Galactic Observer

John J. McCarthy Observatory

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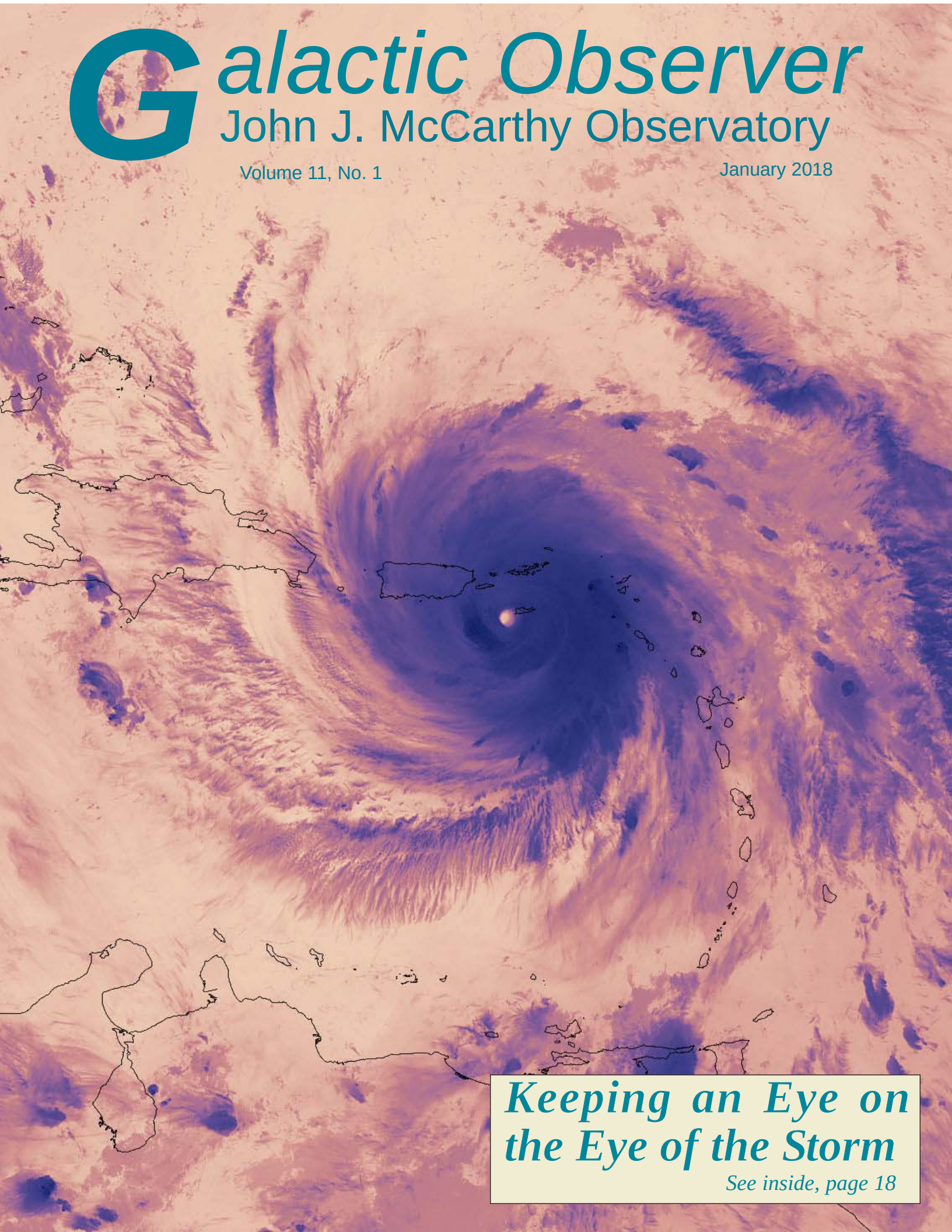

Keeping an Eye on the Eye of the Storm

See inside, page 18

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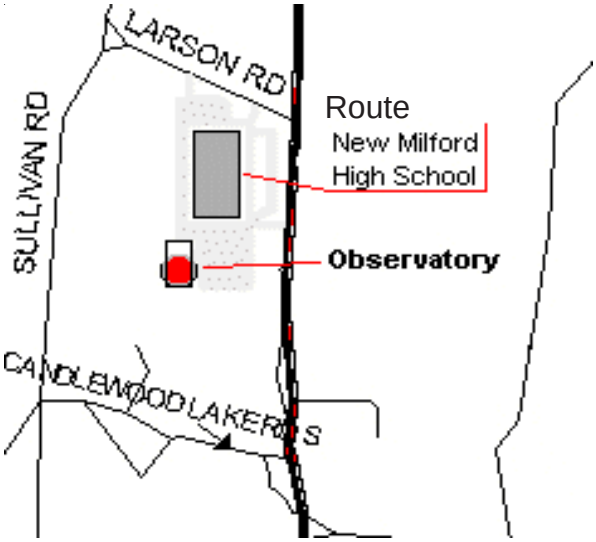


In This Issue

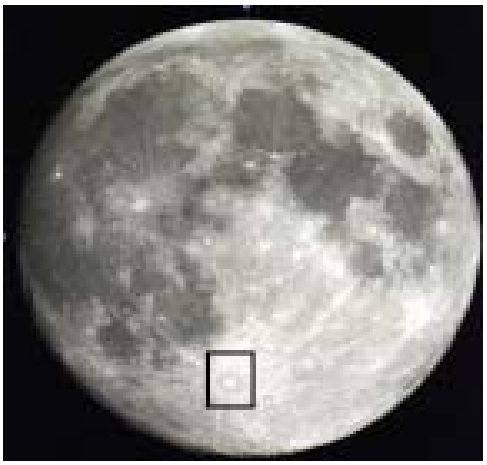
January Astronomy Calendar and Space Exploration Almanac

The Full Moon on December 3rd (above) was the first of three consecutive "supermoons." A supermoon occurs when the Moon is both full and closest to the Earth (the Moon's elliptical orbit varies by 30,000 miles or 50,000 km in its distance from Earth). Supermoons can appear 14% larger and 30% brighter (at perigee) than when at its most distant point in its orbit (apogee). The next two supermoons will occur on January 1st and January 31st.

The Full Moon on the 31st will be the second in the month (sometimes called a "blue moon") and will pass through the Earth's shadow (eclipsed) for spectators in the western U.S. before sunrise.

"Out the Window on Your Left"

IT'S BEEN OVER 45 years since we left the last footprint on the dusty lunar surface. Sadly, as a nation founded on exploration and the conquest of new frontiers, we appear to have lost our will to lead as a space-faring nation. But, what if the average citizen had the means to visit



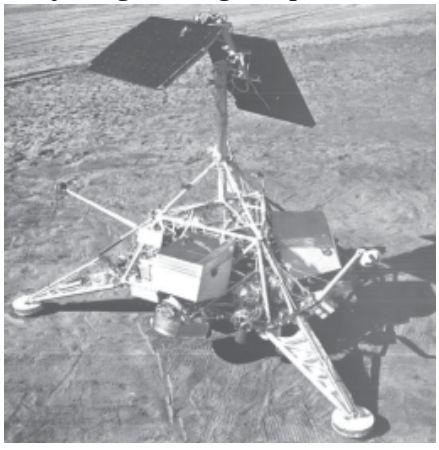
Tycho Crater and landing site of Surveyor 7

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).

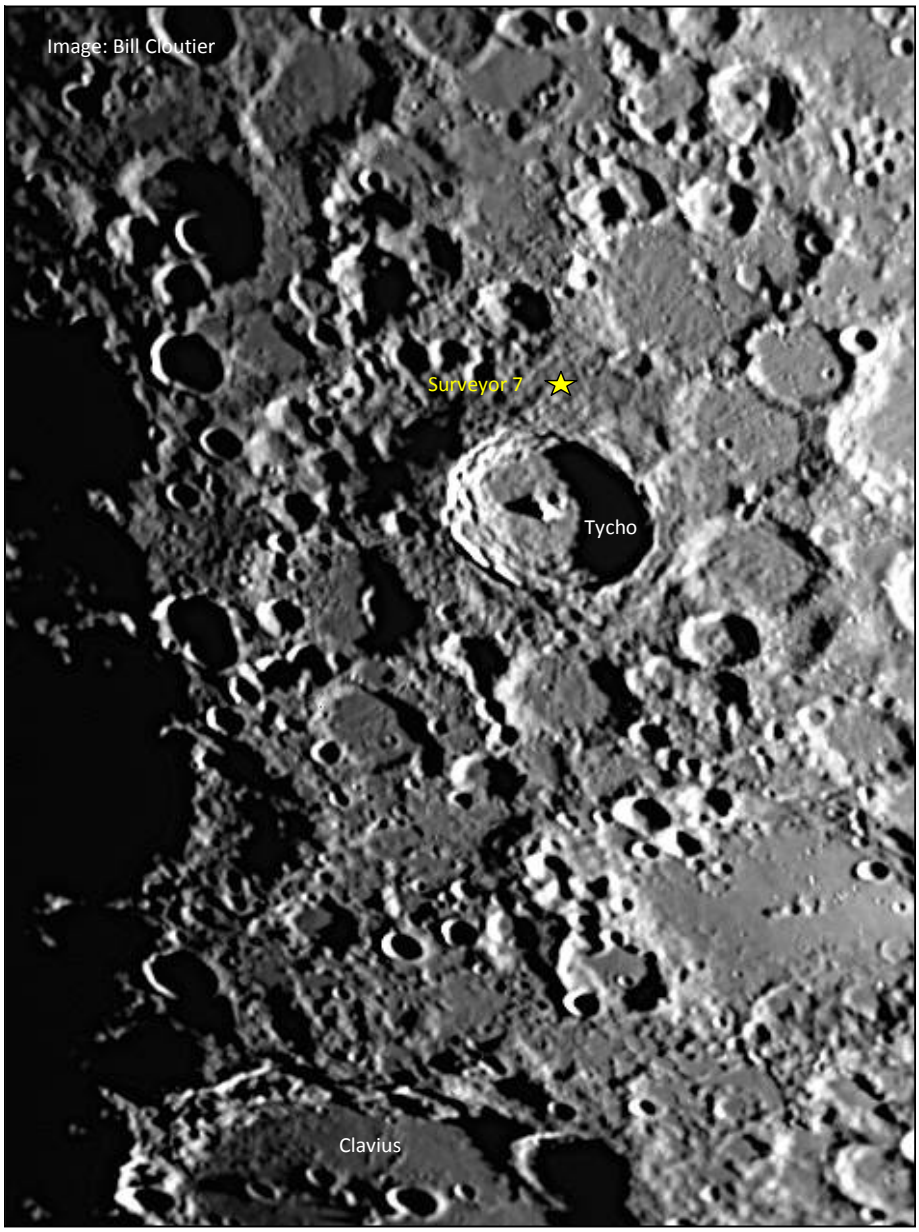
The view this month is the region around Tycho crater, one of the youngest, large impact craters on the Moon (53 miles or 85 km in diameter and estimated to be 108 million years old). The crater was targeted for a visit by Apollo 20 (circa 1972) before the mission was canceled due to budget cuts.

In January 1968, an unmanned spacecraft landed approximately 18 miles north of the rim of Tycho crater. Surveyor 7 was the last of the U.S. robotic probes to explore the Moon in advance of the Apollo missions and the fifth to achieve a soft landing. The Surveyor missions were used to validate landing technology and confirm surface conditions for future landings. Details of the program and a compilation of its results can be found in NASA publication SP-184 issued in 1969 and available on the internet.

Surveyor 7 returned 20,993 pictures in its first lunar day (lunar days are approximately 14 Earth days long). Despite battery damage from the cold lunar night,



Surveyor Lunar Lander model (on Earth) Credit: NASA



Tycho Crater and Surveyor 7

45 additional pictures were returned on the second lunar day. On January 20th, the spacecraft took part in a laser pointing demonstration (in advance of the Apollo astronauts placing reflector arrays on the Moon). Six transmission sites were established on Earth, each using a telescope (backwards) to direct an argon laser beam towards the landing site. Perkin-Elmer in Norwalk participated, attaching a 2-watt laser to the Cassegrain focus of a 24-inch telescope. Surveyor 7's camera was able to record the lasers from both the Kitt Peak and Table Mountain observatories.

Planets in 2018

The outer planets return to the evening sky in the latter half of 2018, appearing at their brightest when they are at or near Opposition (when the planet is opposite the Sun in our sky). Superior planets (located beyond the orbit of Earth) rise at sunset and are highest in our sky at midnight around the time of Opposition.

Jupiter is closest to Earth on May 9th when it reaches Opposition (visible all night). The gas giant can be found in the constellation Libra, the Balance. At a distance of 4.4001 AU from Earth (approximately 410 million miles or 658 million km), Jupiter will shine at an apparent magnitude (maximum brightness) of -2.3.

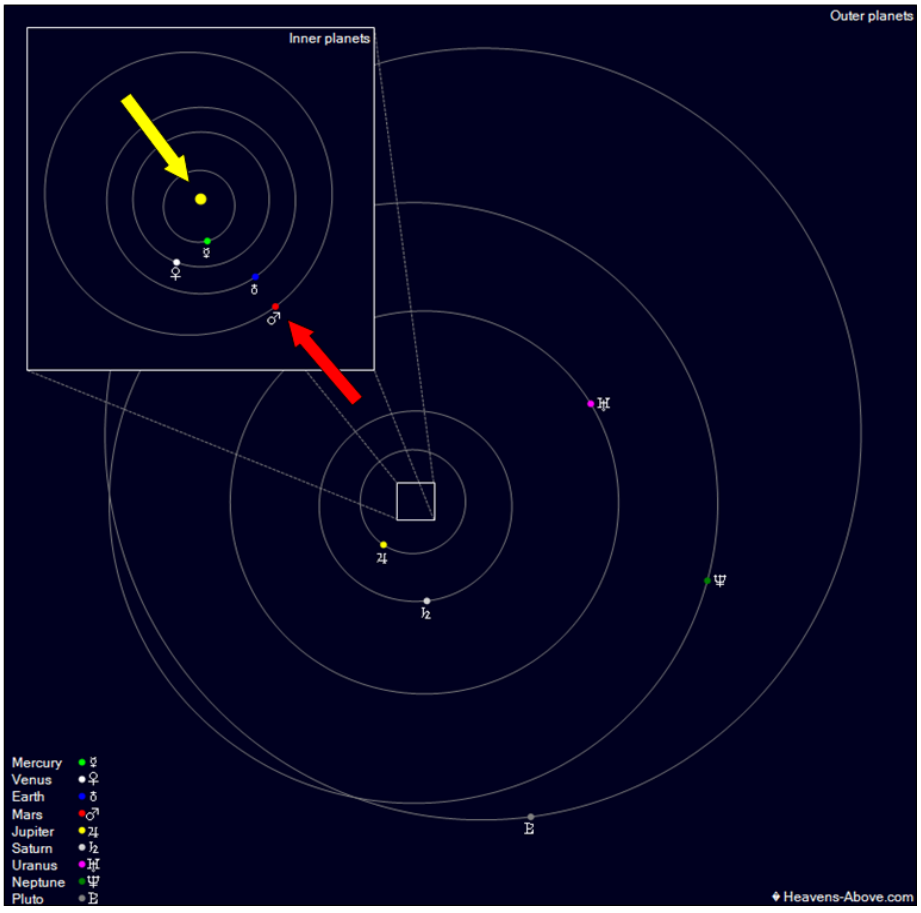
Saturn reaches Opposition on June 27, appearing in the constellation Sagittarius, the Archer. At closest approach the planet will be 9.0488 AU from Earth and 10.0652 AU from the Sun. Its rings will be tilted at an angle of +26°, slightly less open than in 2017, but close to maximum, with the north pole in full view. Saturn will shine at an apparent magnitude (maximum brightness) of +0.0, considerably dimmer than Jupiter (which will be more than 8 times brighter at Opposition).

Mars reaches Opposition on July 27th, appearing in the constellation Capricornus, the Sea-Goat. At closest approach (four days later due to the eccentricity of its orbit) the Red Planet will be 0.3849 AU from Earth (35.7 million miles or 57.6 million kms). Ruddy colored Mars will shine at an apparent magnitude (maximum brightness) of -2.8, briefly rivaling Jupiter, before dimming over the following weeks.

Neptune reaches Opposition on September 7th. The ice giant can be found in the constellation Aquarius, the Water Carrier, but at an apparent magnitude of +7.8, you will need binoculars or a telescope to even locate the eighth planet against the background stars. At its closest, Neptune will be a distant 28.933 AUs from the Earth.

Uranus reaches Opposition on October 23rd. The first planet to be discovered by the telescope can be found in the constellation Aries, the Ram. At an apparent magnitude of +5.7, you will need perfect seeing conditions (dark, clear skies) to visually spot the seventh planet. Uranus will be almost a billion miles closer than Neptune, but still a distant 18.875 AUs from the Earth. Only with the aid of a telescope will you be able to see the blue-green disk of the tipped planet.

[1 AU (Astronomical Unit) is the mean distance between the Earth and Sun or 92,955,807 miles (149,597,871 km)]

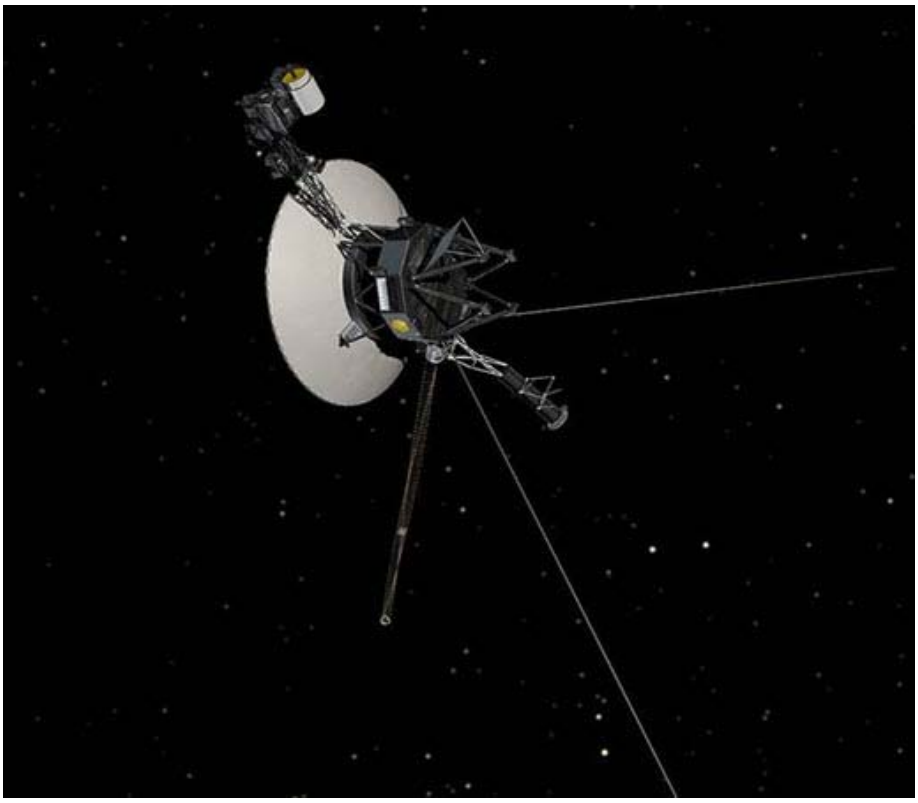


The Opposition of Mars on July 27th (Mars is opposite the Sun in the sky as viewed from Earth and, in this diagram, from above the solar system) Credit: Heavens-Above.com

Voyager 1

After celebrating the 40th anniversary of its launch in September 1977, engineers commanded the spacecraft to test fire its backup thrusters (dormant since it flew past Saturn 37 years ago). The thrusters are needed, if the mission is to continue, due to the gradual degradation of the primary attitude control thrusters.

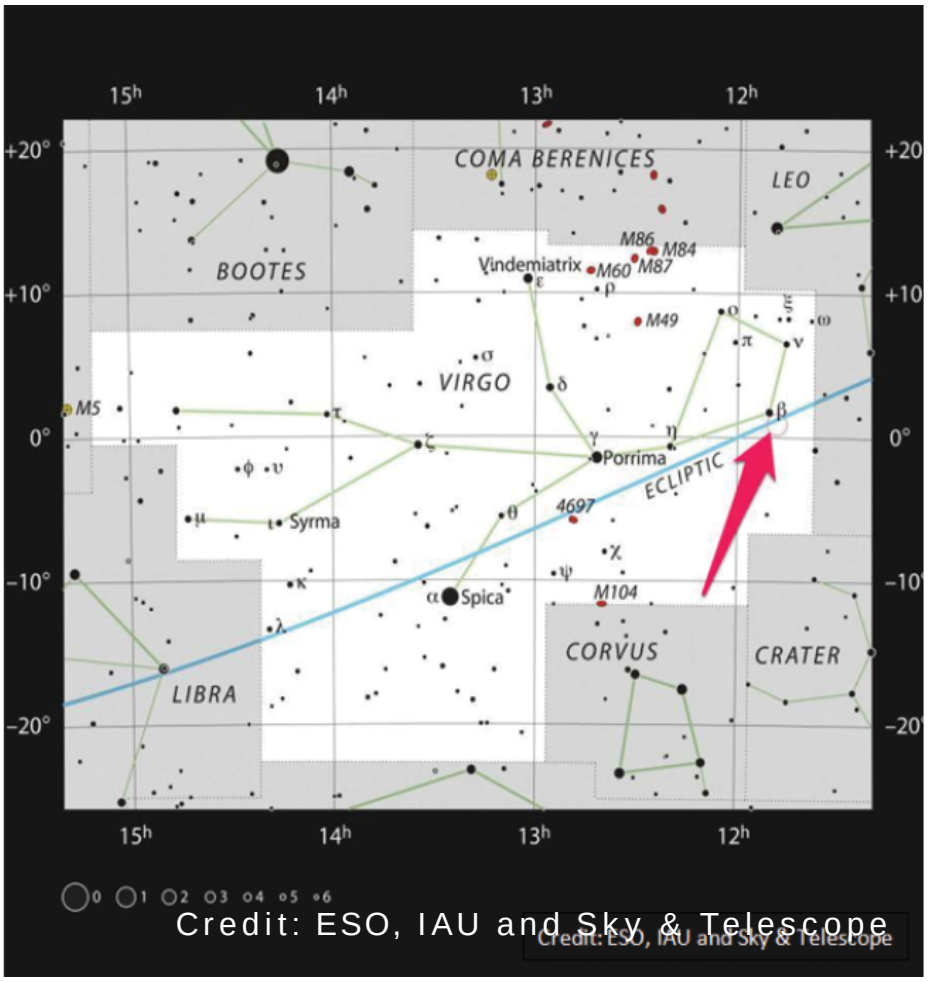
At a distance of more than 13 billion miles, the thrusters are used to orient the spacecraft's antenna so that it can communicate with Earth (with a one way transmission time of 19 hours and 35+ minutes). The spacecraft is already in interstellar space and the Voyager team expects that the backup thrusters will extend the life of the mission by several years.



Ross 128b

Astronomers at the La Silla Observatory in Chile detected an Earth-size exoplanet (approximately 1.35 Earth masses) orbiting the red dwarf star Ross 128 (located approximately 10.9 light-years from Earth). The exoplanet, designated Ross 128b, was detected by the European Organization for Astronomical Research in the Southern Hemisphere (ESO) using its planet-hunting High Accuracy Radial velocity Planet Searcher (HARPS) instrument.

Ross 128 is located in the constellation of Virgo (the Virgin). It is the closest star to the Earth in the constellation and thirteenth closest star system to our Sun. Much smaller and cooler than our Sun, Ross 128 is not visible from Earth without a telescope. However, the star's motion through the Milky Way Galaxy will bring Ross 128 as close as 6.3 light years in 70,000 years.



The exoplanet orbiting Ross 128 is believed to be within the star's temperate zone and close to the inner edge of the conventional habitable zone where liquid water could exist on a planet's surface). It orbits the red dwarf every 9.86 days. Ross 128b is the second closest temperate zone planet discovered to date (Proxima Centauri b being the closest). As one of the quietest red dwarf stars to host a planet (red dwarfs are known to erupt frequently, producing deadly flares of radiation), Ross 128b could be the best, closest candidate for possible life. It is likely that the exoplanet will be targeted by the ESO's Extremely Large Telescope (130 feet or 39 meters in diameter), currently under construction at Cerro Armazones in Chile, when operational in 2024 to study the planet's atmosphere and look for biomarkers such as oxygen.

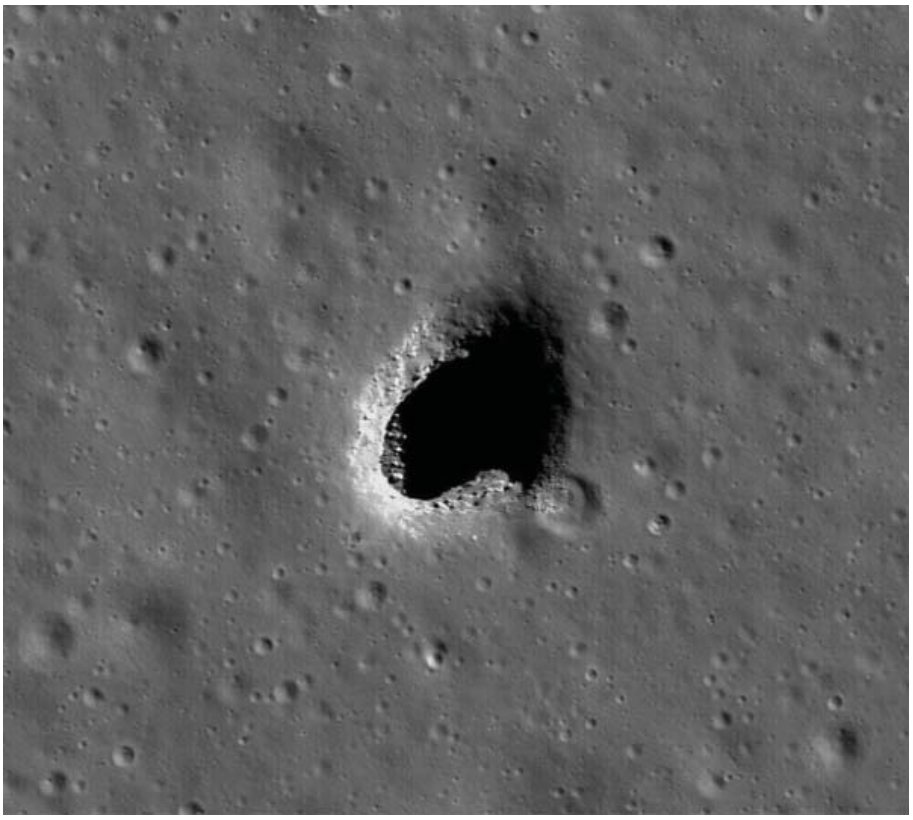
Gimme Shelter

The Marius Hills are a collection of volcanic domes, concentrated in the northwestern region of Oceanus Procellarum (Ocean of Storms). They are visible with a backyard telescope, northwest of the crater Kepler and south of the Aristarchus Plateau.

In 2009, the Japanese lunar orbiter SELENE (Selenological and Engineering Explorer or Kaguya) discovered several large pits on the lunar surface. Subsequent flyovers by NASA's Lunar Reconnaissance Orbiter (LRO) confirmed that the bottom of the pits extended beyond that indicated by the opening above, suggesting the presence of empty magma chambers or ancient lava tubes.

A recently published analysis of the data from SELENE's Lunar Radar Sounder, supports the existance of an intact lava tube, at a depth of several hundred feet that extends for several miles beneath the regolith at the Marius Hills LRO image of an opening into a possible subterranean chamber or lava tube in the Marius Hills location, coincident with a surface rille or channel. The presence of such a subsurface void or cavity is also consistent with the local gravity anomalies identified by NASA's GRAIL spacecrafts during their lunar mapping campaigns in 2012.

Underground caverns could provide future colonists a sanctuary from radiation storms, a shelter from micrometeorites and a ready-made excavation that could be modified as a habitat (sealed to retain an atmosphere). The subsurface living area would also provide a constant temperature as opposed to the Moon's surface where temperatures vary by several hundred degrees between lunar noon and midnight.

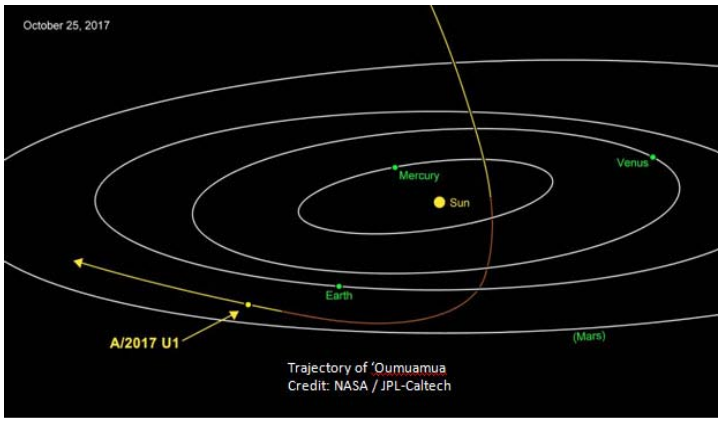


LRO image of an opening into a possible subterranean chamber or lava tube in the Marius Hills Image: NASA/Goddard/Arizona State University

Watcher of the Void

On October 19th, the University of Hawaii's Pan-STARRS1 telescope was surveying the sky in the direction of the constellation Lyra, the Lyre, when it detected, what would be determined to be a very exceptional object. Originally classified as a comet due to its high inclination to the plane of the solar system, the object showed no sign of activity as it zipped past the Sun in early September at a relative speed of 196,000 miles per hour (87.3 kps).

Observations by multiple ground-based telescopes led to the object being reclassified as an interstellar asteroid (1I/2017 U1) by the International Astronomical Union, the first confirmed extrasolar visitor. The Pan-STARRS discovery team informally christened the visitor 'Oumuamua, Hawaiian for "a messenger from afar arriving first."



'Oumuamua is approximately one quarter mile long and more highly elongated than any solar system asteroid or comet observed to date. The rocky body spins on its axis every 7.3 hours, varying in brightness by a factor of 10.

In late November, 'Oumuamua was already beyond the orbit of Mars, travelling at 85,700 miles per hour (38.3 kps) relative to the Sun. By January 2019, it will be past the orbit of Saturn as it heads back out into deep space.

Coast to Coast

Prior to the Challenger disaster in January 1986, NASA had planned to launch space shuttles from both coasts. The west coast site (Vandenberg Air Force Base) was to be used to place military payloads into a polar orbit. In preparing the SLC-6 or "Slick 6" launch facility, the shuttle Enterprise was used for "fit tests" and practice runs. Unlike the process used at the Kennedy Space Center where the shuttle, solid rockets and external tank were mated inside the Vehicle Assembly Building, the space transportation system components were assembled on the pad at Vandenberg. Four-time shuttle astronaut Bob Crippen would have commanded Discovery on the maiden flight (STS-62A).

Shuttle trivia: after the flight of STS-9 in 1983, NASA changed its flight designations from sequential numbering to an alpha-numeric system (the system reverted back to sequential numbering in 1988, with the first flight after the loss of the Challenger in 1986). In the alpha-numeric system, the first number indicated the year in which the shuttle was scheduled to fly, the second number (1 or 2) identified the launch site (Kennedy or Vandenberg, respectively) and the alpha designator, the likely flight sequence. For example, STS-62A, would have been the first flight launched from Vandenberg in 1986.

Explorer 1

Fifty years ago, on January 31, 1958, the United States successfully launched its first satellite, Explorer 1. The launch occurred during the International Geophysical Year, a global initiative which actually ran from July 1957 to December 1958 and coincided with the peak in the 11-year solar cycle. Unlike Sputnik 1, which had been launched by the Soviet Union in October of 1957 and designed to only broadcast radio pulses (or Sputnik 2 which carried a dog into space as a crude biological demonstration), Explorer 1 carried a suite of instruments to study cosmic rays, micrometeoroids, and the satellite's temperature. It was the first artificial satellite designed to return scientific data.

The launch of Explorer 1 followed the unsuccessful launch of a U.S. satellite on a Navy Vanguard rocket in December (the rocket fell back to the pad and exploded shortly after liftoff). Following the humiliating loss of Vanguard, which was widely publicized by the Soviets, the competing Army's rocket team (headed by Wernher von Braun) offered their Jupiter C ballistic missile as an alternative launch vehicle. Teamed with the Jet Propulsion Laboratory (JPL) which designed and constructed the satellite and James Van Allen who designed the cosmic ray detector, the 31 pound (14 kg) satellite was successfully placed into an orbit around Earth with an apogee of 1,563 miles (2,515 km) and a perigee of 220 miles (354 km).

During a 1 am press conference at the National Academy of Sciences on February 1st, shortly after the successful night launch of Explorer 1, the three team leaders (from left to right) Bill Pickering (JPL), James Van Allen (State University of Iowa) and Wernher von Braun (Army's Redstone Arsenal) celebrate by holding aloft a model of the satellite.

Explorer 1 would end up completing more than 58,000 orbits before reentering the Earth's atmosphere on March 31, 1970. The lower than expected counts recorded by the cosmic ray detector led Van Allen to theorize that the instrument had been affected by charged particles trapped by the Earth's magnetic field. The existence of two and sometimes three toroidal "radiation belts" encircling the Earth were later confirmed by subsequent missions and named the Van Allen Belts.

In August 2012, NASA launched the Van Allen Probes to study this dynamic region of space (*http://vanallenprobes.jhuapl.edu/*). With two identical spacecraft, traveling in tandem, scientists are able to measure changes in the belts over time and space. The probes have provided researchers a new understanding of how the belts respond to fluctuations in the Sun's output.

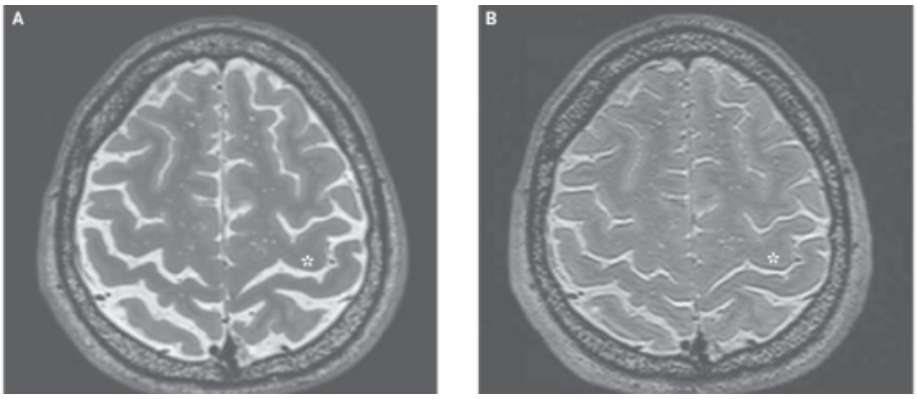
Brain Squeeze

According to a study published in The New England Journal of Medicine, our brains are not immune from the migration of fluid to the upper body that astronauts experience in zero gravity. The human brain is surround by cerebrospinal fluid (CSF). The colorless liquid, which is continually produced by the cells in the ventricles of the brain and absorbed by the body's venous system, cushions the brain within the skull (as well as protects the spinal cord). CSF is also important for good brain health, delivering nutrients and clearing toxins.

Thirty-four astronauts participated in the NASA-funded study, including individuals that flew on short-term space shuttle flights and long-term residents on the International Space Station (ISS). Their brains were scanned with functional magnetic resonance imaging (fMRI) technology shortly before each mission and after returning to Earth. The scans (without any personal or mission data) were then sent to neuroradiologists for analysis.

The brains of 17 of the 18 ISS astronauts showed a narrowing of the brain's central sulcus; a depression or groove in the cerebral cortex. This was seen in only 3 of the shuttle astronauts. Shifting of the brain to the top of the skull was also seen in 12 of the ISS astronauts, and only in those individuals. The brains of twelve of the ISS residents, but only one of the short-term shuttle astronauts, also showed a narrowing of the cerebrospinal fluid channels (channels that surround the blood vessels) at the top of the skull.

Additional research will need to be conducted to better determine the adverse effects of the changes in the brain over time in zero gravity (compression of the venous structure within the skull that could impede the flow of cerebrospinal fluid and blood) and whether the changes continue to progress or plateau over a long duration mission.

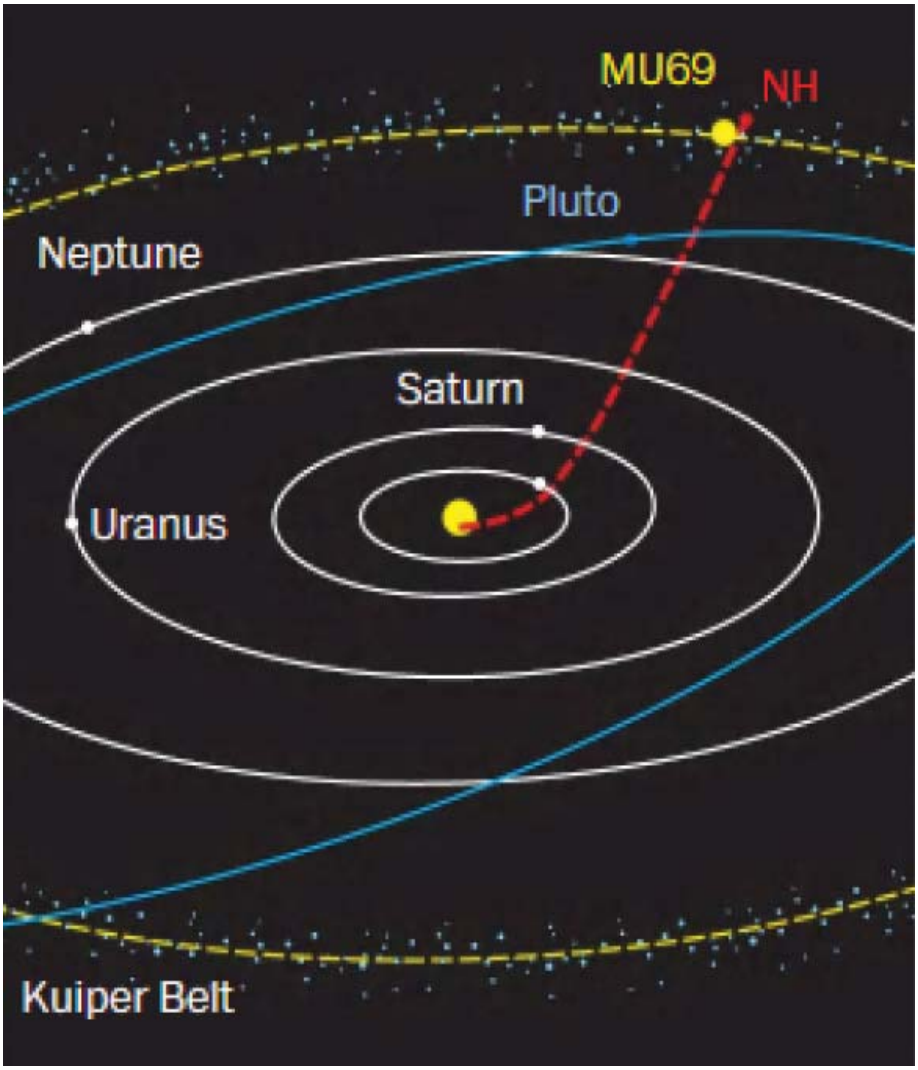


A narrowing of the space between regions of the brain is evident in these before (A) and after (B) long-term space flight images (The New England Journal of Medicine)

New Horizons Update

Next January (January 1, 2019), the New Horizons spacecraft will intercept a small Kuiper Belt object called 2014 MU69, orbiting nearly a billion miles (1.6 billion km) beyond the orbit of Pluto. MU69 is only 30 miles (48 km) across and takes almost 300 years to complete a circuit around the Sun. Scientists believe that the small rocky body may be a relic from the formation of the early solar system and, as such, relatively unchanged over the past 4.5 billion years.

Ground-based telescopic observations of MU69 during several recent stellar occultations (allowing astronomers to measure the drop in light as MU69 passes in front of a star) suggest that the object is either very elongated, two objects in tandem or in orbit around one another. Data gathered by NASA's Stratospheric Observatory for Infrared Astronomy support two separate objects, raising the possibility that MU69 might have a moon (the first asteroid with a moon was discovered in 1993 by the Galileo Jupiter probe as it passed through the main asteroid belt and flew by asteroid 243 Ida the diminutive moon was later med Dactyl).



On New Year's Day, the New Horizons spacecraft will fly within 2,175 miles (3,500 kilometers) of

MU69, as it passes above the object, approximately three times closer than its Pluto flyby in the summer of 2015. At that distance, the spacecraft's instruments should be able to resolve geologic details as small as 230 feet (70 meters) across and provide researchers valuable data on the primordial body's composition.

14 Earth-Years on Mars

On January 25, 2004, the Mars Exploration Rover Opportunity entered the Martian atmosphere after a six month journey and bounced along the Martian surface in an inflatable cocoon before coming to rest in Eagle crater. While only 72 feet (22 meters) in diameter, small nodules of hematite (dubbed blueberries) in the rock layers that formed the crater wall provided the first clear evidence that liquid water played a role in geologic processes that transformed the Red Planet over the past 4 billion years. Eagle would be the first of several impact craters that Opportunity would explore as it traveled across the plains of Meridiani Planum.

Opportunity would spend the second half of 2004 traveling to and exploring nearby Endurance crater. In April 2005, the mission would be threatened when the rover became stuck in a sand dune. It would take six weeks of planning and many, centimeter-sized maneuvers to extract the rover. After escaping "Purgatory Dune," Opportunity narrowly avoided another dune when newly installed software stopped the rover before it lost traction. Circumventing the dune, Opportunity continued on its trek to Victoria crater, stopping by the smaller Erebus crater along the way. On its way, it would pass by its own discarded heat shield and the first of several meteorites.

The rover reached Victoria crater in September of 2006, after traveling 4.3 miles (7 km) from its landing site. It would spend the first nine months circumnavigating the crater's rim, during which it was photographed by the Mars Reconnaissance Orbiter. In mid-2007, a series of dust storms blotted out the Sun. The loss of power threatened to discharge the rover's battery and permanently disable the rover. By late August, however, the storms began to subside and Opportunity was receiving enough sunlight to recharge its battery and return to normal operation. The rover would spend another year exploring rock outcroppings within the crater.

Leaving Victoria, Opportunity would begin a three year journey to Endeavour crater, reaching the rim of the 14 mile (22km) diameter impact crater in August 2011. Shortly after arriving, the rover would discover gypsum deposits on the surface, a clear indication that water once flowed through the surrounding rock. In May 2013, the rover was directed to drive to a high ridge on the rim, designated Solander Point. The sun-facing slope of the ridge allowed Opportunity to continue to work through the Martian winter. On its trek, the rover discovered rocks dating back to the earliest geologic (Noachian) period, approximately 4 billion years ago.

During Opportunity's time on Mars, the rover has found waterborne materials and minerals deposited by water (including hematite, clay and gypsum)—conclusive signs that liquid water once flowed across or percolated through the Martian surface.

The 4.9 foot (1.5 m) high rover has survived dust storms, sand traps and equipment breakdowns. A malfunctioning heater switch has increased the electrical load. An inoperative shoulder azimuth joint limits the robotic arm movement. Nonfunctioning science instruments, sporadic issues with flash memory, and other glitches with software have affected Opportunity's operations as well. The rover drives backwards in an effort to prolong the life of a failing front wheel. Opportunity's ailments include a failed potentiometer in the arm, causing the rover to believe the arm has come unstowed (an event that would preclude driving). Despite the many challenges, Opportunity is still capable of executing its mission.

Opportunity is currently exploring Perseverance Valley, a series of east-west cuts on the inner western rim of Endeavour crater. Unlike other valleys that the rover has explored, Perseverance Valley showed signs (from orbit) of being created by flowing water. The valley(s) extend several hundred yards from the inner crater rim down to the floor.

Opportunity's progress (and batteries) are currently challenged by the low winter sun (Martian winter solstice or the shortest day in the southern hemisphere was on November 20th). The rover's drives along the valley are choreographed so that they conclude each day with the rover's solar panels in a favorable sun-facing configuration.

To date, the cold winter skies have been relatively clear with a tau (measure of optimal depth where 0 represents perfectly clear skies) of 0.416 (tau levels reached a high of 5 during a power-crippling dust storm in 2007 when less than 1% of the direct sunlight reached the surface). Power levels are relatively good with 62% of the sunlight hitting the solar arrays penetrating the accumulated dust layer. The rover has been operating on Mars for more than 4,900 Martian Sols while driving over 28 miles since landing on the Red Planet.

Looking down Perseverance Valley into the crater (approximate true color) Credits: NASA/JPL-Caltech/Cornell Univ./Arizona State University

While the rover hasn't found definitive evidence of water playing a role in the valley's formation, the pace of exploration should pick up with the coming of longer days. The current plan is for Opportunity to eventually exit the valley onto the floor of Endeavour crater.

January History

The month of January has been a difficult one for both the American and Soviet space programs. Untimely deaths set back both the American and Soviet mooprograms. The two space shuttlesthat have been lost were also launched in January.

Sergei Korolyov, the "Chief Designer" of the Soviet space program, died on January 14, 1966 from a botched medical procedure. Korolyov co-founded the Moscow rocketry organization in the 1930s before being thrown into prison during the peak of Stalin's purges. He spent a year in the Kolyma gold mine, the most dreaded part of the Gulag in Siberia before he was recalled to Moscow to aid the Red Army in developing new weapons. Korolyov went on to lead the Soviet space effort. Unfortunately, the Soviet Moon program died with Korolyov in 1966. While the race continued for some time after his death, his N-1 moon rocket never made a successful flight.

The crew of Apollo 1 crosses the gantry to the spacecraft on the day of the fire, Jan. 27, 1967. Credit: NASA

In January of 1967, after a successful conclusion to the Gemini program, NASA was moving forward with testing the new Apollo spacecraft. On the afternoon of the 27th, Gus Grissom, Ed White and Roger Chaffee were sealed inside the Apollo 1 command module sitting on top of an unfueled Saturn rocket in a simulated countdown. The command module had been plagued with problems and was in a state of constant redesign. At 6:31 pm, a spark from a damaged wire ignited the pure oxygen atmosphere in the spacecraft. Within seconds the temperature

reached 2,500°. The astronauts never had a chance to undo the bolts of the hatch before they were asphyxiated. Following their deaths, the spacecraft was completely redesigned. Lessons learned from this accident served to make the spacecraft much safer and contributed to the success of the six moon landings.

Thirty-two years ago, on January 28, 1986, the United States lost its first space shuttle, the Challenger. Due to the low temperature on the launch pad, a rubber-like O-Ring used to seal the joints of the solid rocket boosters failed to seat and stop the hot gasses from escaping. The gas produced a blowtorch-like flame that penetrated the external tank filled with liquid oxygen and hydrogen. The tank exploded 73 seconds after liftoff, destroying the shuttle and killing all seven crew members. Among the crew was Christa McAuliffe, a New Hampshire teacher.

Christa had graduated from Framingham State College (Framingham, Massachusetts) in 1970. Following her death, the college established *The Christa McAuliffe Center* on the campus as a means to continue the educational mission which was Christa's life's work.

On February 1, 2003, a second space shuttle, the Columbia, was lost. The Columbia was the oldest shuttle in the fleet, having been first flown in 1981 by astronauts John Young and Robert Crippen. On its 28th flight, Columbia broke apart during reentry at an altitude of some 200,000 feet and a speed of 12,500 miles per hour. The shuttle and its crew of seven had just completed a 16 day science mission. The most likely cause of the accident was damage to a seal on the left wing from a piece of insulating foam that broke loose from the external fuel tank at launch, striking the wing. The resulting gap in the wing allowed the superheated atmosphere to penetrate the wing during reentry and destroy the spacecraft.

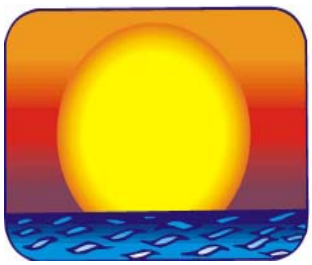
The Columbia accident ultimately led to the decision to stop flying the space shuttle once the International Space Station was complete and spurred efforts to develop a safer manned vehicle.

Space Mirror Memorial on the grounds of the Kennedy Space Center Visitor Complex. Photo: Bill Cloutier

January Nights

January nights can be clear and cold with frigid blasts of polar wind. They also present an opportunity to see stars at every stage in their life cycle, from birth (Orion Nebula) to fiery demise (Crab supernova remnant).

If you are out observing the open star clusters Pleiades or Hyades in the constellation Taurus, don't overlook the red giant Aldebaran. This star is receding from us more rapidly than any other 1st magnitude star in the sky. It was the brightest star in the sky some 320,000 years ago, when it was 21½ light years from Earth. Moving away, Aldebaran is currently 65 light years in distance and the thirteenth brightest star in the sky.



Sunrise and Sunset (from New Milford, CT)

Sun	Sunrise	Sunset
December 1st (EDT)	07:20	16:34
December 15th (EST)	07:18	16:49
December 30th	07:06	16:09

Astronomical and Historical Events

1st Full Moon (Wolf Moon)
1st Moon at perigee (closest distance from Earth)
1st Mercury at its greatest western elongation – apparent separation from the Sun (23°) in the morning sky
1st History: GRAIL-B spacecraft enters lunar orbit (2012)
1st History: Giuseppe Piazzi discovers the first asteroid, now dwarf planet, *Ceres* (1801)
2nd Aten Asteroid 2015 RT1 near-Earth flyby (0.050 AU)
2nd Kuiper Belt Object 2014 WP509 at Opposition (41.569 AU)
2nd History: flyby of Comet Wild 2 by the Stardust spacecraft (2004)
2nd History: launch of the Soviet spacecraft Luna 1; first probe to fly by the Moon (1959)
3rd Earth at Perihelion – closest distance from Sun (0.983 AU)
3rd Apollo Asteroid 2017 UY4 near-Earth flyby (0.067 AU)
3rd Quadrantids meteor shower peaks; radiates from the constellation Boötes (name from an obsolete constellation called Quadrans Muralis)
3rd History: exploration rover Spirit lands on Mars in Gusev Crater; operational for six years before getting bogged down in loose soil at a winter haven called Troy (2004)
3rd History: Stephen Synnott discovers Uranus' moons *Juliet* and *Portia* (1986)
4th History: Isaac Newton born; inventor of the reflecting telescope, described universal gravitation, compiled the laws of motion, and invented calculus (1643)
5th Apollo Asteroid 12711 Tukmit closest approach to Earth (0.624 AU)
5th Apollo Asteroid 2011 MD closest approach to Earth (1.999 AU)
5th History: launch of the Soviet atmospheric probe, Venera 5, to Venus (1969)
5th History: discovery of dwarf planet *Eris* (the Pluto killer) by Mike Brown, et al. (2005)
5th History: discovery of Jupiter's moon *Elara* by Charles Perrine (1905)
6th Aten Asteroid 2015 YG near-Earth flyby (0.094 AU)
6th History: launch of the Lunar Prospector spacecraft; detected signs of water ice in permanently shadowed craters, mapped surface composition and Moon's gravity field and detected outgassing events in the vicinity of craters Aristarchus and Kepler (1998)
6th History: La Criolla (Argentina) meteorite fall (1985)
6th History: launch of Surveyor 7, the last of the unmanned Surveyor spacecrafts; soft-landed near Tycho crater (1968)
7th Aten Asteroid 2013 AT72 near-Earth flyby (0.085 AU)
7th Kuiper Belt Object 230965 (2004 XA192) at Opposition (34.608 AU)
7th History: discovery and first recorded observations of Jupiter's four largest moons *Io*, *Europa*, *Ganymede* and *Callisto* by Galileo Galilei (1610)
8th Last Quarter Moon
8th History: launch of Japanese spacecraft Sakigake with mission to rendezvous with Comet Halley; measured the solar wind and magnetic field (1985)
8th History: launch of Luna 21 and the Lunokhod 2 moon rover (1973)
8th History: Stephen Hawking born (exactly 300 years after the death of Galileo); discovered that black holes could emit radiation - subsequently known as Hawking radiation (1942)
9th History: Voyager 2/Stephen Synnott discovers Uranus' moon *Cressida* (1986)
10th Aten Asteroid 2004 FH near-Earth flyby (0.051 AU)
10th Apollo Asteroid 1620 Geographos closest approach to Earth (1.411 AU)
10th Apollo Asteroid 3360 Syrinx closest approach to Earth (3.240 AU)
10th History: launch of the Soviet atmospheric probe, Venera 6, to Venus (1969)
10th History: U.S. Army first bounces radio waves off the Moon (1946)
11th Atira Asteroid 2007 EB26 closest approach to Earth (0.171 AU)
11th History: the Lunar Prospector spacecraft enters lunar orbit for a nineteen month chemical mapping mission (1998)

Astronomical and Historical Events (continued)

11th History: William Herschell discovers Uranus' moons *Titania* and *Oberon* (1787)
12th Apollo Asteroid 25143 Itokawa closest approach to Earth (1.421 AU)
12th History: launch of the Deep Impact spacecraft for a flyby of Comet Tempel 1; a small "impactor" was later released from the main spacecraft for a July 4th collision with the comet's nucleus (2005)
12th History: Sergei Pavlovich Korolyov born, Chief Designer of the Soviet space program (1907)
13th Second Saturday Stars – Open House at the McCarthy Observatory
13th History: Stephen Synnott discovers Uranus' moons *Desdemona*, *Rosalind* and *Belinda* (1986)
13th History: discovery of the Martian meteorite EETA 79001 in Antarctica; second largest Martian meteorite recovered after Zagami (1980)
14th Moon at apogee (furthest distance from Earth)
14th History: first of three flybys of the planet Mercury by the Messenger spacecraft (2008)
14th History: landing of the Huygens probe on Saturn's largest moon Titan (2005)
15th Aten Asteroid 2007 WM3 near-Earth flyby (0.098 AU)
15th Apollo Asteroid 1864 Daedalus closest approach to Earth (1.143 AU)
15th Apollo Asteroid 3838 Epona closest approach to Earth (1.267 AU)
15th History: Stardust spacecraft returns samples of Comet P/Wild 2 (2006)
15th History: launch of the spacecraft Helios 2, solar orbiter (1976)
15th History: Lunokhod 2, the second of two Soviet unmanned lunar rovers, lands in Le Monnier crater; covered a total distance of 23 miles in almost five months of exploring the floor of the crater and its southern rim (1973)
16th New Moon
16th Apollo Asteroid 438017 (2003 YO3) near-Earth flyby (0.071 AU)
16th History: final launch of space shuttle Columbia (STS-107); lost on re-entry (2003)
17th History: launch of Jason 3, an ocean altimetry satellite from the Vandenberg Air Force Base, California (2016)
17th History: Pierre Mechain's discovery of Comet 2P/Encke (1786); short period comet that completes a circuit around the Sun every 3.3 years, named after Johann Encke who computed the comet's orbit, recognizing it as a periodic comet
18th Apollo Asteroid 4581 Asciepius closest approach to Earth (0.289 AU)
19th History: launch of the New Horizons spacecraft to Pluto; executed a close encounter with the dwarf planet in July 2015 (2006)
19th History: discovery of the Martian meteorite SAU 090, a basaltic shergottite, in Oman (2002)
19th History: discovery of Saturn's moon *Janus* by the Voyager 1 spacecraft (1980)
19th History: launch of Gemini 2, an unmanned suborbital flight designed to test the spacecraft's heat shield (1965)
19th History: Johann Bode born, popularized an empirical law on planetary distances originally developed by J.D. Titius, known as "Bode's Law" or "Titius-Bode Law" (1747)
20th Apollo Asteroid 2015 NJ3 near-Earth flyby (0.056 AU)
20th Apollo Asteroid 2017 MT8 near-Earth flyby (0.057 AU)
20th History: Rich Terrile discovers Uranus' moons *Cordelia* and *Ophelia* (1986)
21st Apollo Asteroid 2015 XK351 near-Earth flyby (0.073 AU)
21st Apollo Asteroid 314082 Dryope closest approach to Earth (1.939 AU)
21st Kuiper Belt Object 20000 Varuna at Opposition (42.904 AU)
21st History: launch of the rocket Little Joe-1B and a rhesus monkey named "Miss Sam" in a successful test of the Mercury capsule's escape system (1960)
21st History: John Couch Adams born, astronomer and mathematician who was the first person to predict the position of a planet beyond Uranus (1792)
22nd Aten Asteroid 306383 (1993 VD) near-Earth flyby (0.037 AU)
22nd Amor Asteroid 2006 AL4 near-Earth flyby (0.055 AU)
22nd History: launch of Apollo 5, the first Lunar Module flight (1968)

Astronomical and Historical Events (continued)

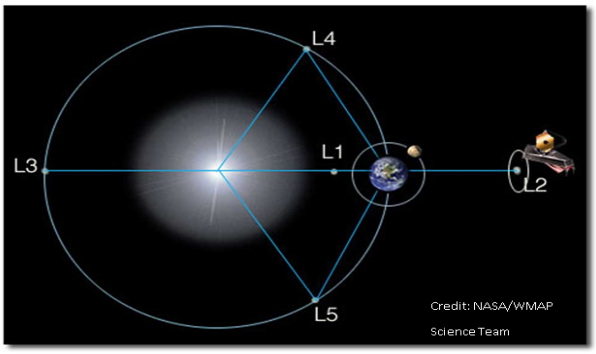
23rd History: Brad Smith discovers Uranus' moon *Bianca* (1986)
24th First Quarter Moon
24th Centaur Object 32532 Thereus at Opposition (11.761 AU)
24th Plutino 208996 (2003 AZ84) at Opposition (43.608 AU)
24th History: launch of space shuttle Discovery (STS-51-C); 100th human spaceflight to achieve orbit (1985)
24th History: discovery of the Martian meteorite Dhofar 019 in Oman (2000)
24th History: launch of Japan's Hiten spacecraft; first use of a low-energy transfer to modify an orbit and the first demonstration of a transfer to the Moon requiring no change in velocity for capture (1990)
24th History: flyby of Uranus by the Voyager 2 spacecraft (1986)
25th History: exploration rover Opportunity lands on Mars at Meridiani Planum; still operational and currently exploring Endeavour Crater (2004)
25th History: launch of the Infrared Astronomical Satellite (IRAS); first space telescope to survey of the entire sky at infrared wavelengths (1983)
25th History: launch of the U.S. Moon orbiter Clementine (1994)
25th History: Joseph Lagrange born (1736); mathematician who discovered five special points in the vicinity of two orbiting masses where a third, smaller mass can orbit at a fixed distance from the larger masses. The L1 Lagrange Point of the Earth-Sun system is the current home of the Solar and Heliospheric Observatory Satellite (SOHO).
26th Aten Asteroid 2011 CD66 near-Earth flyby (0.079 AU)
26th History: discovery of dwarf planet *Haumea*'s moon *Hi'laka* by Mike Brown, et al. (2005)
26th History: discovery of Saturn's moon *Epimetheus* by the Voyager 1 spacecraft (1980)
26th History: launch of the International Ultraviolet Explorer (IUE); space telescope and spectrographs; designed to take ultraviolet spectra (1978)
27th History: fire in the Apollo 1 spacecraft kills astronauts Gus Grissom, Edward White and Roger Chaffee (1967)
27th History: Philibert Melotte discovers Jupiter's moon Pasiphae (1908)
28th Amor Asteroid 4957 Brucemurray closest approach to Earth (2.008 AU)
28th History: final launch of the space shuttle Challenger (STS-51L); lost on lift-off (1986)
28th History: Johannes Hevelius born; leading observational astronomer of the 17th century, published detailed maps of the Moon and determined the rotational period of the Sun (1611)
29th Atira Asteroid 2006 WE4 closest approach to Earth (0.105 AU)
29th History: Soviet spacecraft Phobos 2 enter orbit around Mars; successfully returned 38 images before contact was lost; its lander was not deployed (1989)
30th Moon at perigee (closest distance from Earth)
30th Aten Asteroid 2017 BG136 near-Earth flyby (0.078 AU)
30th Apollo Asteroid 410777 (2009 FD) closest approach to Earth (1.198 AU)
30th History: Yuji Hyakutake discovers the Great Comet of 1996 (1996)
31st Full Moon
31st Total Lunar Eclipse (visible in western U.S., as the Moon will set at 7:06 am EST, just after the start the eclipse on the east coast at 6:48 am EST)
31st Aten Asteroid 2003 CA4 near-Earth flyby (0.054 AU)
31st Aten Asteroid 2017 BB30 near-Earth flyby (0.098 AU)
31st History: launch of Apollo 14; third manned moon landing with astronauts Alan Shepard, Stuart Roosa and Edgar Mitchell (1971)
31st History: launch of Soviet Moon lander Luna 9; first spacecraft to land and to transmit photographs from the Moon's surface (1966)
31st History: launch of Mercury-Redstone 2 rocket with Ham the chimpanzee (1961)
31st History: launch of the first U.S. satellite, Explorer 1; detected inner radiation belt encircling the Earth (1958)

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 un like 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

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).



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°)

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

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.*

International Space Station and Iridium Satellites

Visit www.heavens-above.com for the times of visibility and detailed star charts for viewing the International Space Station and the bright flares from Iridium satellites.

Image Credits

Front page design and graphic calendar: Allan Ostergren

Second Saturday Stars poster: Marc Polansky

All other non-credited photos were taken by the author: Bill Cloutier

A view from orbit of hurricane Maria as it bore down on the U.S Virgin Islands and Puerto Rico on September 20, 2017. The thermal image was taken by NASA/NOAA's Suomi NPP satellite, the Visible Infrared Imaging Radiometer Suite (VIIRS) - a sensor designed and manufactured by the Raytheon Company on board the Suomi National Polar-orbiting Partnership (Suomi NPP) weather satellite. The optical cameras aboard the satellite take a swath of scans across the path of view below and sweeps them into a higher definition composite (or *whisk broom* image).

Credits: NASA Goddard Rapid Response Team

For more information and images on the Suomi NPP mission, go to https://www.nasa.gov/mission_pages/NPP/main/index.html

Source: Ryan Zuber, Scientific Visualization Studio - http://npp.gsfc.nasa.gov/visualizations.html

Second Saturday Stars

FREE EVENT

Every Month at the
John J. McCarthy Observatory
Behind the New Milford High School
860.946.0312
www.mccarthyobservatory.org

January 13th

7:00 - 9:00 pm

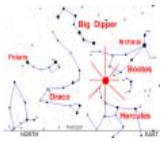
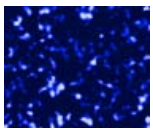
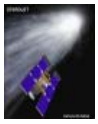
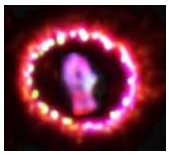
Farewell to Saturn and the Cassini Spacecraft

Refreshments
Family Entertainment
Handicapped Accessible
ASL Interpretation Available with Prior Notice
Rain or Shine

Map

January 2018

Celestial Calendar

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
	1 Moon at perigee (closest distance to Earth)   Giuseppe Piazzi discovers Ceres, 1st asteroid, now dwarf planet (1801)  GRAIL-B spacecraft enters lunar orbit (2012)	**2** Soviet spacecraft Luna 1 circles Moon (1959)   Flyby of comet Wild 2 by Stardust spacecraft (2004)	**3**  Rover Spirit on Mars (2004)  Quadrantids meteor shower peak	**4**  Isaac Newton born (1643)	**5**  Discovery of Jupiter's moon Elara by Charles Dillon Perrine (1905)	**6**  La Criolla (Argentina) meteorite fall (1985)  Launch of Lunar Prospector: detected signs of water ice in shadowed craters, mapped surface composition and Moon's gravity field (1998)
7  Launch of Surveyor 7, the last of the Surveyor Lunar landers; soft-landed near Tycho crater (1968)  Discovery and first recorded observations of Jupiter's four largest moons by Galileo Galilei (1610)	**8** launch of Luna 21 and the Lunokhod 2 moon rover (1973)   Launch of Japanese spacecraft Sakigake to Comet Halley (1985) Stephen Hawking born (1942) 	**9**  Physicists at Fermilab and Berkeley unveil maps of the invisible scaffolding of the universe - dark matter (2012)	**10**  U.S. Army bounces radio waves off the Moon (1946) Surveyor 7 lands on Moon (1968) 	**11**  William Herschell discovers Uranus moons Titania and Oberon (1787)	**12** Launch of Deep Impact spacecraft for flyby of comet Tempel 1 (2005)   Sergei Pavlovich Korolyov born, designer of Soviet space program (1907)	**13** Discovery of Uranus moons Desdemona, Rosalind and Belinda by Stephen Synnott (1986)   Discovery of Martian meteorite EETA 79001 in Antarctica (1980)  2nd Saturday Stars Open House McCarthy Observatory
14 Moon at apogee (furthest from the Earth)   Landing of the Huygens probe on Saturn's largest moon Titan (2005) Messenger spacecraft flyby of Mercury (2008) 	**15**  Stardust spacecraft returns with samples of comet P Wild 2 (2006) Launch of Helios 2, solar orbiter (1976) 	**16**  Final launch of space shuttle Columbia (2003)	**17**  Harvey H.Nininger born, American meteoriticist and founder of the American Meteorite Museum near Meteor Crater, Arizona (1887)	**18**  Astronomers discover a pulsar in remnants of Supernova 1987A, but observation not later confirmed (1989)	**19** discovery of the Martian meteorite SAU 090 in Oman (2002)   Launch of New Horizons spacecraft to Pluto (2006) Johann Bode born, developed law on planetary distances (1747) 	**20**  Rich Terrile discovers Uranus' moons Cordelia and Ophelia (1986)
21 Launch of the rocket Little Joe-1B and a rhesus monkey "Miss Sam" (1960)   John Couch Adams born, predicted planet beyond Uranus (1792)	**22**  Apollo 5 launch to Moon (1968)	**23** Discovery of Uranus' moon Bianca by Brad Smith (1986)	**24** Discovery of the Martian meteorite Dhofar 019 in Oman (2000) Rover Opportunity arrives on Mars (2004) Flyby of Uranus by Voyager 2 (1986)	**25** Launch of the Infrared Astronomical Satellite (IRAS): first space telescope to survey of the entire sky at infrared wavelengths (1983) Joseph Louis Lagrange born (1736) Launch of U.S. Moon orbiter Clementine (1994)	**26** Discovery of Saturn's moon Epimetheus by the Voyager I spacecraft (1980) Launch of the International Ultraviolet Explorer (IUE); space telescope and spectrographs; designed to take ultraviolet spectra (1978)	**27** Philibert Melotte discovers Jupiter's moon Pasiphae (1908) Fire in Apollo 1 spacecraft (1967)
28 Johannes Hevelius born (1611) Space shuttle Challenger lost on lift-off (1986)	**29** Phobos 2, Soviet spaecraft enters Mars orbit in study of solar environment. Mission, with cooperation of U.S and 3 others (1989)	**30** John Herschel uses camera obscura and hyposulphite to fix "snapshot" images from 48" (120cm) telescope (1839)	**31** Apollo 14, 3rd Moon mission (1971) Explorer 1, first U.S. satellite (1958) Ham Launch of Mercury-Redstone 2 rocket with Ham, the astrochimp (1961)		

Phases of the Moon