* Dobsonian telescopes are reflectors on a simple, swivel mount. They offer a low-cost solution for those on a limited budget with aperture fever (an insatiable desire for a larger telescope).

to" telescopes come with a large database, some of which can be modified (supplemented) by the user. While "go-to" capability is extremely convenient and can take you to thousands of objects in its database in a blink of an eye, it doesn't necessarily mean that you will be able to see the object. Depending upon the size of your telescope (see Aperture), many objects in these databases are just too dim to see with the equipment provided. CCD cameras are much more sensitive than your eye and can accumulate light for long durations. So, if you are planning on using your telescope primarily as a camera lens, then some of the disadvantage of a small aperture can be overcome. However, if you plan on doing most of your observing at the eyepiece, you may want to consider spending the money on a larger aperture rather than on "go-to" electronics.

What to Do

If you are seriously considering acquiring a telescope, a little bit of research can go a long way in enjoying your final purchase. If possible, try to observe through the telescope(s) that you are considering. Check out product reviews in trade magazines such as Sky & Telescope and Astronomy and on their websites. Contact reputable dealers and visit trade shows such as the Northeast Astronomical Forum where you can pick the brains of industry experts. When the McCarthy Observatory reopens - attend an open house. When the skies are clear, up to a dozen telescopes can be found on the premises (including refractors, reflectors, a Dobsonian, and several Schmidt–Cassegrains). Compare the same celestial objects through different scopes, talk to the owners about portability, ease of setup and operation.

December Nights

Nights in December are not to be missed. While the often frigid and turbulent atmosphere can be frustrating for astronomers, the reflection of shimmering starlight (or moonlight) off a snow-covered landscape can be truly magical. The bright stars of the winter sky glow with color from orange to yellow to brilliant blue-white. A star-filled sky in December is unsurpassed in grandeur.

Sunrise and Sunset (New Milford, CT)

Sun	Sunrise	Sunset
December 1st (EST)	07:00	16:24
December 15th	07:13	16:24
December 31st	07:20	16:33

Astronomical and Historical Events

1st Scheduled launch the Japanese Hakuto-R lunar lander (and two small rovers) aboard a SpaceX Falcon 9 rocket the Cape Canaveral Space Force Station, Florida. NASA's Lunar Flashlight CubeSat will be a rideshare payload on this launch.
1st Apollo Asteroid *2009 BD* closest approach to Earth (0.118 AU)
1st Asteroid *2062 Aten* closest approach to Earth (1.763 AU)
1st Kuiper Belt Object 523759 (*2014 WK509*) at Opposition (50.877 AU)
1st History: launch of Soviet satellite Sputnik 6 and two dogs: Pchelka and Mushka (1960)
2nd Aten Asteroid *2010 VQ* near-Earth flyby (0.030 AU)
2nd Apollo Asteroid *2009 HV58* near-Earth flyby (0.032 AU)

Astronomical and Historical Events (continued)

2nd Aten Asteroid *2010 TK7* (Earth Trojan) closest approach to Earth (0.221 AU)
2nd History: Soviet Mars 3 lander became the first spacecraft to attain a soft landing on Mars, only to fail after 110 seconds (1971)
2nd History: launch of the Hayabusa 2 spacecraft to the asteroid *162173 Ryugu* from the Tanegashima Space Center, Japan (2014)
2nd History: dedication of the John J. McCarthy Observatory in New Milford, CT (2000)
2nd History: launch of SOHO solar observatory (1995)
2nd History: launch of space shuttle Endeavour (STS-61), first servicing of the Hubble Space Telescope, including the installation of corrective optics and new solar panels (1993)
2nd History: Pioneer 11 spacecraft makes its closest approach to Jupiter; encounter redirects the spacecraft to Saturn and an escape trajectory out of the solar system (1974)
2nd History: touchdown of Soviet Mars 3 lander: communications were lost with the lander, the first spacecraft to touch down on the Red Planet, after 20 seconds possibly due to raging dust storm (1971)
3rd Apollo Asteroid *2017 QL33* near-Earth flyby (0.041 AU)
3rd Vatira Asteroid *594913 'Aylo'chaxnim* closest approach to Earth (0.435 AU)
3rd Apollo Asteroid *2102 Tantalus* closest approach to Earth (0.626 AU)
3rd Kuiper Belt Object 386723 (*2009 YE7*) at Opposition (49.781 AU)
3rd Kuiper Belt Object *2006 QH181* at Opposition (83.899 AU)
3rd History: NASA spacecraft OSIRIS-REx arrives at asteroid *Bennu* (2018)
3rd History: Pioneer 10 spacecraft makes its closest approach to Jupiter; first space probe to fly through the asteroid belt and to an outer planet (1973)
3rd History: discovery of Jupiter's moon *Himalia* by Charles Perrine (1904)
4th History: launch of space shuttle Endeavour (STS-88), first International Space Station construction flight, including the mating of the Unity and Zarya modules (1998)
4th History: launch of the Pathfinder spacecraft to Mars (1996)
4th History: Pioneer Venus 1 enters orbit, first of two orbiters (and probes) to conduct a comprehensive investigation of the atmosphere of Venus (1978)
4th History: launch of Gemini 7 with astronauts Frank Borman and Jim Lovell, spending almost 14 days in space (1965)
4th History: launch of Little Joe 2 rocket, test flight for the Mercury capsule and first U.S. animal flight with Sam, a Rhesus monkey (1959)
6th Kuiper Belt Object 145453 (*2005 RR43*) at Opposition (39.177 AU)
6th History: recovery of Hayabusa 2's sample return capsule containing material from the asteroid Ryugu (2020)
6th History: Japanese spacecraft Akatsuki enters around Venus five years after unsuccessful first attempt and main engine failure (2015)
7th Full Moon (Cold Moon)
7th Moon Occults Mars (western Massachusetts and central New York)
7th Jupiter Trojan *588 Achilles* at Opposition (3.492 AU)
7th Kuiper Belt Object *2018 VG18* at Opposition (122.682 AU)
7th History: launch of the Jason-1 satellite to measure ocean surface topography from the Vandenberg Air Force Base, California (2001)
7th History: arrival of the Galileo space probe at Jupiter (1995)
7th History: launch of Apollo 17 with astronauts Ronald Evans, Harrison Schmitt (first scientist – geologist) and Eugene Cernan (last man on the Moon – so far) (1972)

Astronomical and Historical Events (continued)

8th Mars at Opposition (closest approach was on November 30th)
8th History: launch of the Chinese Chang'e 4 spacecraft to the far side of the Moon from the Xichang, China launch site (2018)
8th History: Dragon spacecraft, launched by SpaceX into low-Earth orbit, is recovered in the Pacific Ocean: first time a spacecraft recovered by a commercial company (2010)
8th History: Japanese spacecraft IKAROS becomes the first to successfully demonstrate solar sail technology in interplanetary space during a Venus flyby (2010)
8th History: discovery of asteroid *5 Astraea* by Karl Hencke (1845)
9th History: Pioneer Venus 2 enters orbit, second of two orbiters (and probes) to conduct a comprehensive investigation of the atmosphere of Venus (1978)
10th Second Saturday Stars – Open House at the McCarthy Observatory (7:00 pm)
10th Apollo Asteroid *2019 XY* near-Earth flyby (0.009 AU)
10th Kuiper Belt Object *148780 Altjira* at Opposition (45.148 AU)
10th History: launch of the X-ray Multi-Mirror Mission (XMM-Newton), the largest scientific satellite built in Europe and one of the most powerful (1999)
10th History: launch of Helios 1 (also known as Helios A) into solar orbit; joint venture by Federal Republic of Germany and NASA to study the Sun (1974)
10th History: launch of the Boeing X-37B Orbital Test Vehicle 1 (unmanned space plane) from the Cape Canaveral Air Force Station (2012)
11th Moon at apogee (furthest distance from Earth at 252,195 miles or 405,868 km)
11th Parker Solar Probe, 14th Perihelion
11th Amor Asteroid *1916 Boreas* closest approach to Earth (1.698 AU)
11th Jupiter Trojan *911 Agamemnon* at Opposition (4.040 AU)
11th Kuiper Belt Object *229762 G!kun||'homdima* at Opposition (40.073 AU)
12th Scheduled launch of the Surface Water and Ocean Topography mission for NASA (SWOT) aboard a SpaceX Falcon 9 from the Vandenberg Space Force Base, California
12th Amor Asteroid *3553 Mera* closest approach to Earth (0.782 AU)
12th Amor Asteroid *1943 Anteros* closest approach to Earth (1.965 AU)
12th History: discovery of Saturn moons *Fornjot*, *Farbauti*, *Aegir*, *Bebhionn*, *Hati* and *Bergeimi*r by Scott Sheppard, et al's (2004)
12th History: discovery of Saturn moons *Hyrrokkin* by Sheppard/Jewitt/Kleyna (2004)
12th History: launch of Uhuru, the first satellite designed specifically for X-ray astronomy (1970)
12th History: launch of Oscar, first amateur satellite (1961)
13th Geminids meteor shower peak
13th Apollo Asteroid *2003 YS70* near-Earth flyby (0.027 AU)
13th Aten Asteroid *2019 XQ1* near-Earth flyby (0.037 AU)
13th Apollo Asteroid *2018 XU3* near-Earth flyby (0.038 AU)
13th Kuiper Belt Object 470443 (*2007 XV50*) at Opposition (46.119 AU)
13th History: flyby of Asteroid 4179 *Toutatis* by the Chang'e 2 spacecraft, China’s second lunar probe (2012)
13th History: discovery of Saturn’s moons *Fenrir* and *Bestla* by Scott Sheppard, et al's (2004)
13th History: launch of Pioneer 8, third of four identical solar orbiting, spin-stabilized spacecraft (1967)
13th History: Mt. Wilson’s 100-inch telescope used to measure the first stellar diameter (Betelgeuse); measured by Francis Pease and Albert Michelson (1920)

Astronomical and Historical Events (continued)

13th History: first light of Mt. Wilson's 60-inch telescope (1908)
14th Kuiper Belt Object 145451 (*2005 RM43*) at Opposition (37.136 AU)
14th Kuiper Belt Object *2004 XR190* at Opposition (55.871 AU)
14th History: landing of China's Chang'e 3 Moon lander on Mare Imbrium (2013)
14th History: flyby of Mars by Japan's Nozomi spacecraft after an attempt to achieve orbit fails (2003)
14th History: creation of the Canadian Space Agency (1990)
14th History: flyby of Venus by Mariner 2; first spacecraft to execute a successful encounter with another planet, finding cool cloud layers and an extremely hot surface (1962)
14th History: Weston meteorite fall: first documented fall in the United States (1807); best coordinates for the fall are based upon investigative research conducted by Monty Robson, Director of the McCarthy Observatory, published in 2009
14th History: birth of Tycho Brahe, Danish astronomer noted for his observational skills, the precision of his observations, and the instruments he developed; builder of the Uraniborg and Stjenborg observatories on the Swedish island of Ven (1546)
15th Apollo Asteroid *2015 RN35* near-Earth flyby (0.005 AU)
15th History: launch of Soviet spacecraft, Vega 1 to Venus and then to Comet Halley (1984)
15th History: landing of Soviet spacecraft Venera 7 on the surface of Venus (1970)
15th History: discovery of Saturn's moon *Janus* by Audouin Dollfus (1966)
15th History: launch of Gemini 6 with astronauts Walter Schirra and Thomas Stafford (1965)
15th History: Gemini 6 and 7 execute the first manned spacecraft rendezvous (1965)
15th History: Simon Marius – first observation of the Andromeda Galaxy through a telescope (1612)
16th Last Quarter Moon
16th Jupiter Trojan *624 Hektor* at Opposition (4.321 AU)
16th History: launch of Pioneer 6, the first of four identical solar orbiting, spin-stabilized spacecraft (1965)
16th History: birthday of futurist Arthur C. Clarke (1917)
17th History: GRAIL spacecraft impact Moon (end of mission) (2012)
17th History: Project Mercury publicly announced (1958)
17th History: Wright Brothers' first airplane flight, Kitty Hawk, North Carolina (1903)
18th Apollo Asteroid *2016 YE* near-Earth flyby (0.048 AU)
18th History: discovery of Saturn's moon *Epimetheus* by Richard Walker (discovery shared with Stephen Larson and John Fountain) (1966)
19th Plutino 307463 (*2002 VU130*) at Opposition (38.154 AU)
19th History: launch of the Gaia spacecraft from French Guiana to survey more than one billion stars in an effort to chart the chart the evolution of the Milky Way galaxy (2013)
19th History: launch of space shuttle Discovery (STS-103), third servicing of the Hubble space telescope including the installation of new gyroscopes and computer (1999)
19th History: launch of Mercury-Redstone 1A; first successful flight and qualification of the spacecraft and booster (1960)
20th Winter Solstice at 4:48 pm EST (21:48 UT)
20th Apollo Asteroid *2014 HK129* near-Earth flyby (0.017 AU)
20th Atira Asteroid *2021 PB2* closest approach to Earth (0.386 AU)
20th Apollo Asteroid *1864 Daedalus* closest approach to Earth (0.588 AU)
20th Centaur Object *8405 Asbolus* at Opposition (23.506 AU)

Astronomical and Historical Events (continued)

20th Plutino 84922 (*2003 VS2*) at Opposition (35.842 AU)
20th History: launch of the Active Cavity Radiometer Irradiance Monitor satellite (ACRIMSAT); designed to measure Sun's total solar irradiance (1999)
20th History: Ames Research Center founded as the second National Advisory Committee for Aeronautics (NACA) laboratory at Moffett Federal Airfield in California (1939)
20th History: founding of the Mt. Wilson Observatory (1904)
21st Mercury at its Greatest Eastern Elongation (20°) – furthest separation from the Sun in the evening sky
21st Aten Asteroid *2017 XQ60* near-Earth flyby (0.048 AU)
21st History: launch of the Soviet spacecraft Vega 2 to Venus, continued on to Comet Halley (1984)
21st History: landing of Soviet spacecraft Venera 12 on the surface of Venus, found evidence of thunder and lightning in the atmosphere (1978)
21st History: launch of Apollo 8 with astronauts Frank Borman, Jim Lovell and William Anders, first to circumnavigate the Moon (1968)
21st History: launch of Luna 13, Soviet moon lander (1966)
22nd Ursids Meteor Shower peak
22nd Kuiper Belt Object *19521 Chaos* at Opposition (40.197 AU)
22nd History: first asteroid (323 *Brucia*) discovered using photography (1891)
23rd New Moon
23rd History: discovery of Saturn's moon *Rhea* by Giovanni Cassini (1672)
24th Moon at perigee (closest distance from Earth at 222,618 miles or 358,269 km)
24th Centaur Object *54598 Bienor* at Opposition (12.811 AU)
24th History: inaugural of ESA's Ariane 1 rocket and first artificial satellite carried by an ESA rocket (1979)
24th History: the largest and best recorded meteorite fall in British history over the Leicestershire village of Barwell (1965)
24th History: Deep Space Network created (1963)
24th History: Jean-Louis Pons born into a poor family with only basic education, took post at observatory at Marseilles as concierge, went on to become most successful discover of comets (discovered or co-discovered 37 comets, 26 bear his name) (1761)
24th History: inaugural launch of the Arianne rocket, Europe's attempt to develop a cost-effective launcher to serve the commercial market (1979)
25th Apollo Asteroid *2013 YA14* near-Earth flyby (0.007 AU)
25th History: launch of the James Webb Space Telescope (JWST) from Arianespace's ELA-3 launch complex near Kourou, French Guiana (2021)
25th History: European Space Agency's Mars Express spacecraft enters orbit around Mars (2003)
25th History: landing of Soviet spacecraft Venera 11 on Venus, second of two identical spacecraft (1978)
26th Mars Spring Equinox (northern hemisphere)
26th Apollo Asteroid *2018 YK2* near-Earth flyby (0.040 AU)
26th Centaur Object 154783 (*2004 PA44*) at Opposition (22.453 AU)
26th History: launch of Soviet space station Salyut 4 from Baikonur Cosmodrome; third Soviet space station and second space station devoted primarily to civilian objectives; deorbited in 1977 (1974)

Astronomical and Historical Events (continued)

- 27th Aten Asteroid *2010 XC15* near-Earth flyby (0.005 AU)
- 27th Aten Asteroid 341843 (*2008 EV5*) closest approach to Earth (0.424 AU)
- 27th Amor Asteroid *6456 Golombek* closest approach to Earth (1.974 AU)
- 27th Plutino 15875 (*1996 TP66*) at Opposition (29.492 AU)
- 27th History: discovery of the ALH84001 Martian meteorite in the Allan Hills, Far Western Icefield, Antarctica, made famous by the announcement of the discovery of evidence for primitive Martian bacterial life (1984)
- 27th History: Johannes Kepler born, German mathematician and astronomer who postulated that the Earth and planets travel about the sun in elliptical orbits, developed three fundamental laws of planetary motion (1571)
- 28th Apollo Asteroid *2021 AE* near-Earth flyby (0.042 AU)
- 28th Kuiper Belt Object 78799 (*2002 XW93*) at Opposition (45.087 AU)
- 29th First Quarter Moon
- 29th Apollo Asteroid *2008 HU4* closest approach to Earth (1.791 AU)
- 30th Amor Asteroid *13553 Masaakikoyama* closest approach to Earth (2.076 AU)
- 30th Jupiter Trojan *3548 Eurybates* at Opposition (3.802 AU)
- 30th History: flyby of Jupiter by Cassini spacecraft on mission to Saturn (2000)
- 30th History: discovery of Uranus' moon *Puck* by Stephen Synnott (1985)
- 30th History: Army Air Corp Captain Albert William Stevens takes first photo showing the Earth's curvature (1930)
- 31st Apollo Asteroid 136617 (*1994 CC*) (2 Moons) closest approach to Earth (1.308 AU)
- 31st History: GRAIL-A, lunar gravity mapping spacecraft enters orbit (2011)

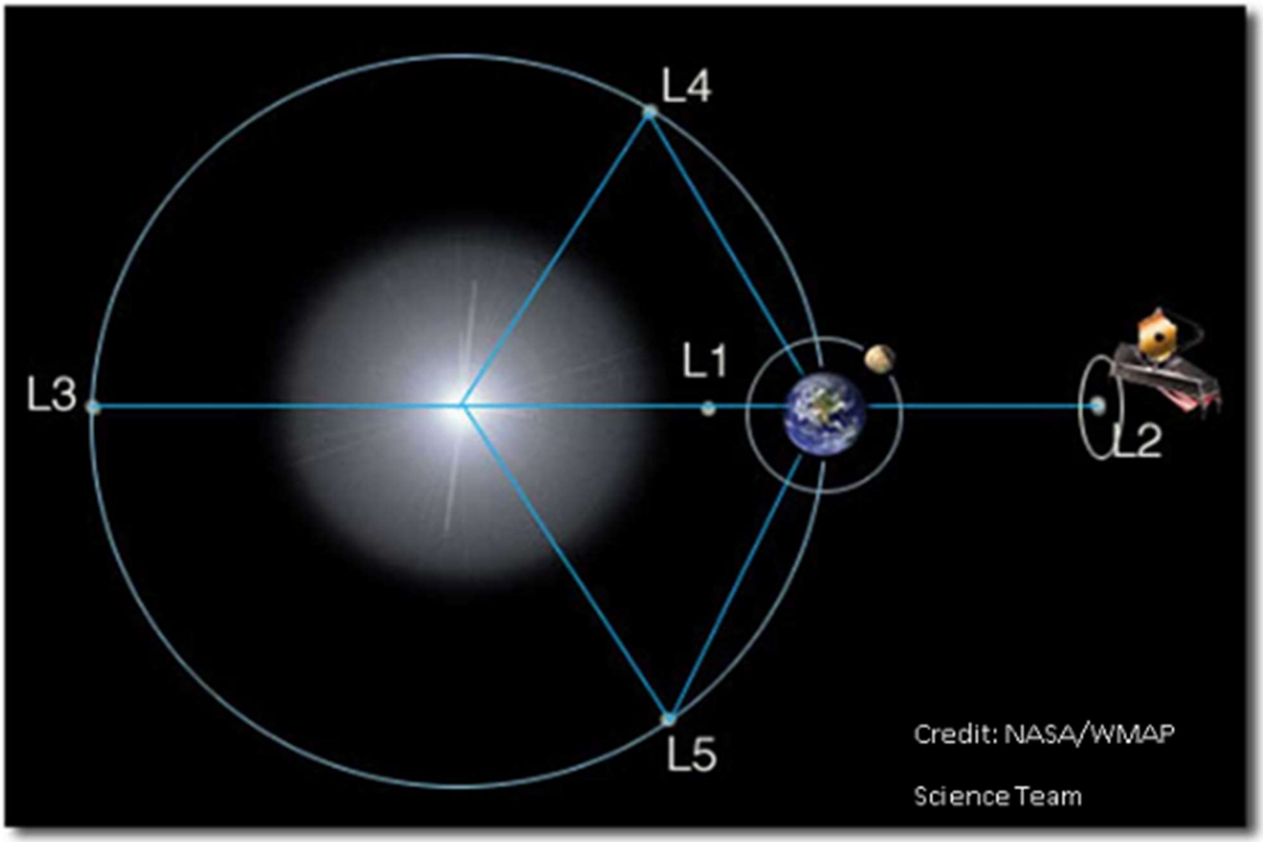
Commonly Used Terms

- 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 future location of the James Webb telescope) is located 1.5 million kilometers beyond the Earth (as viewed from the Sun).

James Webb Space Telescope

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

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, Hubble Space Telescope, artificial satellites and other spacecraft.

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 Helicopter (Ingenuity): https://mars.nasa.gov/technology/helicopter/

Mars Science Laboratory (Curiosity rover): https://mars.nasa.gov/msl/home/

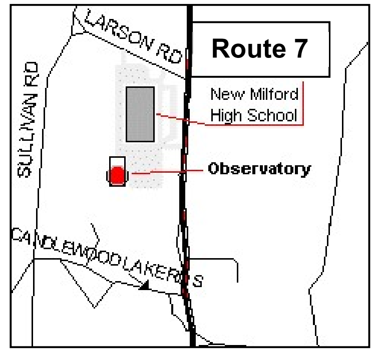
Mars InSight (lander): https://mars.nasa.gov/insight/

Contact Information

The John J. McCarthy Observatory
P.O. Box 1144
New Milford, CT 06776

New Milford High School
388 Danbury Road
New Milford, CT 06776

Phone/Message: (860) 946-0312
www.mccarthyobservatory.org



	www.mccarthyobservatory.org
	@McCarthy Observatory
	@McCarthy Observatory
	mccarthy.observatory@gmail.com
	@JJMObservatory
	@mccarthy.observatory