Galactic Observer

John J. McCarthy Observatory

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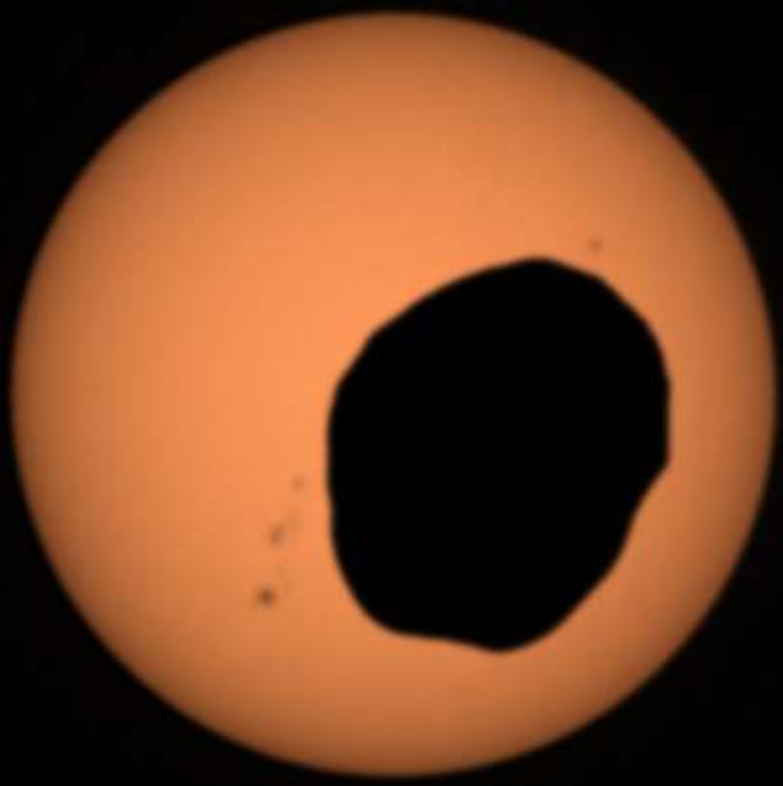


Martian Solar Eclipse

NASA's Perseverance rover recorded the Martian moon Phobos crossing in front of the Sun. The video from which this frame was extracted was recorded by the rover's Mastcam-Z camera and is being used to assess how the moon's orbit is changing over time. It is the most zoomed-in, highest-frame-rate observation of a Martian solar eclipse ever taken.

Credit: NASA/JPL-Caltech/ASU/MSSS/SSI

June Astronomy Calendar and Space Exploration Almanac

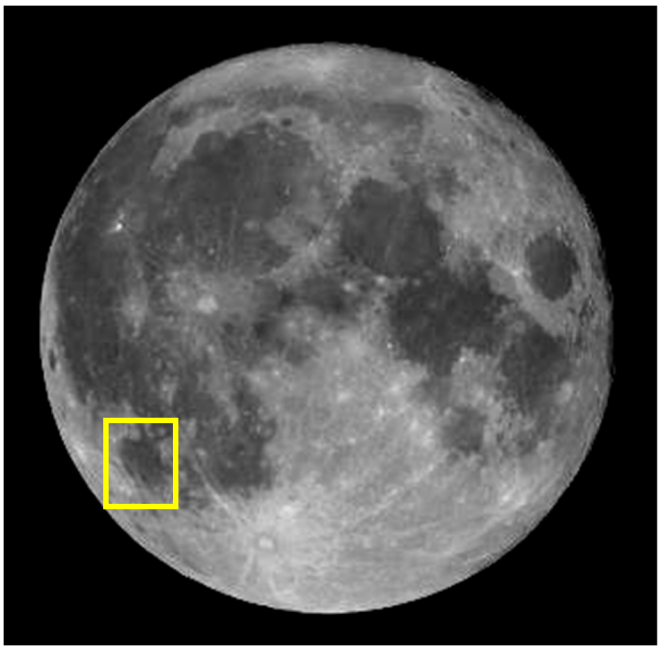
The construction of the neolithic stone circle, Stonehenge, may have been influenced by other cultures according to a new study, as delineated on page 6

In This Issue

"Out the Window on Your Left"

It's been almost 53 years since Neil Armstrong first stepped onto the Moon's surface and more than 49 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).

Mare Humorum, or the "Sea of Moisture," fills a circular impact basin that appears foreshortened into an oval when viewed from Earth. The lava plain has a diameter of about 260 miles (420 km) and is believed to be between 3.85 and 3.92 billion years old.



Location of Mare Humorum

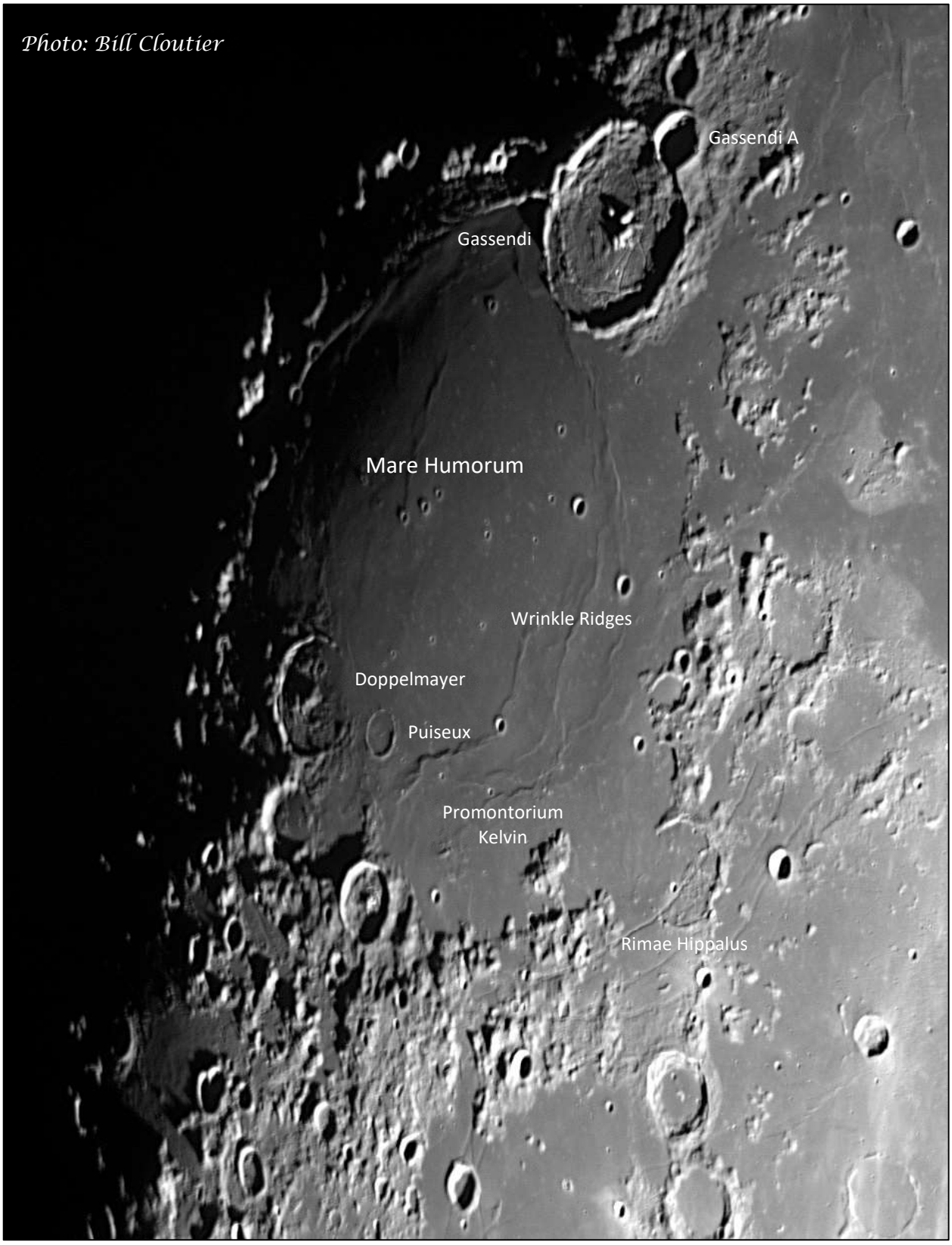
Serpentine ("wrinkle") ridges are visible along the surface of the mare in the early lunar morning, as seen in the image on the following page. The ridges are high enough to cast a shadow in the low-Sun and appear concentric to the edge of the impact basin. The ridges are believed to have formed when the dense mare lava compressed the less dense and underlying anorthosite crust, causing the crust to sag and fracture, and the overlying lava to buckle.

There are a number of small craters and craterlets on the mare floor. Puiseux crater (15.5 miles or 25 km in diameter) is completely flooded with only the top of its rim visible. This is known as a "ghost crater." Along the southern edge of Mare Humorum, the eastern side of the crater Doppelmayer (40 miles or 65 km in diameter) has been breached by mare lavas, indicating that the impact that created the crater occurred after the formation of the Humorum basin but before the subsequent filling by lava. The crater's central peak and western flank are discernable and appear unaffected by the intrusion of the lava.

The 69-mile-wide (111 km) crater Gassendi interrupts the northern reach of the impact basin and is the mare's more prominent feature through a small telescope. Gassendi was considered as one of the three potential landing sites for the Apollo 17 mission. The fractured-floor crater has been partially flooded, is crisscrossed by rilles (channels) and pitted by small impact craters. The group of hills in the center ("central peaks") rise roughly three quarters of a mile (1.2 km) above the floor. A smaller crater, Gassendi A (20 miles or 32 km in diameter), shown in shadow, penetrates the northern wall of the larger.

Other noteworthy features include a rocky outcropping poking through the mare, Promontorium Kelvin, and a series of three arc-shaped rilles (Rimae Hippalus) beyond the eastern shore. These tectonic features formed as the lava that filled the basin cooled and contracted.

Mare Humorum



Flower Moon Lunar Eclipse

The totally eclipsed Moon as seen shortly before midnight on May 15th. The Moon's indirect illumination is from sunlight that is filtered and refracted by the Earth's atmosphere. The red color is due to the shorter wavelengths of light (e.g., blue) being scattered by aerosols in the upper atmosphere. The more abundant the dust and/or clouds, the darker red the Moon will appear. The exceptionally dark appearance of the May eclipse is being attributed to presence of ash from the Tonga volcanic eruption in the atmosphere.

Stonehenge – An Eastern Mediterranean Connection?

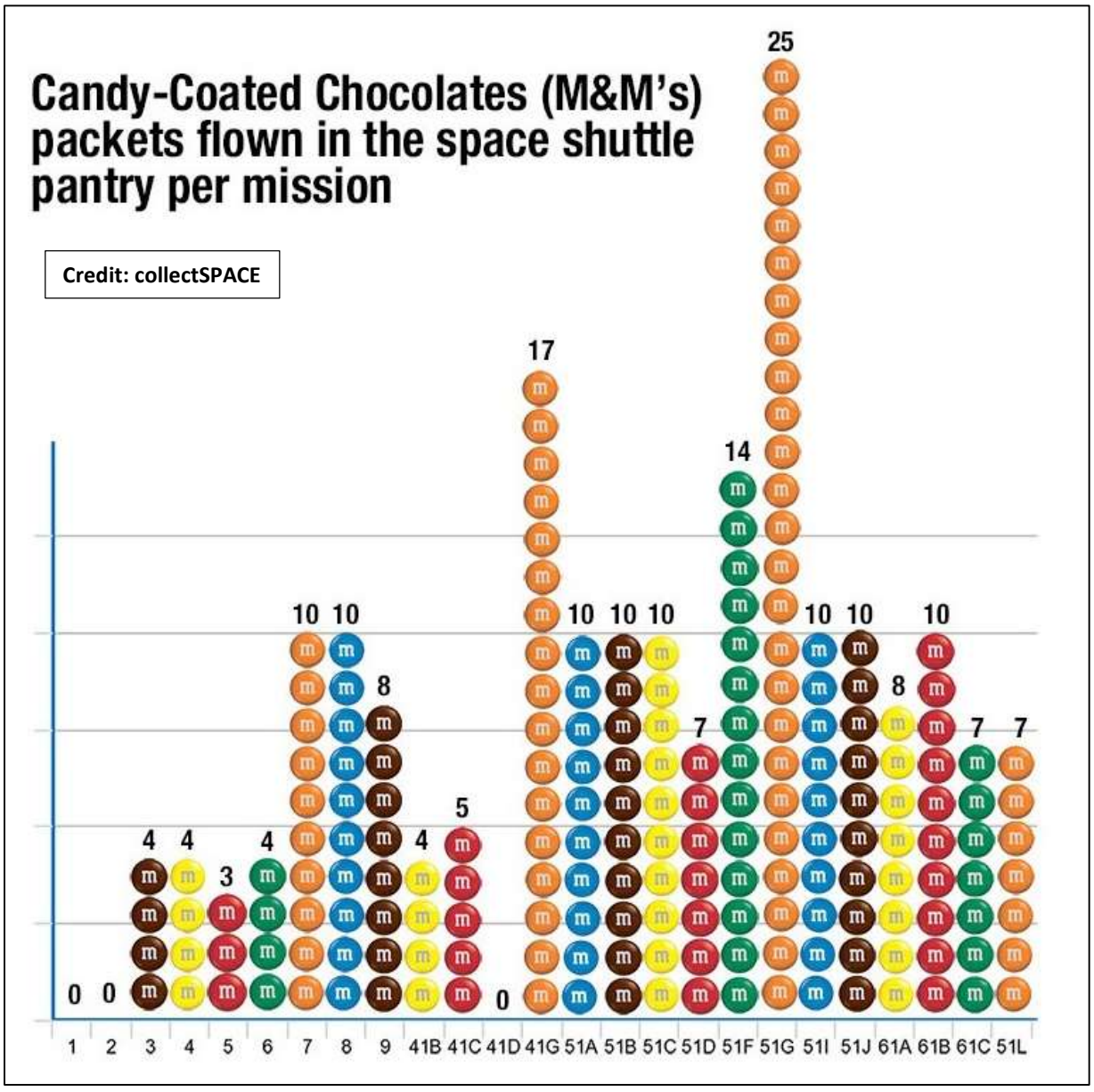
Divining the purpose of this neolithic monument on the Salisbury Plain has puzzled archeologists and scholars alike. Built in its current configuration sometime between 2620 and 2480 B.C., the 5,000-year-old monument is no longer complete with many of the original stones removed or displaced, hindering efforts to uncover the workings of what is believed to be an astronomical calendar.

Professor Timothy Darvill of Bournemouth University, in revisiting the numerology and comparing Stonehenge to other known calendars from this time period, believes that the stone circle may have functioned as a solar calendar. The ancient Egyptians abandoned their lunar calendar in favor of a more precise civil calendar sometime around the first half of the third millennium B.C. The civil calendar consisted of 12 months of 30 days each. Five additional days were added to the end of the year (epagomenals or an intercalary), bringing the total to 365, a number close to the length of the tropical or solar year.

Stonehenge, around that time period, consisted of a circle of 30 large sarsen stones linked with 30 stone lintels (a 12-month progression would yield 360 days). The five pairs of stones inside the circle could have served as the intercalary, and 4 station stones outside the circle as quarter days. Darvill further suggests that the dressing of certain circle stones was used to partition the days into three evenly divided periods, i.e., the 10-day week also used by the Egyptians. The alignment of the monument with the solstices would serve to calibrate the calendar. While we will never know for sure, the mysteries of Stonehenge may be starting to unravel.

Setting a Sweet Record Straight

The space shuttle mission STS-3 was the third in a series of four that constituted the Orbital Flight Test program in the years 1981 and 1982. While science experiments were included in the payload, the primary objective was to assess the performance of the orbiter and its flight systems. STS-3 was the longest of the test flights at eight days in length. It was also the first to fly with an unpainted main fuel tank, to carry out science experiments on the mid-deck of the crew cabin, and the first and only shuttle to land at the White Sands Space Harbor in New Mexico when it returned in March 1982. It was also the first to carry several packages of M&M chocolates in its pantry (despite the candy company's undocumented claim that they were aboard the first shuttle flight).



The candy on STS-3 returned to Earth uneaten. It wasn't until the following mission, STS-4 in June 1982, that the candy was first eaten (one of the four packages). Peanut M&M's were available to the crew on the tenth shuttle mission, STS-41B in 1984, the first mission to include the candy on the astronauts' pre-set menus. M&Ms remain a favorite today on the International Space Station.

Birthday Portrait

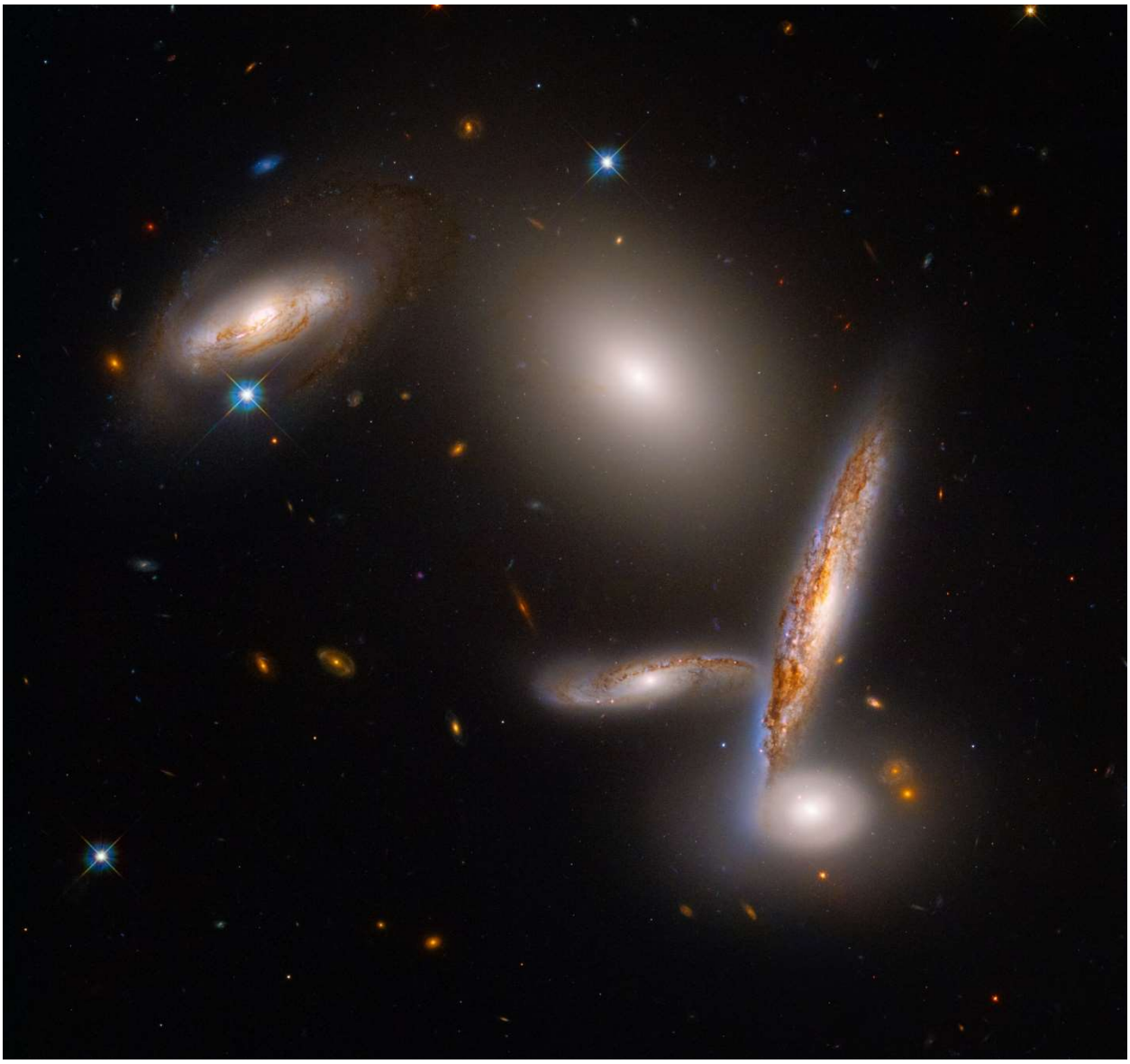


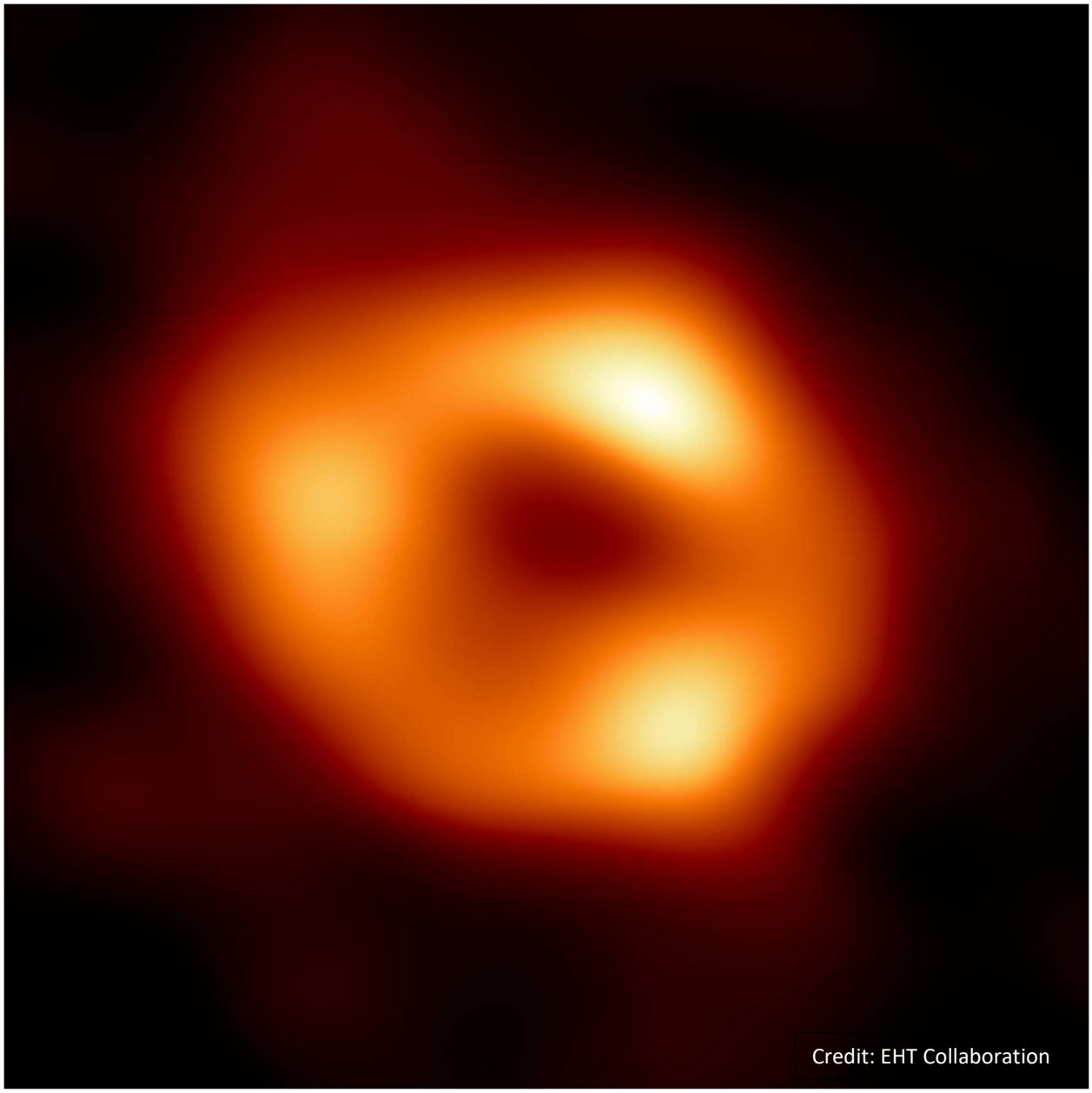
Image Credit: NASA, ESA, STScI; Image Processing: Alyssa Pagan (STScI)

In celebration of the Hubble Space Telescope's 32nd birthday, NASA released an image of the Hickson Compact Group 40. The grouping includes three spiral galaxies, an elliptical galaxy and a lenticular (lens-like) galaxy. The group of galaxies is so compact that they could fit within a volume of space less than twice the diameter of the Milky Way's disk.

Hickson Compact Group 40 is one of the most densely packed galaxy groups found to date (of over 100 such groups catalogued). The galactic menagerie is about 300 million light-years away in the direction of the constellation Hydra. There is evidence that several of the galaxies host a supermassive black hole at their core.

The galaxies are interacting with each other gravitationally and will likely collide in the next billion years to form an enormous elliptical galaxy.

Black Hole Reveal

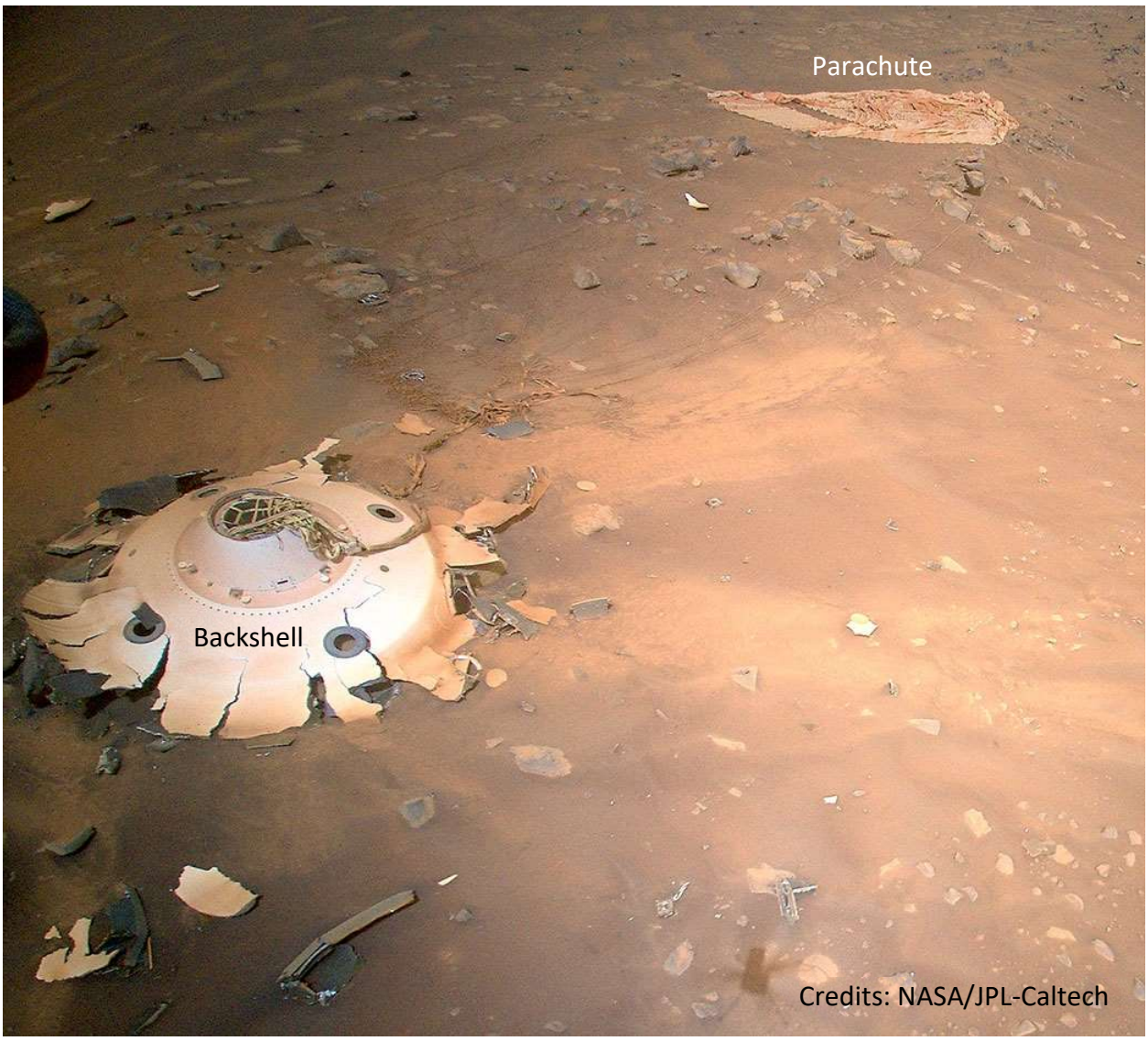


The Event Horizon Telescope (EHT) has released the first image of the black hole at the center of the Milky Way galaxy. To capture the image, eight radio observatories across the globe collaborated to function as an "Earth-sized" virtual telescope. The black hole, called Sagittarius A* or Sgr A*, is approximately 27,000 light years from Earth in the direction of the constellation Sagittarius.

While we can't see the black hole itself, the image reveals the glowing gas orbiting around the dark central region (called a "shadow"). The intense gravity of the black hole, four million times more massive than our Sun, bends the light into a ring-like structure. This is the second black hole imaged by the EHT team. In 2019, they captured the glowing gas around the M87* galactic black hole, one of the largest known at roughly 6.6 billion solar masses, and at a distance of 55 million light years.

Ingenuity the Scout

On April 19, 2022, during its 26th flight, the Mars helicopter named Ingenuity flew over the backshell of the Mars 2020 spacecraft and supersonic parachute that delivered the Perseverance rover to the floor of Jezero crater in February 2021. Ingenuity flew at an altitude of 26 feet (8 meters), and traveled a total distance of 630 feet (192 meters), as it made its way towards the fan-shaped delta and a rendezvous with the Perseverance rover. The flight was planned to gather data on the spacecraft's components that could provide valuable insight for planning future missions.



The backshell and parachute separated from the rover and its jet-powered sky crane about 6 minutes into the 7-minute landing sequence, at an altitude of about 13 miles (21 km) and velocity of 200 mph (322 kph). The backshell impacted the surface at about 78 mph (126 kph).

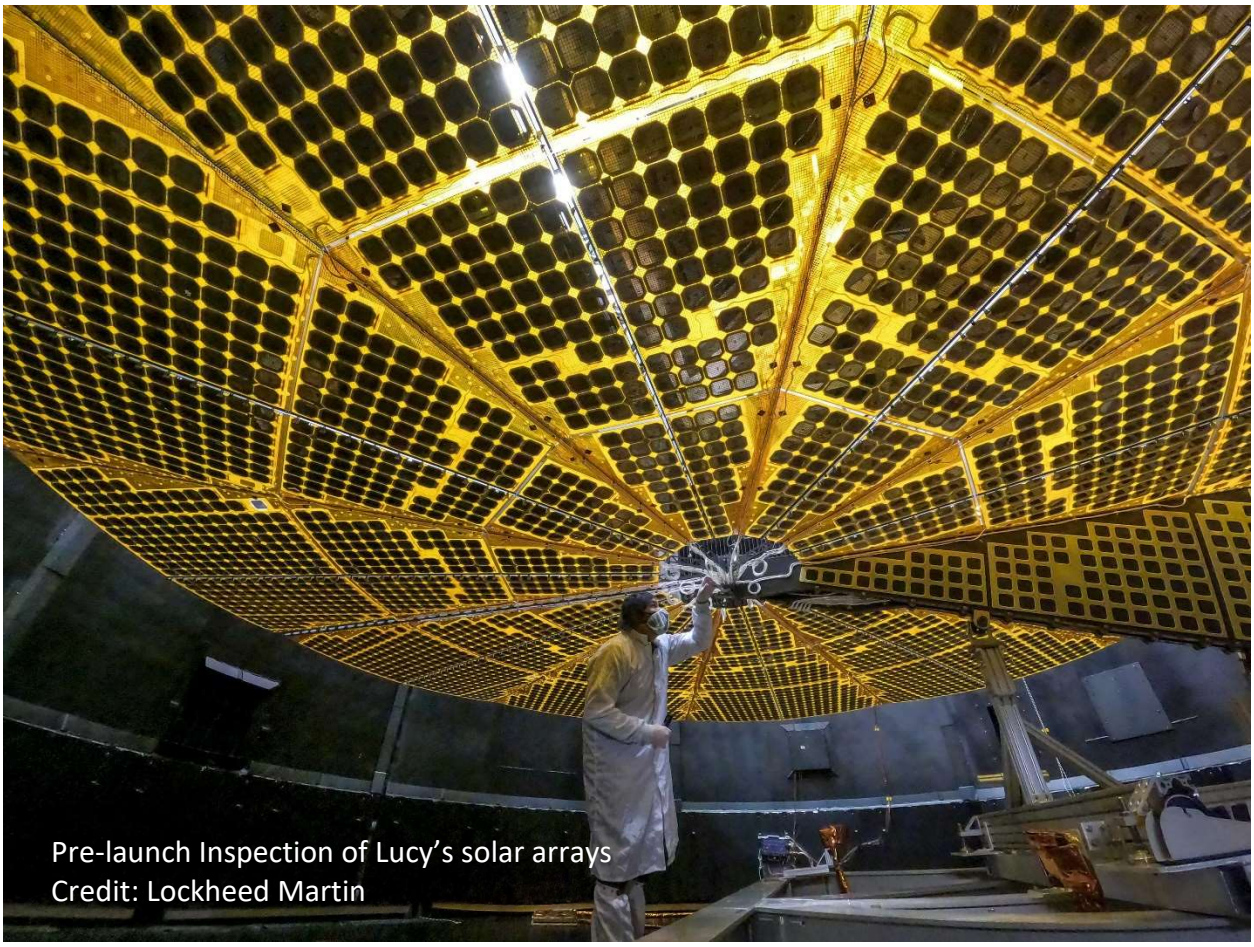
Despite the crash landing, the backshell's protective coating appears to have endured its atmospheric entry. A number of the 80 high-strength suspension lines connecting the backshell to the parachute can be seen in the image and also appear intact. A portion of the orange-and-white parachute (70.5 feet or 21.5 meters in diameter), lies a distance from the backshell on the dusty surface. It too appears to have survived supersonic inflation (at roughly 1,000 mph or 1,600 kph).

Lucy Update

NASA's Lucy mission was successfully launched on October 16, 2021. The twelve-year, 4-billion-mile (6.4 billion km) mission will visit eight asteroids – one main belt and seven Jupiter Trojan asteroids located at the L4 and L5 Lagrange points along the gas giant's orbit (roughly 60° in front and behind the planet). Astronomers believe that the Trojan asteroids are relics from a time over 4 billion years ago when the first protoplanets were accreting from within the solar nebula and, as such, are time capsules that may provide insight into the planet-building process.

The spacecraft is powered by two large arrays of solar cells, each over 24 feet (almost 7 meters) in diameter. They were designed to unfold and latch into place after launch using a small motor to reel in a lanyard attached to both ends of the folded solar array. However, only one of the arrays fully opened as planned, the other stopped just short of completing this operation (about 345° out of the full 360°).

While the arrays are currently supplying ample energy for the spacecraft, engineers are concerned about the integrity of the partially-deployed panel during a main engine burn. Based upon ground tests, the project team estimates that 20 to 40 inches (51 to 102 cm) of the lanyard remains to be retracted for latching. On May 9th, both the primary and secondary lanyard motors were engaged for a short run. Engineers are now viewing the data. If the motors performed as anticipated, a latching will be attempted in early June.



Pre-launch Inspection of Lucy's solar arrays
Credit: Lockheed Martin

Remembering "Oppy"

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

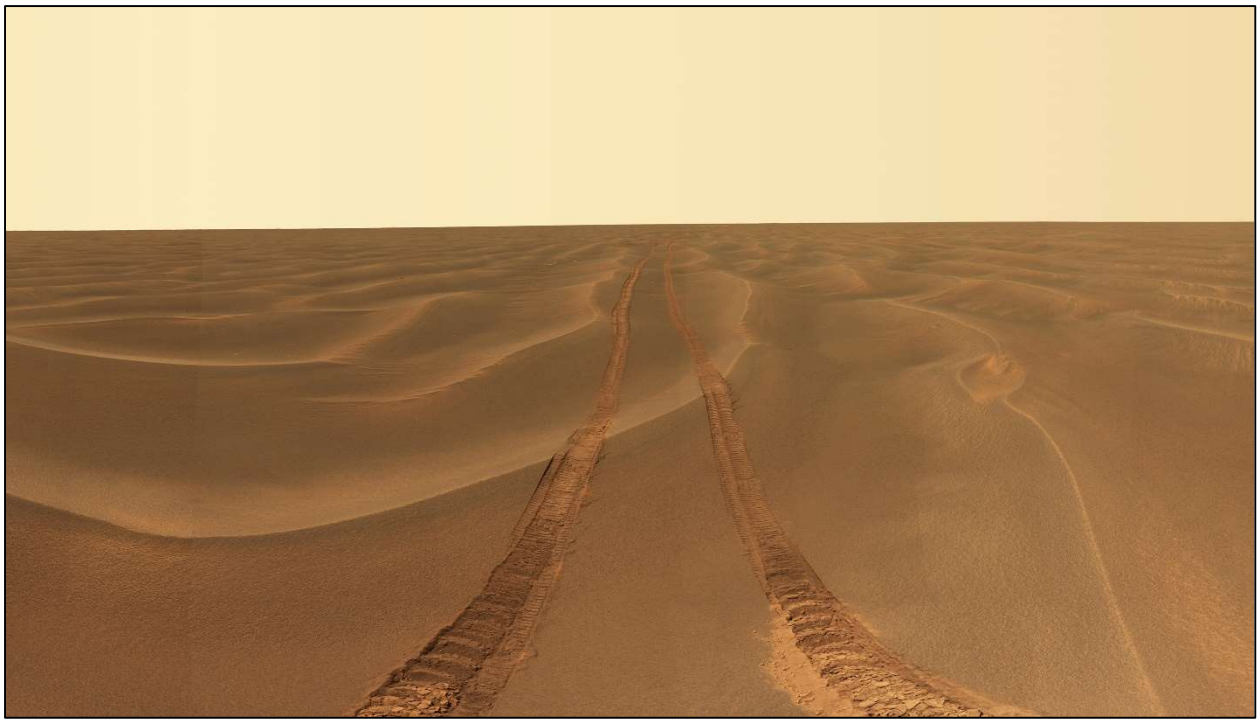
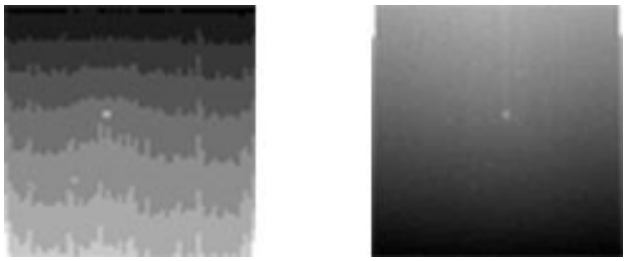


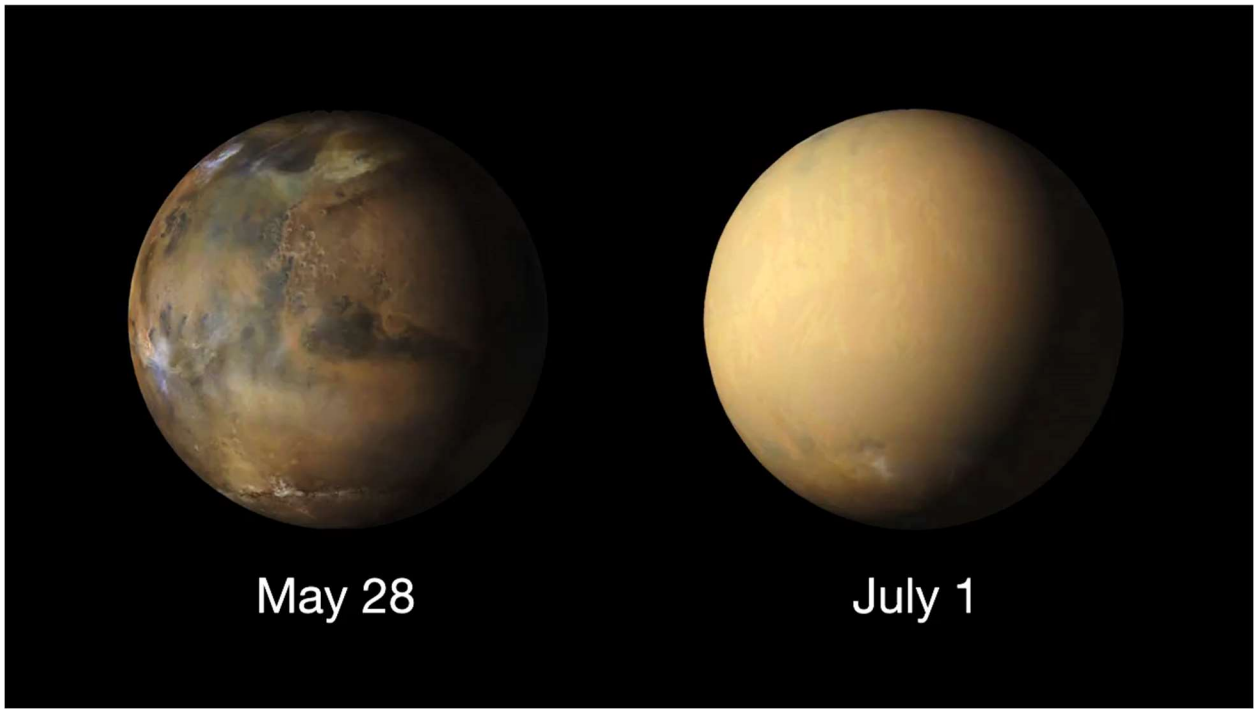
Image Credit: NASA/JPL-Caltech/Cornell Univ./Arizona State Univ.

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

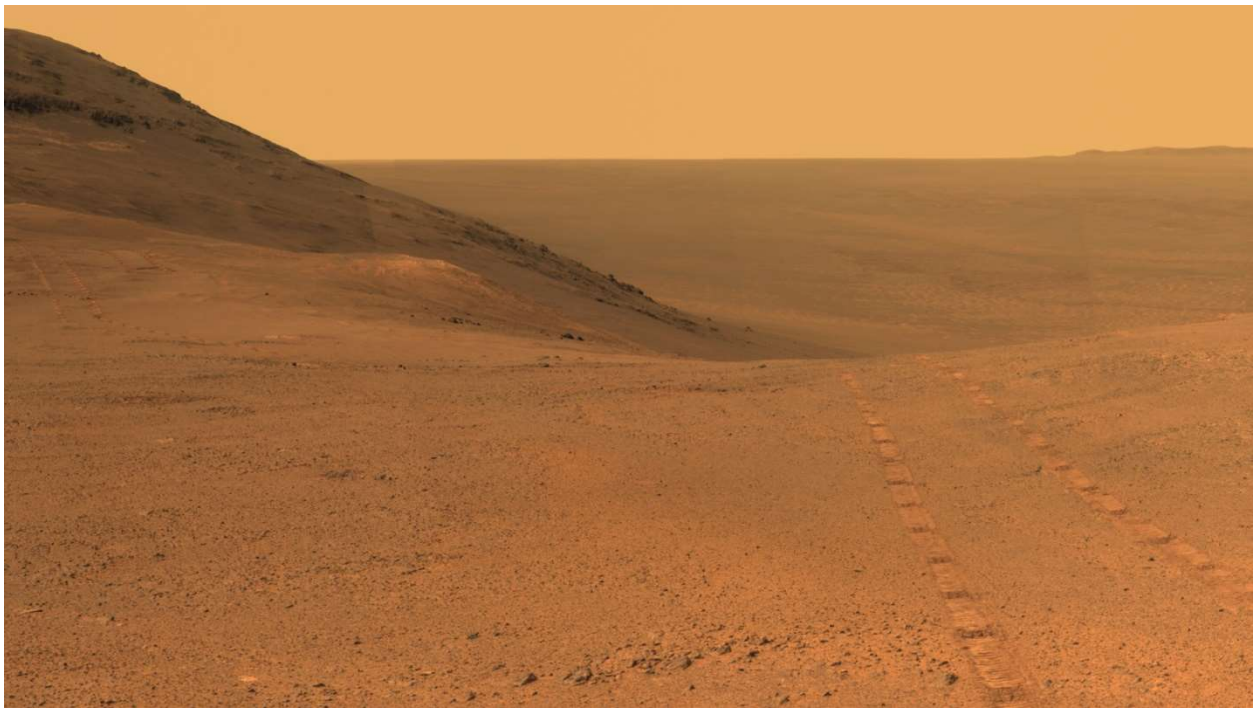


Credit: NASA/JPL-Caltech/Cornell/ASU

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



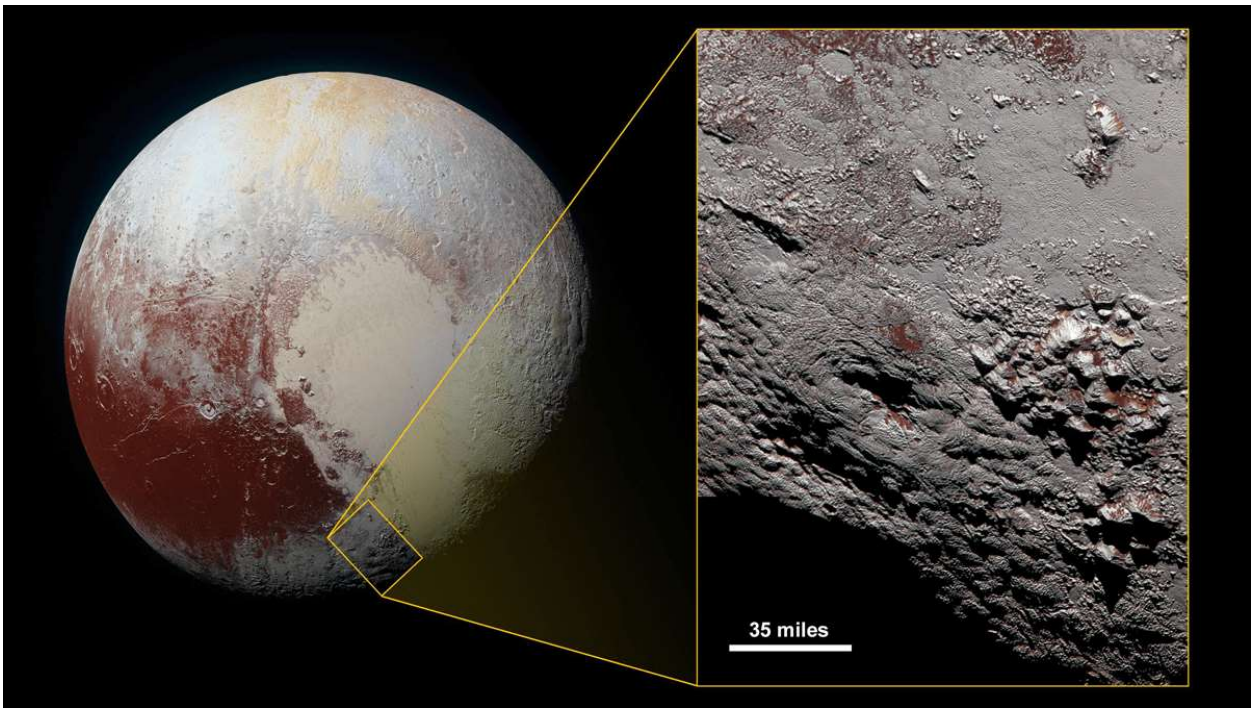
Development of the 2018 global dust storm, courtesy of the Mars Color Imager (MARCI) camera onboard NASA's Mars Reconnaissance Orbiter (MRO).
Image Credit: NASA/JPL-Caltech/MSSS



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

Icy Volcanoes

Seven years and two billion miles later, the data returned by New Horizons on its close flyby of Pluto continues to yield surprises. Scientists on NASA's New Horizons mission team have been studying geological structures on the diminutive world that are unique in the solar system.



Credit: NASA/Johns Hopkins University Applied Physics Laboratory/Southwest Research Institute/Isaac Herrera/Kelsi Singer

The area of interest is located southwest of Pluto's bright, icy "heart," Sputnik Planitia. The region appears to have been created by multiple episodes of cryovolcanism which extruded large amounts of water-rich material onto the surface. The area is geologically young with a scarcity of craters, suggesting that Pluto's interior retained its heat over much of its lifetime – completely unexpected for a tiny, frozen world so far from the Sun.

The cryovolcanic region contains multiple large domes, ranging from about one-half to 4 miles (1 to 7 km) in height and 18 to 60 miles or more (30 to 100 km) across. In some instances, the domes merge to form more complex structures. Hummocky terrain (interconnected hills, mounds and depressions) blanket the area.

Wright Mons
Image credit: NASA/JHUAPL/SwRI.

Wright Mons, if truly an ice volcano, would be the largest such feature discovered in the outer solar system at about 90 miles (150 km) across and 2.5 miles (4 km) high.

Decadal Survey

The planetary science decadal survey is a report prepared by the National Academy of Sciences, Engineering, and Medicine at the request of NASA every 10 years. In the report, the committee of leading planetary scientists presents their consensus opinions on those scientific questions that could be answered by future NASA missions. The most recent decadal survey, "Origins, Worlds, and Life: A Decadal Strategy for Planetary Science and Astrobiology 2023-2032," was released in April. The work product provides a rationale for funding priorities and for defending the agency's budget requests.

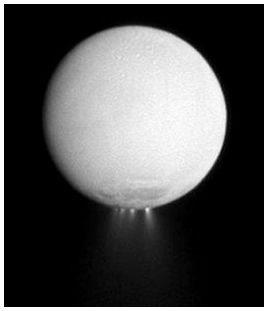
The report contains several different types of endorsements. Continued funding for the Mars Sample Return mission was strongly recommended (as long as the cost is kept under control so as not to undermine other endeavors). The mission would collect, and return to Earth, the samples being collected in Jezero crater by the Perseverance rover. Closer to home, the committee endorsed a medium-class Endurance-A lunar rover mission that would explore the South Pole Aiken basin, collect about 100 kg of samples for return to Earth by future visiting astronauts. The mission would be coordinated with NASA's Artemis program for human exploration of the Moon.

Planetary science via robotic exploration was identified as needing addition investment and a strong and steady commitment. NASA was encouraged to pursue low-cost Discovery and mid-level cost New Frontier missions to address high-priority science objectives. Suggested missions include a Ceres sample return, comet sample return, Enceladus (Saturn moon) multiple flyby, Saturn probe, Titan (Saturn moon) orbiter and Triton (Neptune moon) ocean world surveyor.

For Flagship missions, the committee prioritized a mission to Uranus, an ice giant briefly visited by the Voyager spacecraft in a 1986 flyby. A multi-year orbital tour of the Uranian system was suggested along with an atmospheric probe. The second-highest priority was for an Enceladus Orbitlander. The diminutive moon of Saturn was discovered to not only have an internal ocean, but active plumes of icy material erupting from a subsurface reservoir.

NASA would require a budget increase to adopt the committee's full slate of proposed missions. If the current funding is maintained, it would likely result in lower dollars committed to research and analysis, fewer New Frontier missions, a several year delay in the Uranus Orbiter and deferral of the Enceladus Orbitlander beyond this decade.

Planetary defense was also deemed a priority with a recommendation for a fly-by mission to a near-Earth object in the 50-to-100-meter diameter class which poses the highest probability of a destructive Earth impact.



L to R: Perseverance, Uranus and Enceladus Credits: NASA/JPL-Caltech/MSSS, NASA/JPL-Caltech, NASA/JPL/Space Science Institute

Europa Clipper News

NASA has started to assemble its spacecraft for the Europa Clipper flagship mission to Jupiter's icy moon. The main body of the spacecraft was designed and is being assembled by the Johns Hopkins Applied Physics Laboratory in Laurel, Maryland, with help from NASA's Goddard Space Flight Center in Greenbelt, Maryland. The 10-foot-tall (3-meter-tall) propulsion module unit, fitted with electronics, cabling, and subsystems, will be shipped to the agency's Jet Propulsion Laboratory (JPL) in Southern California for installation of the nine science instruments, the 10-foot-wide (3-meter-wide) high-gain antenna, and the remaining flight hardware. JPL will also install the massive solar arrays (spanning about 100 feet or 30 meters) needed to power the spacecraft during its journey to Jupiter and while operating so far from the Sun. Once fully assembled, the spacecraft will undergo a rigorous testing program, including exposure to space-like conditions in JPL's thermal vacuum chamber, and vibration testing (launch simulation) before being shipped to Cape Canaveral, Florida for an October 2024 launch.

Clockwise from left: the propulsion module for NASA's Europa Clipper, the ultraviolet spectrograph (called Europa-UVS), the high-gain antenna, and an illustration of the spacecraft. Credit: NASA/JPL-Caltech / Johns Hopkins APL

Since Europa orbits within Jupiter's harsh radiation belts, the spacecraft will be placed into a looping orbit around Jupiter and conduct multiple close flybys of the moon, which is slightly smaller than Earth's moon. This will minimize the time spent in the radiation field around Europa, and damage to the electronics, as it gathers data on the moon's atmosphere, surface, and interior. Expectations are for the Europa Clipper to conduct 45 or more flybys during the primary mission, as it comes as close as 16 miles (25 kilometers) above the surface.

Scientists are confident that Europa harbors an internal ocean with twice the amount of water in Earth's oceans combined. While not a life-detection mission, the spacecraft's instruments should be able to assess whether the icy moon has the capability to support life.

Milky Way Season

The core of the Milky Way rises around 10 pm (EDT) in the days round the New Moon on June 28th. Look to the southeast with the brightest star clouds appearing between the constellations Sagittarius and Scorpius. The faint stream of stars, that defines our galaxy seen edge-on, can be traced from Sagittarius, though Cygnus and beyond to Cassiopeia in the north.

June History

Women in Space

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

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

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

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

An Extraordinary Feat

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

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

On June 3, 1965, Gemini 4 lifted off on a four-day mission. The highlight of the mission was to be a spacewalk by Ed White. NASA was very concerned with "putting guys in vacuums with nothing between them but that little old lady from Worcester, Massachusetts [the seamstress at the David Clark Company], and her glue pot and that suit." However, the Soviets had challenged the United States with a spacewalk by Cosmonaut Alexei Leonov in March during a Voskhod II mission, and the United States did not want to appear to be falling behind its adversary.
After struggling with a faulty hatch, Ed White finally exited the spacecraft as it passed over the Pacific Ocean. Using a gun powered by compressed oxygen, he was able to maneuver outside the capsule, just avoiding the flaming thrusters of the Gemini capsule. After a 23-minute spacewalk, Jim McDivitt struggled to get the six-foot-tall Ed White back inside the capsule and close the balky door.

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

Sunrise and Sunset (from New Milford, CT)

Sun	Sunrise	Sunset
June 1st (EDT)	05:22	20:21
June 15th	05:18	20:29
June 30th	05:22	20:31

Astronomical and Historical Events

1st Moon at apogee (furthest distance from Earth)
1st Parker Solar Probe, 12th Perihelion (closest approach to the Sun at 5.8 million miles)
1st Apollo Asteroid *2020 DA4* near-Earth flyby (0.014 AU)
1st Amor Asteroid *3199 Nefertiti* closest approach to Earth (2.007 AU)
1st History: final landing of Space Shuttle Endeavour (STS-134) (2011)
1st History: launch of the ROSAT (Röntgen) X-ray observatory; cooperative program between Germany, the United States, and United Kingdom; among its many discoveries was the detection of X-ray emissions from Comet Hyakutake (1990)
1st History: Founding of the Caltech Rocket Research Group (precursor to the Jet Propulsion Laboratory) (1936),
2nd Kuiper Belt Object 2010 JO179 at Opposition (59.059 AU)
2nd History: founding of the Baikonur Cosmodrome, Kazakhstan (Soviet and Russian launch complex) (1955)
2nd History: launch of the Mars Express spacecraft and ill-fated Beagle 2 lander (2003)
2nd History: launch of the Space Shuttle Discovery (STS-91); ninth and final Mir docking (1998)
2nd History: launch of Soviet Venus orbiter Venera 15; side-looking radar provided high resolution mapping of surface in tandem with Venera 16 (1983)

Astronomical and Historical Events (continued)

2nd History: Surveyor 1 lands on the Moon (1966)
2nd History: Gemini 5, Gemini 11, Apollo 12 and Skylab 2 astronaut Pete Conrad born (1930)
2nd History: discovery of Comet Donati by Italian astronomer Giovanni Battista Donati; brightest comet of the 19th century and first comet to be photographed (1858)
3rd Scheduled launch of a Russian Progress cargo-carrying spacecraft from the Baikonur Cosmodrome, Kazakhstan to the International Space Station 81P
3rd Plutino 469987 (*2006 HJ123*) at Opposition (31.848 AU)
3rd History: discovery of two rings around the centaur asteroid 10199 *Chariklo*, the smallest known object to have rings (2013)
3rd History: discovery of Jupiter impact event by Anthony Wesley (2010)
3rd History: launch of Gemini 9 with astronauts Thomas Stafford and Eugene Cernan (1966)
3rd History: launch of Gemini 4; Ed White becomes first American to walk in space (1965)
3rd History: dedication of the 200-inch Hale Telescope at Palomar Mountain (1948)
4th Amor Asteroid *887 Alinda* closest approach to Earth (2.573 AU)
4th History: maiden flight of SpaceX's Falcon 9 rocket; launched from Cape Canaveral, Florida (2010)
4th History: discovery of Classical Kuiper Belt Object 50000 *Quaoar* by Mike Brown and Chad Trujillo from images acquired at the Samuel Oschin Telescope at Palomar Observatory (2002)
5th Plutino 470308 (*2007 JH43*) at Opposition (39.530 AU)
6th Scheduled launch of NASA's Cislunar Autonomous Positioning System Technology Operations and Navigation Experiment, or CAPSTONE, mission to the Moon aboard a Rocket Lab Electron rocket from the Mahia Peninsula, New Zealand
6th Aten Asteroid *2021 GT2* near-Earth flyby (0.024 AU)
6th Apollo Asteroid *66391 Moshup* closest approach to Earth (0.436 AU)
6th Atira Asteroid 459883 (*2014 JX25*) closest approach to Earth (1.419 AU)
6th History: launch of Soviet Venus orbiter Venera 16; side-looking radar provided high resolution mapping of surface in tandem with Venera 15 (1983)
7th First Quarter Moon
7th Scheduled launch of a SpaceX Falcon 9 rocket with a Dragon 2 cargo-carrying spacecraft from the Kennedy Space Center, Florida to the International Space Station. Fifth cargo resupply mission under a Commercial Resupply Services contract with NASA
8th Plutino *38628 Huya* at Opposition (27.909 AU)
8th History: New Horizons spacecraft, on its way to Pluto, crosses the orbit of Saturn (2008)
8th History: discovery of Nova Aquila; a supernova explosion from the collapse of a white dwarf (1918)
8th History: launch of Soviet Venus orbiter/lander Venera 9; transmitted the first black and white images of the surface of Venus (1975)
8th History: Giovanni Cassini born, observer of Mars, Jupiter and Saturn (1625)
9th Comet *8P/Tuttle* at Opposition (2.616 AU)
9th Apollo Asteroid *2018 LU2* near-Earth flyby (0.038 AU)
9th Atira Asteroid *2021 BS1* closest approach to Earth (1.391 AU)
9th Amor Asteroid *4503 Cleobulus* closest approach to Earth (2.467 AU)
9th History: Abee meteorite fall in Canada (1952)
9th History: dedication of the Kathleen Fischer Sundial at the McCarthy Observatory (2012)

Astronomical and Historical Events (continued)

10th Kuiper Belt Object 278361 (*2007 JJ43*) at Opposition (39.732 AU)
10th History: launch of Mars Exploration Rover A (Spirit) in 2003
10th History: launch of Explorer 49, Moon orbiter and radio astronomy explorer (1973)
11th History: flyby of Venus by Soviet spacecraft Vega 1 on its way to Comet Halley; dropped off lander and a balloon to study middle cloud layers (1985)
12th Apollo Asteroid *2006 XW4* near-Earth flyby (0.015 AU)
12th Aten Asteroid *2014 OL339* closest approach to Earth (0.312 AU)
12th Kuiper Belt Object *2010 KZ39* at Opposition (44.859 AU)
12th History: launch of Venera 4, Soviet Venus lander; first to enter atmosphere of another planet (1967)
13th History: return of the sample capsule from the Hayabusa (MUSES-C) spacecraft (2010)
14th Full Moon (Strawberry Moon and Supermoon)
14th Moon at perigee (closest distance from Earth)
14th Comet *73P-AM/Schwassmann-Wachmann* near-Earth flyby (0.071 AU)
14th Atira Asteroid *2018 JB3* closest approach to Earth (0.568 AU)
14th History: launch of a V-2 rocket carrying a rhesus monkey (Albert II) – monkey survived flight and successfully transmitted biomedical data, but died on impact when parachutes failed to open (1949)
14th History: first radar astrometry for an asteroid from Goldstone and Haystack antennae observations of the asteroid 1566 *Icarus* (1968)
14th History: launch of Mariner 5; Venus flyby mission (1967)
14th History: launch of Venera 10; Soviet Venus orbiter/lander (1975)
15th History: flyby of Venus by Soviet spacecraft Vega 2 on its way to Comet Halley; dropped off lander and a balloon to study middle cloud layers (1985)
16th Mercury at its Greatest Western Elongation (23°) – greatest separation from the Sun in the morning sky
16th Comet *337P/WISE* closest approach to Earth (0.674 AU)
16th Kuiper Belt Object *174567 Varda* at Opposition (45.237 AU)
16th History: Liu Yang becomes the first Chinese woman in space aboard a Shenzhou-9 spacecraft, joining two other crew members on a thirteen-day mission to the orbiting Tiangong 1 laboratory module (2012)
16th History: Valentina Tereshkova; first woman in space aboard Soviet Vostok 6 (1963)
17th Apollo Asteroid *3361 Orpheus* closest approach to Earth (0.462 AU)
18th History: launch of the Lunar Reconnaissance Orbiter (LRO) and Lunar CRater Observation and Sensing Satellite (LCROSS) to the Moon (2009)
18th History: Sally Ride becomes the first American woman in space aboard the Space Shuttle Challenger (1983)
19th Asteroid "Boblambert," named for one of the founders of the John J. McCarthy Observatory, closest approach to Earth (1.97 au)
19th Atira Asteroid *2021 PH27* closest approach to Earth (0.948 AU)
19th History: discovery of the potentially hazardous asteroid (PHA) 99942 *Apophis* – on April 13, 2029, the asteroid will pass within 19,000 miles (31,000 km) of the Earth (2004)
19th History: flyby of Earth by the ill-fated Nozomi spacecraft on its way to Mars (2003)
20th Last Quarter Moon
20th Apollo Asteroid *9162 Kwiila* closest approach to Earth (1.086 AU)

Astronomical and Historical Events (continued)

20th History: successful landing of the Viking 1 spacecraft on Mars' Chryse Planitia (Plains of Gold) (1976)
20th History: discovery of Nova 1670 in Vulpeculae (1670)
21st Summer Solstice at 5:14 a.m. EDT (09:14 UT)
21st Comet *73P-AM/Schwassmann-Wachmann* perihelion (0.971 AU)
21st History: SpaceShipOne makes first privately funded human spaceflight (2004)
22nd History: launch of Soviet space station Salyut 5 (1976)
22nd History: founding of the Royal Greenwich Observatory (1675)
22nd History: discovery of Pluto's largest moon *Charon* by Jim Christy (1978)
23rd Amor Asteroid *20460 Robwhiteley* closest approach to Earth (0.483 AU)
24th Eight planets visible in the morning sky
24th Atira Asteroid 413563 (*2005 TG45*) closest approach to Earth (0.297 AU)
24th Atira Asteroid 481817 (*2008 UL90*) closest approach to Earth (0.587 AU)
24th Plutino *28978 Ixion* at Opposition (37.463 AU)
24th History: launch of the Salyut 3 Soviet space station (1974)
24th History: Fred Hoyle born; British astronomer and proponent of nucleosynthesis (1915)
24th History: Sir William Huggins makes first photographic spectrum of a comet (1881)
25th Apollo Asteroid *5011 Ptah* closest approach to Earth (1.352 AU)
25th History: Rupert Wildt born, German-American astronomer and first to hypothesize that the CO_2 in the Venusian atmosphere was responsible for the trapped heat (1905)
25th History: Hermann Oberth born, father of modern rocketry and space travel (1894)
26th Apollo Asteroid *2015 WP2* near-Earth flyby (0.047 AU)
26th History: Discovery of Saturn's moons Surtur, Jarnsaxa, Greip and Loge (2006)
26th History: Charles Messier born, famed comet hunter (1730)
27th Amor Asteroid *481984 Cernunnos* closest approach to Earth (0.753 AU)
27th History: discovery of the Mars meteorite SAU 060, a small 42.28 g partially crusted grey-greenish stone found near Sayh al Uhaymir in Oman (2001)
27th History: flyby of the asteroid *Mathilde* by the NEAR spacecraft (1997)
27th History: Space Shuttle Atlantis (STS-71) first docking with the Russian space station Mir (1995)
27th History: launch of SEASAT, the first Earth-orbiting satellite designed for remote sensing of the Earth's oceans (1978)
27th History: Alexis Bouvard born, French astronomer, director of Paris Observatory, postulated existence of eighth planet from discrepancies in his astronomical tables for Saturn and Uranus. Neptune was subsequently discovered by John Couch Adams and Urbain Le Verrier after his death where he had predicted (1767)
28th New Moon
28th Kuiper Belt Object *50000 Quaoar* at Opposition (41.743 AU)
28th History: discovery of Pluto's moon *Kerberos* by Mark Showalter, et al., using the Hubble Space Telescope (2011)
28th History: Nakhla meteorite fall in Egypt (Mars meteorite), a piece of which was claimed to have vaporized a dog; first direct evidence of aqueous processes on Mars (1911)
29th Moon at apogee (furthest distance from Earth)
29th Centaur Object *5145 Pholus* at Opposition (28.748 AU)
29th History: George Ellery Hale born, founding father of the Mt. Wilson Observatory (1868)
30th History: the Cassini-Huygens spacecraft enters orbit around Saturn (2004)

Astronomical and Historical Events (continued)

30th History: discovery of *Haume*a's moon *Namaka*, the smaller, inner moon of the dwarf planet, by Mike Brown, Chad Trujillo, David Rabinowitz, et al. (2005)
30th History: crew of Soyuz 11 dies upon return from the Salyut space station when capsule depressurizes (1971)
30th History: Tunguska Explosion Event (1908)

Commonly Used Terms

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

References on Distances

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

International Space Station and Artificial Satellites

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

Solar Activity

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

NASA's Global Climate Change Resource

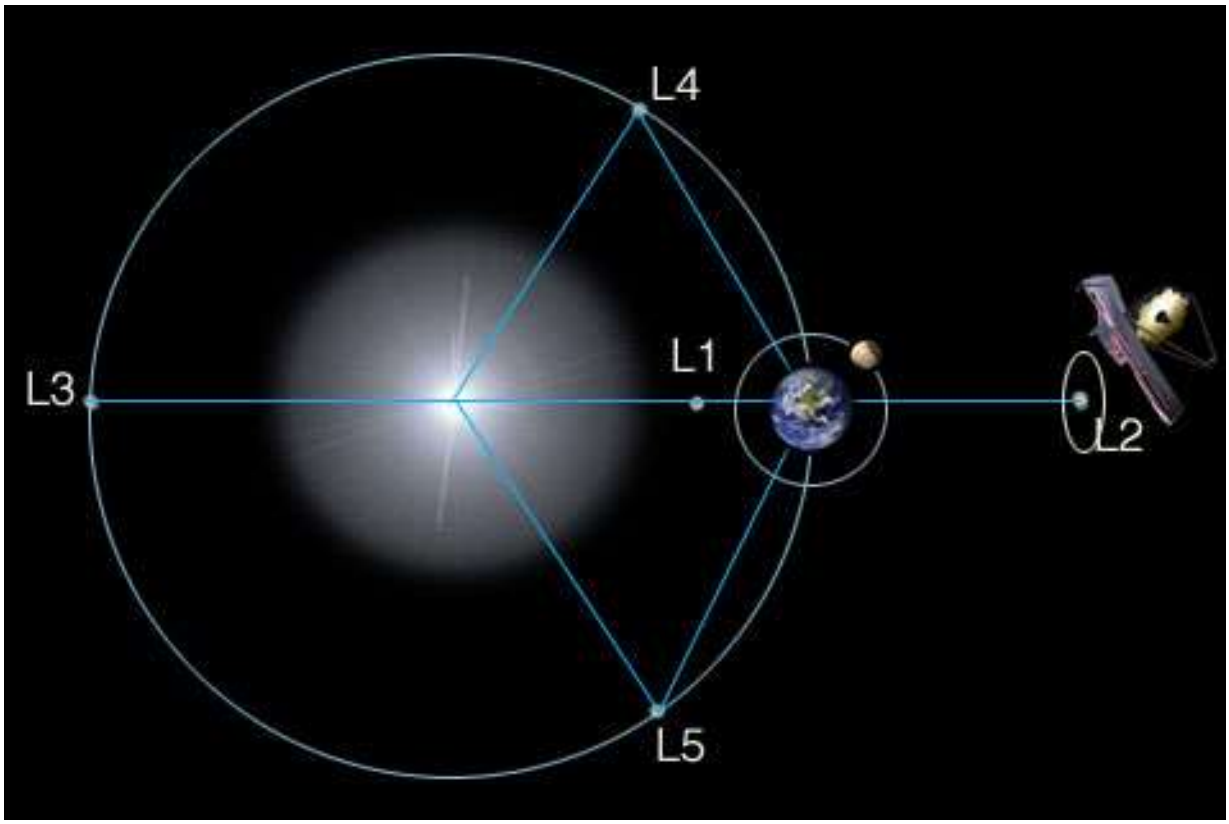
- Vital Signs of the Planet: https://climate.nasa.gov/

Mars – Mission Websites

- Mars 2020 (Perseverance rover): https://mars.nasa.gov/mars2020/
- Mars Helicopter (Ingenuity): https://mars.nasa.gov/technology/helicopter/
- Jezero Crater map: https://mars.nasa.gov/mars2020/mission/where-is-the-rover/
- Mars Science Laboratory (Curiosity rover): https://mars.nasa.gov/msl/home/
- Mars InSight (lander): https://mars.nasa.gov/insight/

Lagrange Points

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



James Webb Space Telescope

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

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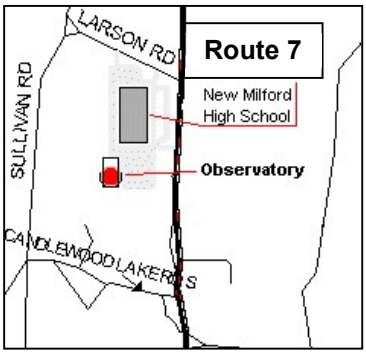

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