

Galactic Observer

John J. McCarthy Observatory

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July/August 2016



Is this an exoplanet in the Goldilox zone of a distant star, where conditions might have supported life? . . . or perhaps an artist's depiction of an ancient Mars nourished by an oxygen-rich atmosphere and abundance of surface water? Find out more on page 24.

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It is through their efforts that the McCarthy Observatory has established itself as a significant educational and recreational resource within the western Connecticut community.

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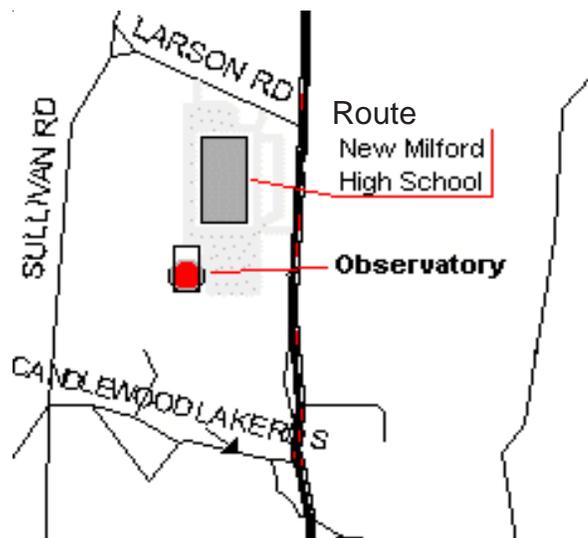
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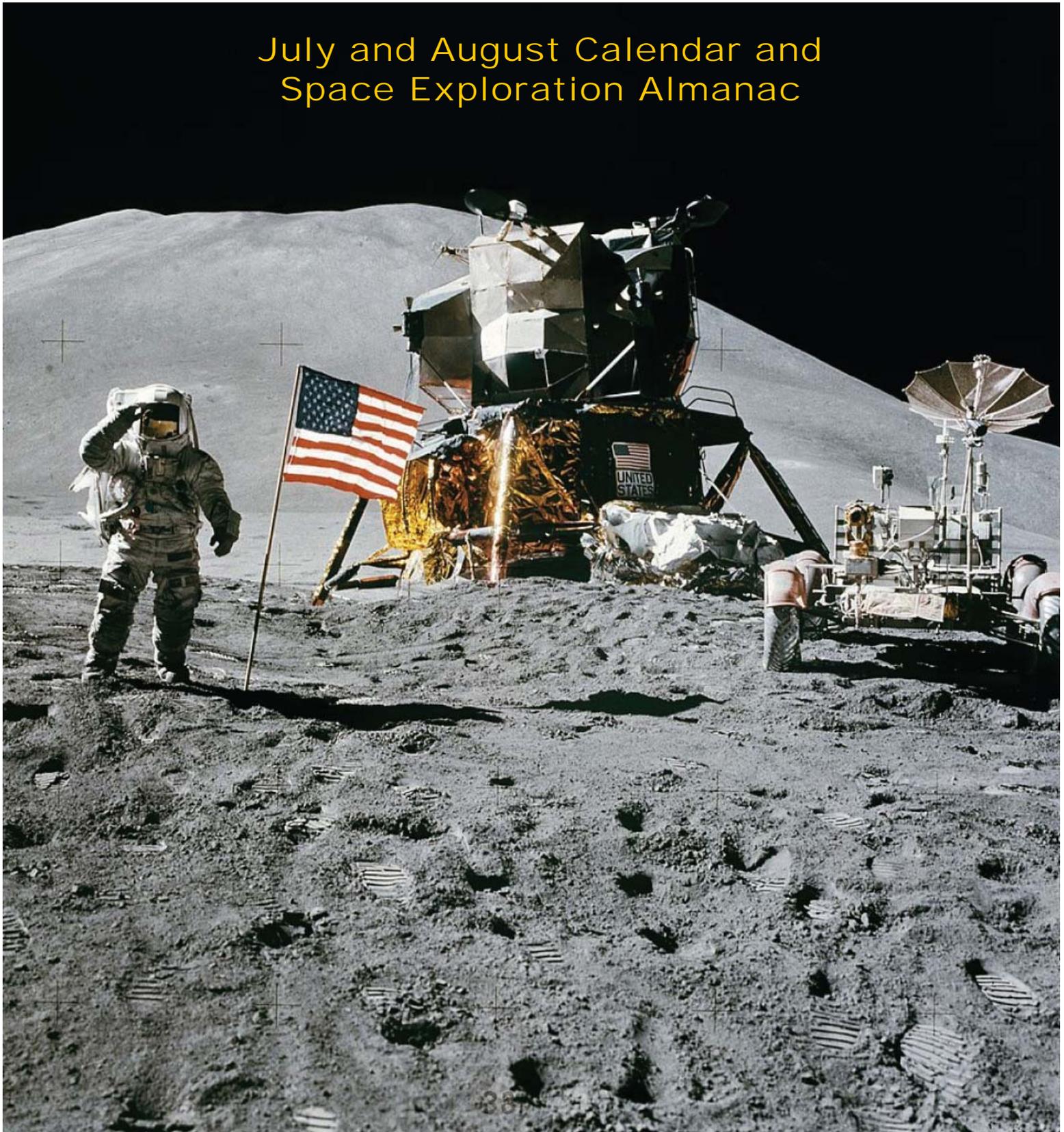
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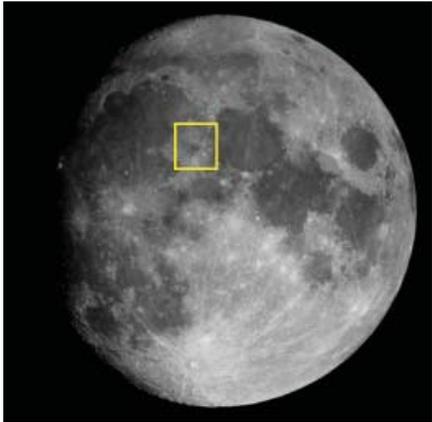
July and August Calendar and Space Exploration Almanac



NASA Photo: Apollo 15 Lunar Module Pilot James Irwin salutes the American flag at the Hadley Rille/Apennine Mountain landing site. The Lunar Roving Vehicle is parked alongside the Lunar Module "Falcon" with Mons Hadley Delta (relative height 11,500 feet or 3.5 km above and to the south of the landing site) in the background. Photo taken by Commander David Scott.

"Out the Window on Your Left"

IT'S BEEN ALMOST 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



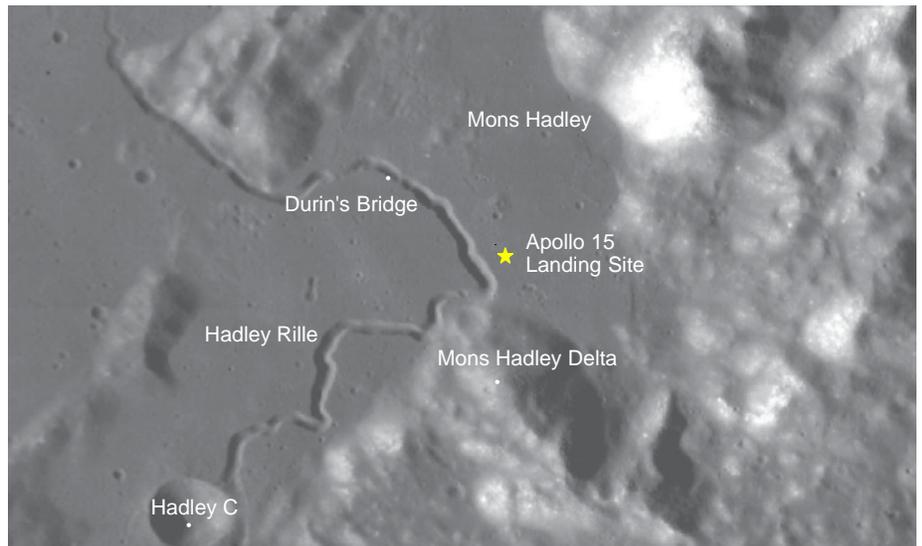
Lunar "seas" are expansive, low-lying plains formed by ancient lava flows

to lead as a space-faring nation. 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).

July is best known in lunar exploration history for the date of the first manned landing on the Moon. Astronaut and Commander Neil Armstrong set the Apollo 11 lunar module "Eagle" gently down on the dusty basaltic plains of Mare Tranquillitatis (Sea of Tranquility) at 4:17:39 P.M. (EDT) on Sunday, July 20, 1969. Two years later, without the fanfare, another Apollo crew landed on the Moon to continue the exploration of our nearest celestial neighbor. On July 30, 1971, Commander David Scott guided the Apollo 15 lunar module "Falcon" to a pinpoint landing at the base of the Apennine Moun-



NASA Photo: Apollo 15 Lunar Rover on the rim of Hadley Rille



Images from LRO/LROC Quickmap (<http://target.lroc.asu.edu/q3/>) showing the Apollo 15 landing site (above) and an elevation profile of Hadley Rille adjacent to the landing site (GLD: Global Lunar Digital Terrain Map)

tains and on the brink of an ancient lava channel, Hadley Rille.

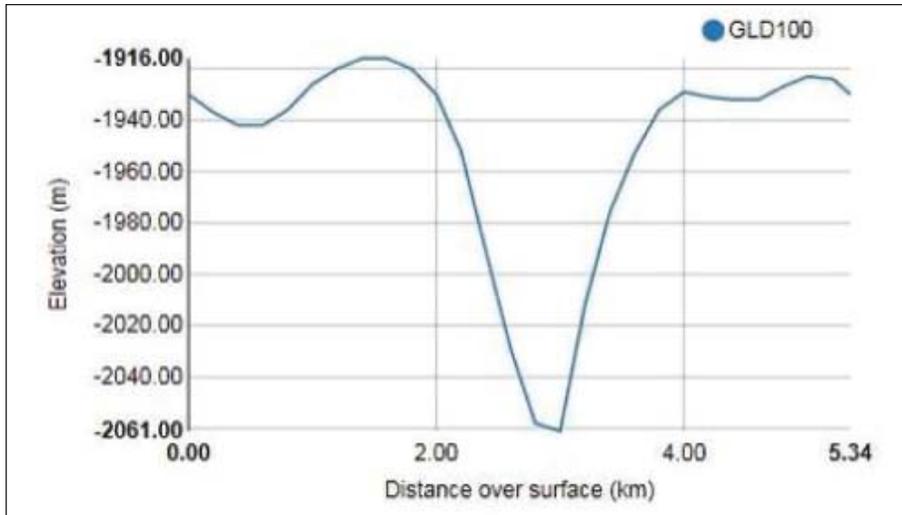
While Armstrong and Aldrin spent only 2½ hours out on the surface and stayed within several hundred feet of Eagle, Scott and Irwin conducted three separate extravehicular activities (EVAs) totaling 10½ hours. The first mission

equipped with an electric powered, 4-wheel drive rover, the Apollo 15 astronauts were able to traverse 17 miles (27.9 km)

The Apennine mountain range forms the southeastern border of Mare Imbrium (Sea of Rains) and rises to a maximum height of 15,000 feet (4,572 m). Hadley

Rille is one of the largest sinuous rilles on the Moon; a channel that was likely formed during the eruptions of basaltic lavas that flooded the region about 3.3

billion years ago. The rille measures 84 miles (135 km) in length, one mile in width (1 km) and averages 1,300 feet (400 meters) in depth.



Orbit Insertion

The Juno spacecraft was launched in August 2011 and is scheduled to enter orbit around Jupiter on July 4, 2016. The diagram (next page) was produced by Jet Propulsion Laboratory's



Solar System Simulator (<http://space.jpl.nasa.gov/>) for July 4th, and shows the Juno spacecraft (in green) entering the Galilean system, as seen from above the solar system.

Juno will execute 37 revolutions of the gas giant in a polar orbit over a period of 20 months. The orbit minimizes the time the spacecraft spends in the planet's intense radiation belts located around the equator. The spacecraft's electronics are also shielded in a titanium vault to mitigate the damage from the high velocity, charged particles trapped within the belt. At closest approach the spacecraft will pass within 3,100 miles (5,000 km) of the planet's cloud tops. At the end of the mission in February 2018, Juno will be deorbited for destruction within the Jovian atmosphere (preventing potential contamination of Jupiter's Galilean moons).

Mission objectives for Juno include mapping the planet's magnetic and gravity fields. Juno will also measure the amount of water and ammonia in the atmosphere to test various formation theories (since Jupiter's mass has retained much of its original elemental composition).

The Apennines and Apollo 15

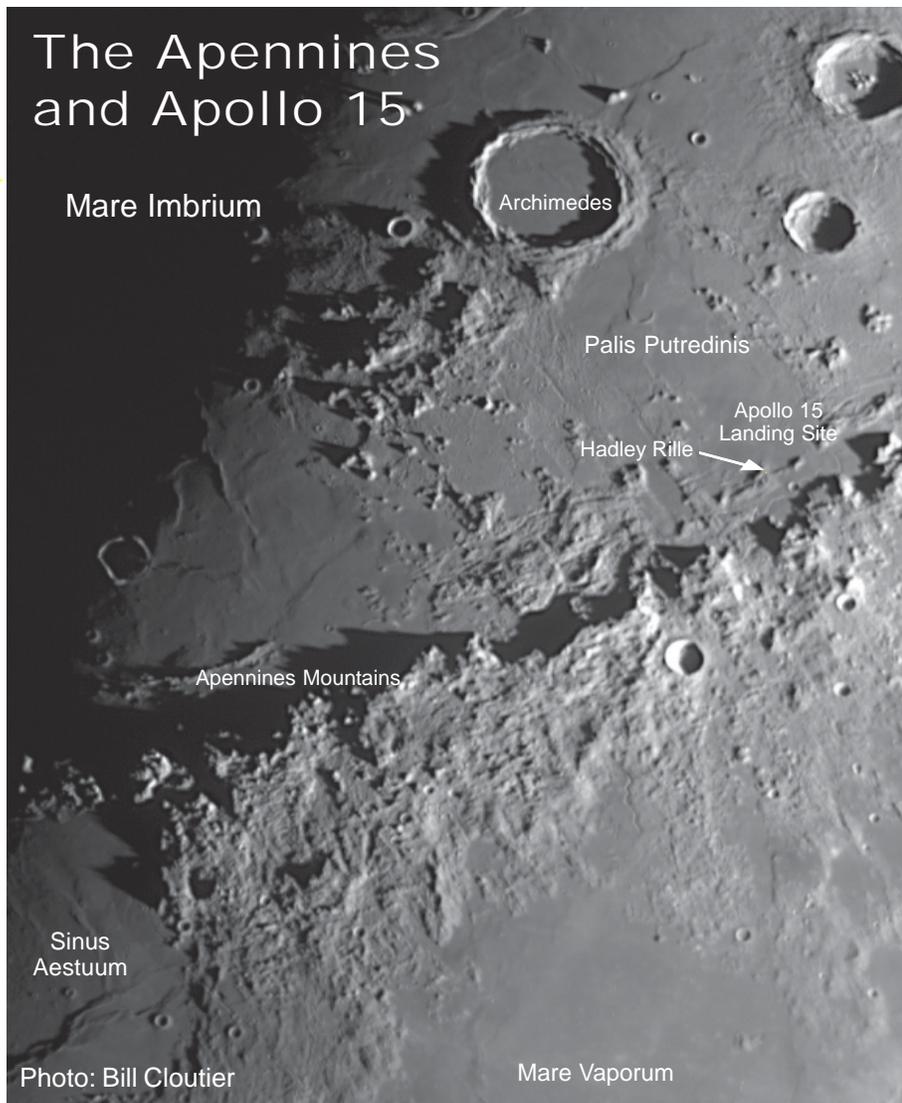
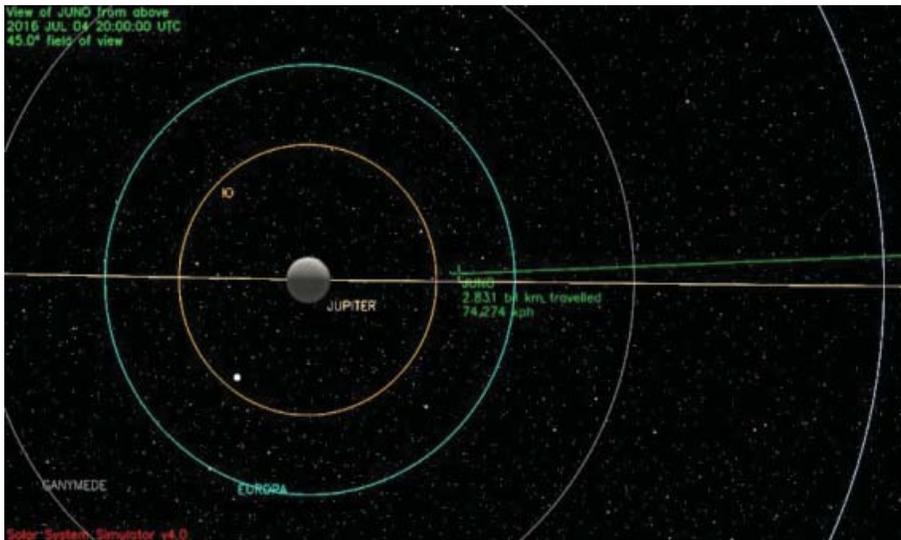


Photo: Bill Cloutier

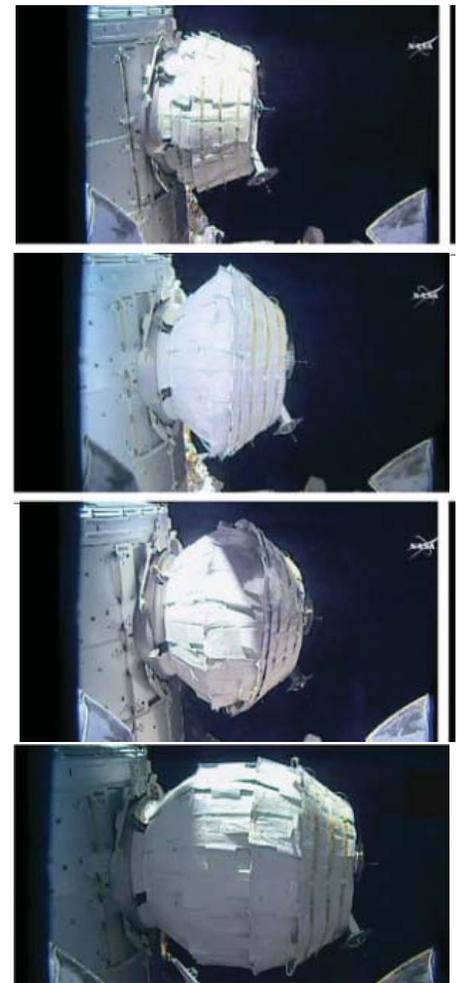
Mare Vaporum



Open Space

The 7,000 lbs. of supplies and science experiments carried to the International Space Station (ISS) by the SpaceX's Dragon spacecraft last April included a prototype, inflatable space habitat designed by Bigelow Aerospace. The Bigelow Expandable Activity Module (BEAM) was attached to the ISS shortly after arrival for a two-year test period. BEAM was successfully inflated

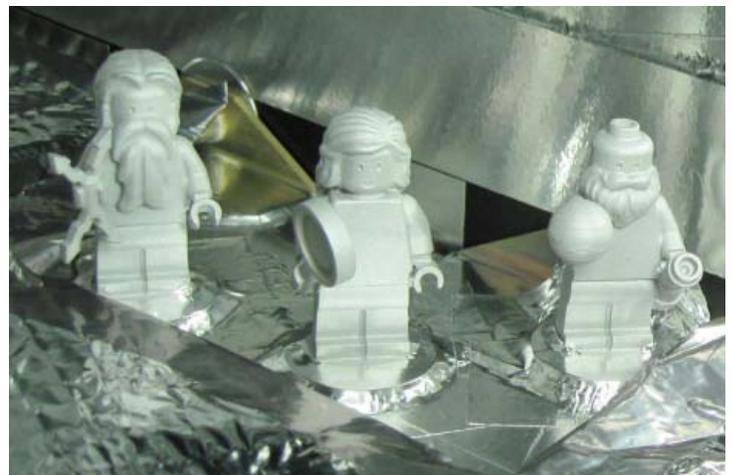
and pressurized on May 28th, a process that more than doubled the module in size. NASA astronaut Jeff Williams and Russian cosmonaut Oleg Skripochka entered the module on June 6th to check the module's structural integrity, install sensors and other hardware. The hatch to BEAM has since been closed and the module won't be accessed again until August.



BEAM Inflation Sequence on May 28th after installation on the ISS. Credit: NASA



Prelaunch configuration of BEAM
Credit: Bigelow Aerospace



LEGO figurines representing the Roman god Jupiter, his wife Juno and Galileo Galilei are shown here aboard the Juno spacecraft. Credits: NASA/JPL-Caltech/KSC

First Earthrise

Fifty years ago, on August 23, 1966, Lunar Orbiter 1 transmitted the first photo of the Earth as seen

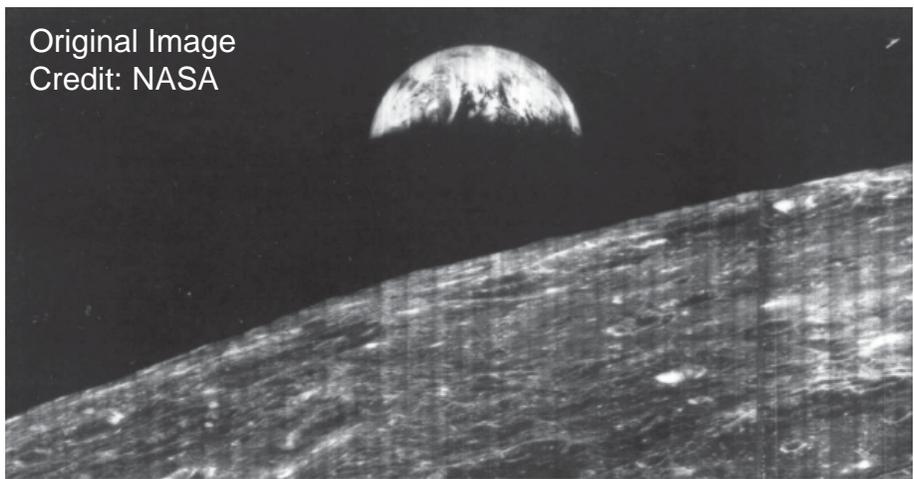
from the Moon. The spacecraft was the first of five orbiters that would photograph 99% of the Moon's

surface to support the selection of landing sites for the follow-on Surveyor landers and Apollo missions.

The five orbiters returned 2,180 high resolution and 882 medium resolution photos. Image information was stored on 1,500 data tapes. The original tapes were archived for 20 years and then released to NASA's Jet Propulsion Laboratory (JPL) for disposition. JPL archivist Nancy Evans elected to preserve the tapes (rather than to destroy the tapes). With limited funding for acquiring original 1960's vintage, highly specialized tape drives to read the analog tapes, finding the technical specifications and operating procedures, and restoring the drives to working condition (some of the hardware was no longer available), the project stalled. It was not until almost twenty years later, as NASA was preparing to send the Lunar Reconnaissance Orbiter to the Moon, that interest in the Lunar Orbiter data was renewed (as a comparative baseline for changes in the Moon's surface over the previous 40 years).

In 2007, Dennis Wingo, the president of the aerospace engineering company SkyCorp and Keith Cowing, a former NASA employee and president of SpaceRef Interactive, joined forces to spearhead the Lunar Orbiter Image Recovery Project (LOIRP). Setting up shop in a vacant McDonalds (dubbed "McMoon's"), located outside the gate of NASA's Ames Research Center, Wingo and Cowing were able to attract the talent and sufficient funding for a pilot program in 2008 that demonstrated that the drives could be repaired and an image recovered. The first successfully retrieved photo was Lunar Orbiter 1's Earth-rise image.

The LOIRP project team was able to apply modern digital image capture and processing techniques to the images retrieved from the



Original Image
Credit: NASA



Restored and Enhanced
Image Credit: NASA

magnetic tapes to bring out detail not seen before. The enhanced images from the Lunar Orbiter pro-

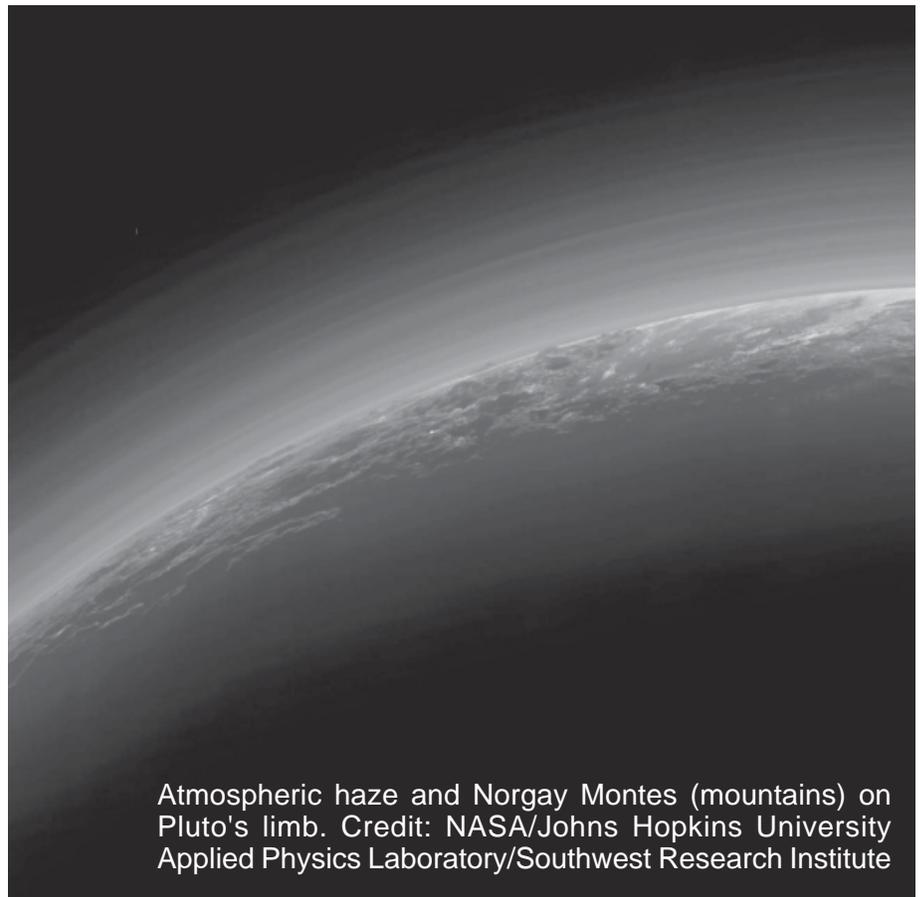
gram are available on the NASA website http://sservi.nasa.gov/LOIRP/loirp_gallery/.



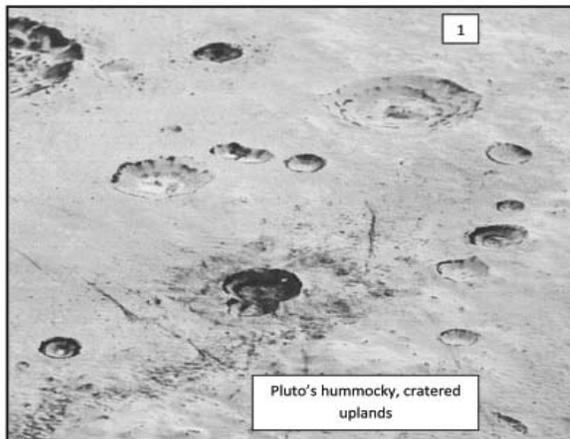
Lunar Orbiter Magnetic Tapes at McMoon's. Credit: LOIRP

Pluto Revisited

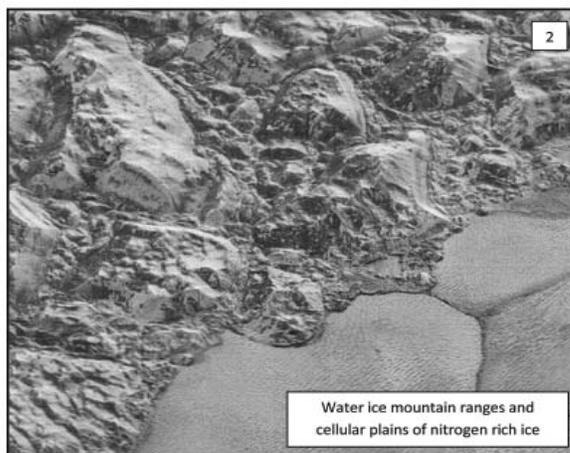
A year has passed since the New Horizons spacecraft successfully executed a high-speed pass of the dwarf planet Pluto and its five moons on July 14, 2015. The spacecraft is now more than 3.2 billion miles (5.2 km) from Earth. At that distance it takes almost 5 hours for a radio signal to reach Earth and NASA's largest antennas to receive it. With a relatively slow downlink speed and limited availability of the Deep Space Network for reception, the downlink process is expected to take 16 months (through the end of 2016). The spacecraft had transmitted the high priority scientific and spacecraft performance data from the July 14th pass in a compressed form last year. Since then, the entire database is being retransmitted, including the photographic surveys of the Pluto system, in its native form and resolution.



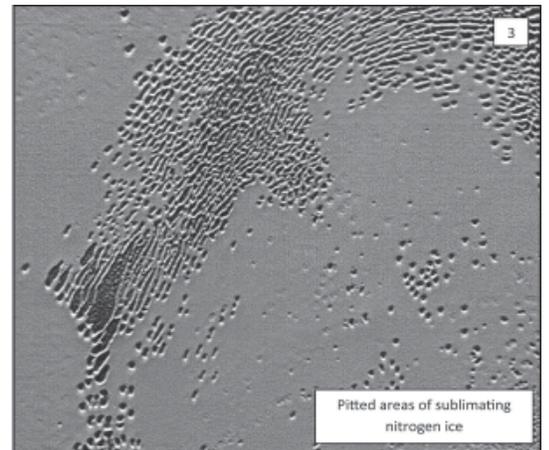
Atmospheric haze and Norgay Montes (mountains) on Pluto's limb. Credit: NASA/Johns Hopkins University Applied Physics Laboratory/Southwest Research Institute



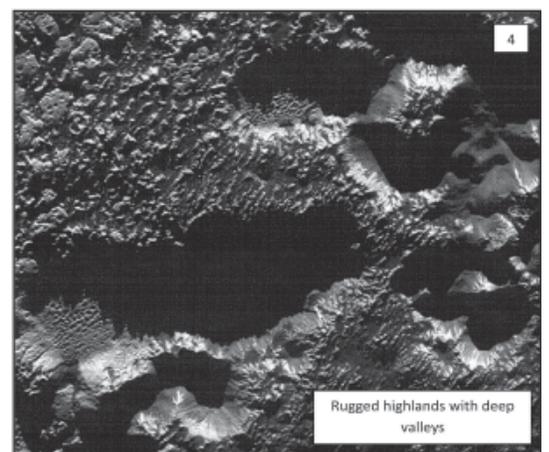
Pluto's hummocky, cratered uplands



Water ice mountain ranges and cellular plains of nitrogen rich ice



Pitted areas of sublimating nitrogen ice



Rugged highlands with deep valleys

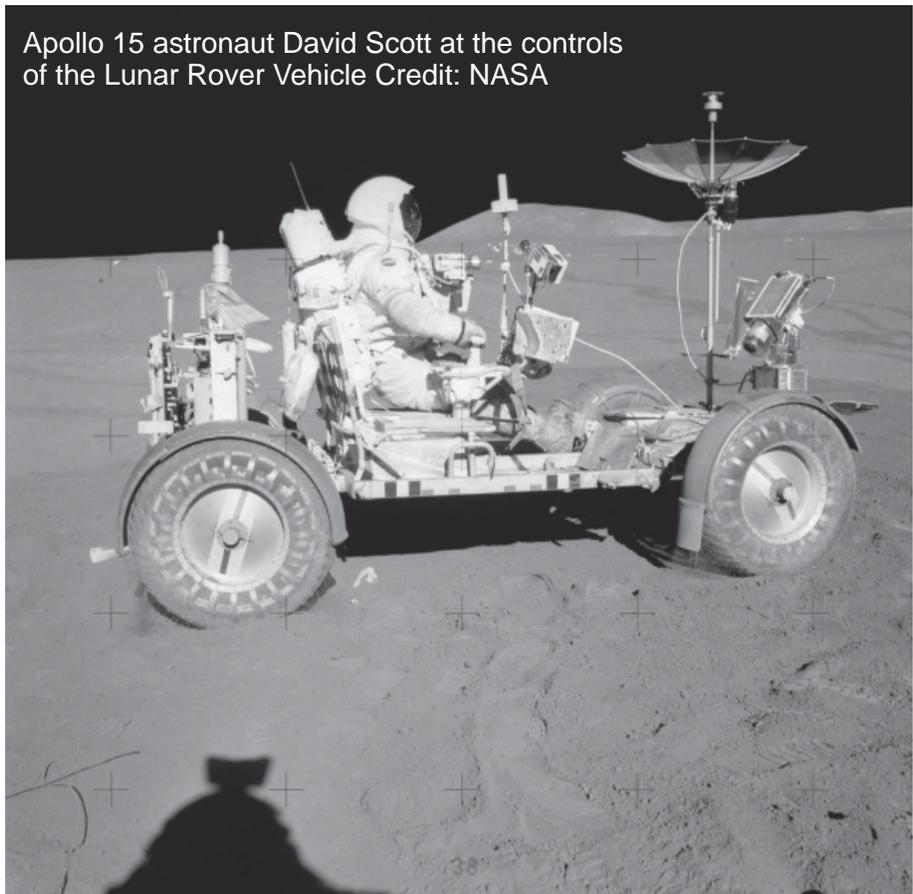
On May 27th, the New Horizons' project team released a mosaic strip of Pluto's terrain covering the hemisphere visible to the spacecraft at closest approach. The mosaic includes the highest resolution images captured by the spacecraft's camera at a distance of approximately 9,850 miles (15,850 km) and offers a cross section of the dwarf planet's diverse and extraordinary terrain.

First Wheeled Vehicle on Moon

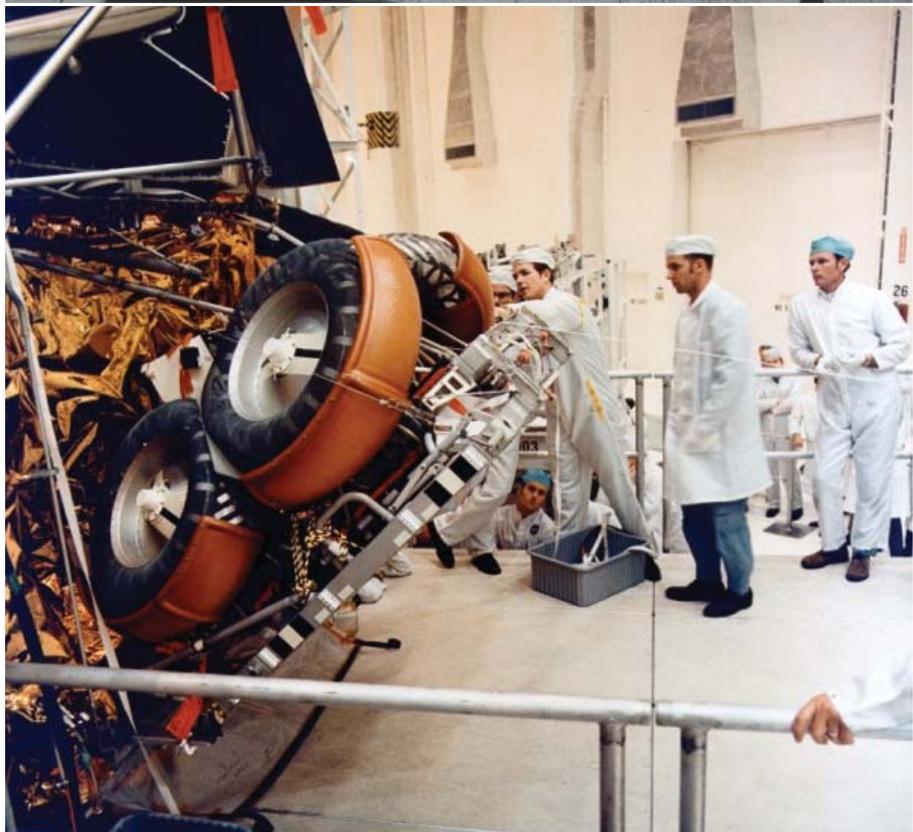
Forty-five years ago, astronaut David Scott became the first person to drive a vehicle on the Moon. The Commander of the Apollo 15 mission used an electric powered vehicle that had been specifically designed and built (by Boeing and Delco) to operate in lunar conditions (lower gravity, vacuum, and on loose, fragmented regolith). The Apollo 15 Lunar Roving Vehicle (LRV) was the first of three rovers driven on the Moon. It covered a total of 17 miles (27.9 km) in three separate excursions, carrying the astronauts up to 3 miles (5 km) from the landing site.

The LRV's chassis was constructed from aluminum alloy tubing and was hinged so that it could be folded for storage on the outside of the Lunar Module. Its four wire wheels were constructed of woven steel strands and titanium chevrons for traction. Each wheel was equipped with its own electric motor for a top speed of approximately 8 miles per hour (13 km/hr).

The LRV was designed to carry the two astronauts and their life support systems, communications and scientific equipment, photographic gear and up to 60 pounds (27 kg) of lunar samples as they explored their surroundings. However, NASA restricted the rover's range to the distance the astronauts could walk back to the Lunar Module in the event of an emergency.



Apollo 15 astronaut David Scott at the controls of the Lunar Roving Vehicle Credit: NASA



Astronaut David Scott (center) watches as technicians fit check the folded Lunar Roving Vehicle in an exterior bay of the Lunar Module. The rover was deployed by the astronauts once on the Moon's surface using a system of pulley, ropes and cloth tapes. Photo Credit: NASA

News Bulletins from the Red Planet

Mars Exploration Rover Opportunity

The Opportunity rover is finishing up its exploration of Marathon Valley, a cut through the western rim of Endeavor Crater. The rover entered the valley in July of 2015 after water-related clay minerals were detected by orbiting spacecraft. Large clay deposits proved elusive, but the rover did find bands of reddish-colored, crumbly material on the valley's southern edge. When the rover's wheels were used to abrade the surface, the underlying material was found to be high in magnesium sulfate. It was the highest sulfur content found anywhere on Mars and compelling evidence for liquid water interacting with the surrounding rock.

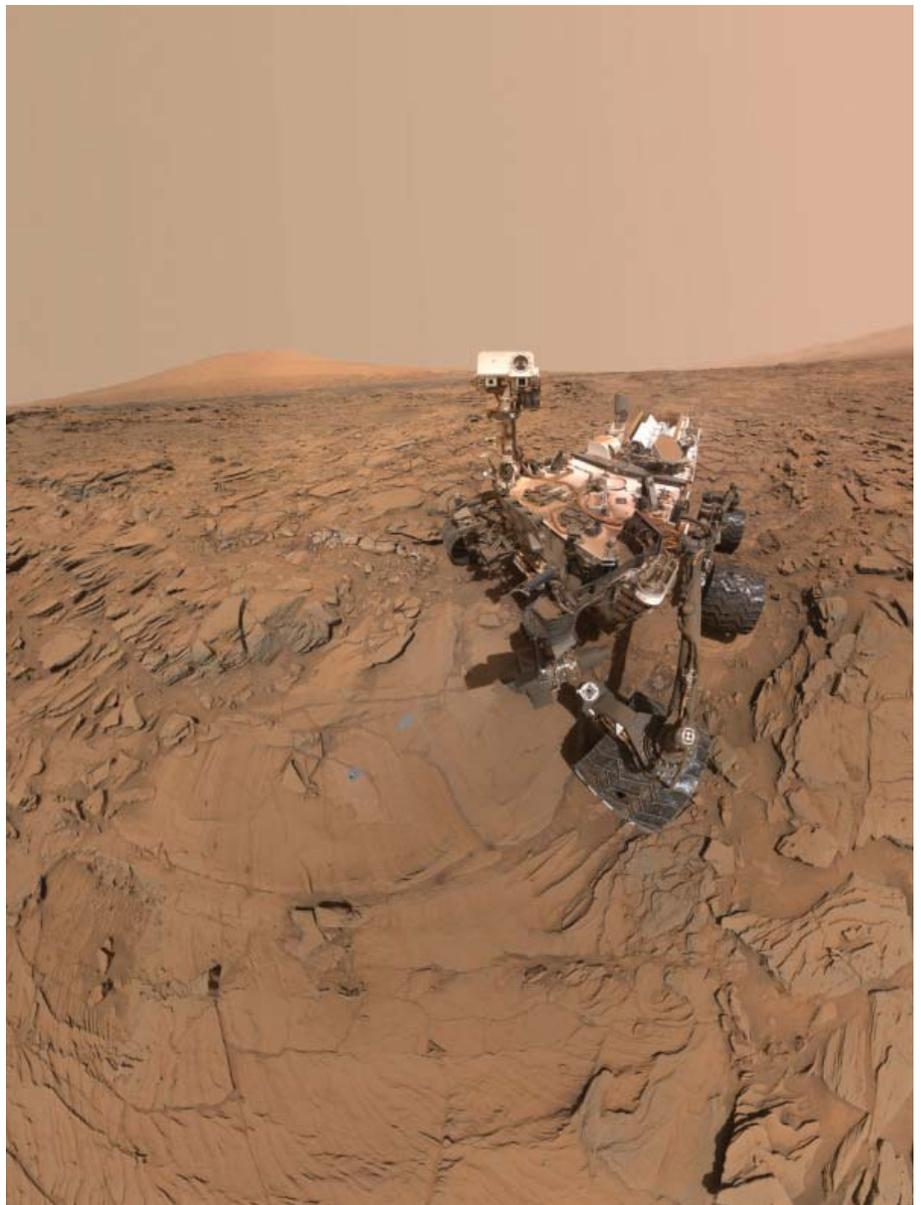
Mars Science Laboratory Curiosity

The Curiosity rover has completed its second Martian year (in August it will be four Earth years since landing) of exploration as it works its way through the foothills of Mount Sharp in Gale Crater. The mountain rises several miles above the floor of the crater and is believed to have been created by layered deposits over many eons.

The rover is equipped with a rotary-percussion drill that acquires samples by rotating and hammering the various rock types found at the landing site. Powdered samples are collected at depths up to 50 mm (approximately 2 inches) below the surface. The powder is then processed and transferred to the science instruments housed within the rover. During the various sampling campaigns, researchers found evidence of tridymite, a mineral that had not been identified before on Mars. Tridymite is created, on Earth, in intense heat of explosive volcanic eruptions (e.g., Mount St.



Opportunity's view of Marathon Valley with the eastern rim of the 14 mile (22 km) diameter Endeavour crater on the distant horizon. Image Credit: NASA/JPL-Caltech/Cornell University/Arizona State University



Self-portrait of the Curiosity Mars rover on the Nauyflatt Plateau. A drilled sample site can be seen in front of the rover, marked by gray colored drill cuttings. Image Credit: NASA/JPL-Caltech/MSSS

Helens). Mount Sharp is a sedimentary feature and not volcanic.

Martian volcanoes were believed to have been formed by effusive eruptions: the high temperature magma rising to the surface and flowing out of vents as a liquid (e.g., volcanoes forming the Hawaiian islands). Either tridymite is created by some other process on Mars or there is still much to learn about Mars' ancient geologic past.

Space Shuttle Legacy

The dramatic success of the Apollo program was also responsible for its demise. Once Kennedy's challenge had been met and the Soviet Union bested, Congress quickly lost interest in funding NASA's ambitious and expensive exploration programs, including an expedition to Mars, development of a nuclear rocket, construction of a space station and deep space bases, and a space shuttle to service orbiting facilities.

Less than six months after Neil Armstrong had stepped onto the Moon, NASA began to cancel future missions due to draconian budget cuts. Apollo 20 was cancelled in January 1970, followed by two additional cancellations by the following September. One by one, cancellation of the other programs followed.

If not for the political support of the Air Force, the shuttle would have met the same fate. The Air Force, after having several of its own space programs canceled in the 1960s, including Dyna-Soar and the Manned Orbiting Laboratory, was interested in a low-cost means of launching reconnaissance satellites and military hardware. Air Force support on Capitol Hill, however, did not come without a cost. The price of their support was the re-

design of the shuttle from a straight wing to a delta wing for greater cross-range capability (for example, to execute a one-orbit mission from Vandenberg Air Force Base, polar orbit and short-duration capture missions (capturing Soviet satellites in flight)). The change in flight profile and wing configuration would significantly increase the reentry temperature - and therefore the demands on the shuttle's thermal

protection system - which would one day have disastrous consequences.

The space shuttle that flew was a compromise, designed to meet Air Force requirements and the Office of Management and Budget's constraints. It was likely a much different (and more expensive) vehicle than if NASA had been allowed to pursue its fully reusable, potential hot-metal, straight-wing, initial design.



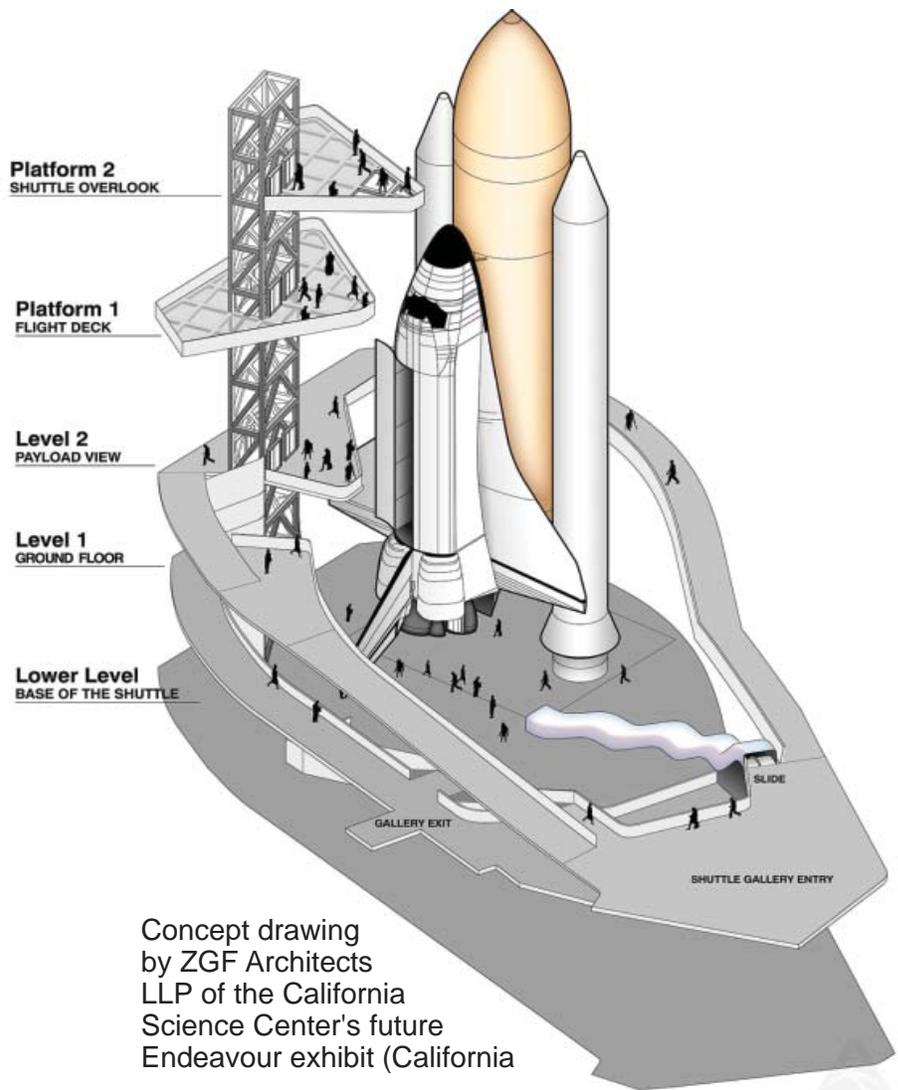
Photo: Bill Cloutier

The space shuttle (or orbiter) is only one component of the Space Transportation System (STS). The three main engines of the reusable orbiter, carrying crew and cargo into orbit, are powered by 143,000 gallons of liquid oxygen and 385,000 gallons of liquid hydrogen contained within an expendable external tank during the first 8½ minutes of flight. Two solid rocket boosters (recoverable) provide an additional 2.6 million pounds of thrust during the first two minutes of flight. The solid rockets return to Earth (ocean) by parachute. The orbiter returns in an unpowered glide to a runway landing.

Six orbiters were built at Rockwell International's facility in Palmdale, California. The first, Enterprise, was used for atmospheric testing, the other five for travel to, and for long-duration stays in, low-Earth orbit. Between April 12, 1981 and July 21, 2011, the five space-worthy orbiters (Columbia, Challenger, Discovery, Atlantis and Endeavour) completed a total of 135 missions, carried 355 men and women, flew over 500 million miles, and spent more than 1,300 days in orbit.

The orbiters rendezvoused with Russia's Mir space station nine times, the International Space Station more than 35 times, and the Hubble Space Telescope five times. They carried to orbit satellites, space station components, space telescopes, laboratories and laboratory experiments, and spacecraft to explore the solar system.

Unfortunately, the STS never delivered as a low-cost transportation system. The greater concern, however, was the loss of two shuttles and crew. The loss of the Columbia upon reentry on February 1, 2003 prompted a comprehensive reevaluation of the program. The Columbia Accident Investigation Board concluded that: "Because of the risks inherent in the original design of the



Concept drawing by ZGF Architects LLP of the California Science Center's future Endeavour exhibit (California)

Space Shuttle, because that design was based in many aspects on now-obsolete technologies, and because the Shuttle is now an aging system but still developmental in character, it is in the nation's interest to replace the Shuttle as soon as possible as the primary means for transporting humans to and from Earth orbit." Shortly after the release of the Board's findings, President Bush announced the remaining space shuttle fleet would be retired once the construction of the International Space Station was complete.

The landing of Atlantis on July 21, 2011 signaled the end of the shuttle program and the beginning of the effort to prepare the orbiters for a new life on public display. Toxic fuels were drained, hazard-

ous materials and toxic chemicals neutralized, pyrotechnics disarmed, the main engines removed and preserved for future use and the shuttle's control systems placed in a safe configuration.

The Smithsonian requested the Discovery as the oldest and most traveled orbiter for display at its National Air and Space Museum, Udvar-Hazy Center in Virginia. The Enterprise, which had been on display at the Udyar-Hazy Center, was moved to the Intrepid Sea, Air & Space Museum in New York City.

NASA awarded Endeavour to the California Science Museum in Los Angeles, close to the Palmdale facility where it was built. Atlantis stayed close to home and put on display at the Kennedy Space Center.

Enterprise

The Enterprise, designated Orbital Vehicle (OV)-101, was a test vehicle. It was not intended for spaceflight but provided critical test data on the orbiter's handling within the atmosphere, needed for a successful return from flight. It flew several captured flights (attached to the top of a Boeing 747) and five free flights at the Edwards Air Force Base. The orbiter was originally to be named Constitution; however, a write-in campaign by viewers of the Star Trek television show persuaded the administration to christen OV-101: Enterprise.

Once the Smithsonian acquired Discovery, the Enterprise was transported by barge to the Intrepid Sea, Air & Space museum where it went on display on July 19, 2012.

Discovery

Discovery was NASA's third orbiter (OV-103) and flew more missions than any of the other orbiters - 39 flights between 1984 and 2011. It was the workhorse of the fleet and the orbiter that flew the "return-to-flight" missions after the Challenger and Columbia accidents. Discovery delivered the Hubble Space Telescope to orbit and flew two of the follow-on servicing missions in 1997 and 1999. The orbiter made two flights to the Russian space station Mir and 13 flights to the International Space Station. The name Discovery was chosen to honor historic sailing ships of the past.

Discovery was delivered to the Smithsonian (near Dulles Airport) in April 2012 mounted atop NASA's Shuttle Carrier Aircraft, a modified Boeing 747 jumbo jet. It

is displayed in a landing configuration with its gear deployed.

Endeavour

Endeavour (OV-105) was the last orbiter to join the fleet, built to replace the Challenger. Its maiden flight was on May 7, 1992 - the first of 25 missions. Endeavor carried the "corrective optics" in the first servicing mission to the Hubble Space Telescope. The orbiter also delivered the first U.S. component, the Unity Module, to the International Space Station. The orbiter is named after the British HMS Endeavour, the ship commanded by Captain James Cook on his first expedition to Australia and New Zealand between 1769 and 1771.

The California Science Center was selected to display the Endeavour, based, in part, on its proximity to Palmdale. The orbiter was deliv-



Photos: Bill Cloutier

Enterprise



Discovery

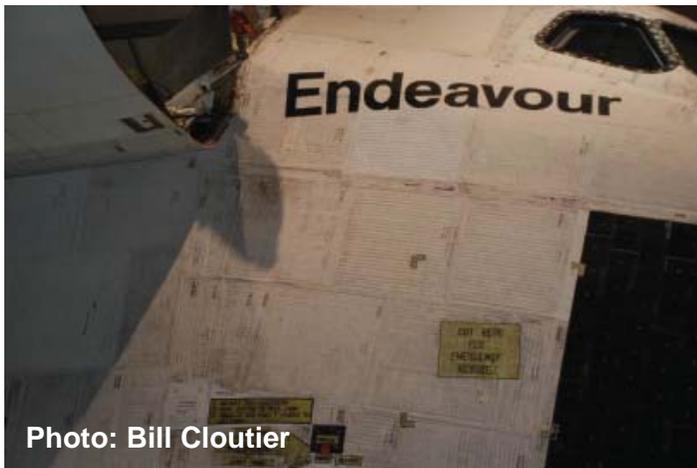


Photo: Bill Cloutier

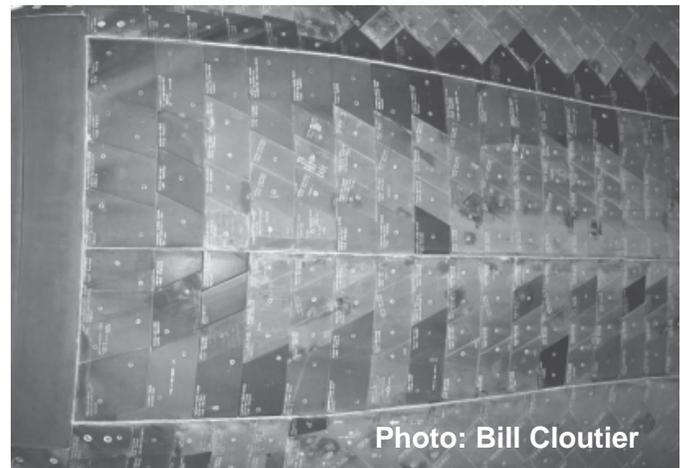


Photo: Bill Cloutier

ered to the Los Angeles International Airport by the Shuttle Carrier Aircraft on September 21, 2012. Three weeks later, the orbiter was towed 12 miles through the streets of Los Angeles to the museum. Endeavour is on temporary display until a permanent home can be constructed. It is currently mounted in an elevated horizontal position, allowing visitors to walk beneath the orbiter. The orbiter will eventually be displayed in a vertical, launch configuration.

The California Science Center also acquired two solid rocket boosters from the Kennedy Space Center in 2012 (currently in storage at NASA's Armstrong Flight Research Center). The museum had planned to use a replica for the external tank, since the tanks used for flight were not recovered. However, by happenstance, one tank was never used (it was too heavy to be used for ISS construction). Instead, the tank became

a test article and even considered for future use on the Space Launch System. Ultimately, it was recently decided not to repurpose the tank, making it available to the California Science Center. The tank was transported from NASA's Michoud Assembly Facility in Louisiana by barge, through the Panama Canal to Los Angeles, arriving on May 18, 2016. Once the new 188,000 square foot addition to the California Science Center is complete (the Samuel Oschin Air and Space Center), the tank will be joined to the orbiter and solid rocket boosters and lifted into place. The exhibit is scheduled to open in 2019.

Atlantis

Atlantis was NASA's fourth orbiter (OV-104), named after the two-masted boat that served as the primary research vessel for the Woods Hole Oceanographic Insti-

tute from 1930 to 1966. It benefited from the lessons learned in the construction of its predecessors, being completed in half the hours spent on Columbia and weighing in at 3.5 tons lighter (allowing it to carry more payload).

Atlantis was the first orbiter to dock with the Russian Mir space station. It carried to orbit planetary probes that would explore Venus (Magellan) and Jupiter (Galileo) and the Compton Gamma Ray Observatory. Atlantis delivered the U.S. laboratory module Destiny and the Joint Airlock Quest to the International Space Station, as well as sections of the Integrated Truss Structure (the structural backbone of the ISS).

Atlantis is on display at the Kennedy Space Center's Visitor Center. It is displayed as in flight, with payload doors open and its Canadarm (robotic arm) extended.



Photo: Bill Cloutier



Photo: Bill Cloutier

Lost Orbiters

Columbia

Columbia (OV-102) was NASA's first space-worthy orbiter. It lifted off on its maiden voyage on April 12, 1981, piloted by mission commander (and former Gemini and Apollo astronaut) John Young and pilot Robert Crippen. The orbiter was named for the first American ship to circumnavigate the globe in 1790 as well as the Apollo 11 command module. Among its many accomplishments, Columbia carried the Chandra X-ray Observatory into orbit in July 1999.

The orbiter and crew were lost during reentry on February 1, 2003 when hot gases entered a hole in the orbiter's left wing. The hole had been created by a small piece of foam shed by the external tank on takeoff. The hot gases melted the airframe, causing the vehicle to break up in the atmosphere.

Challenger

Challenger (OV-099) was originally built as a test vehicle. In 1979, Rockwell International received a contract to convert the orbiter for space flight (NASA believed Challenger to be a less complex conversion than Enterprise). Challenger arrived at the Kennedy Space Center in 1982, joining the Columbia.

The orbiter was named after the British Naval research vessel HMS Challenger that sailed the Atlantic and Pacific oceans during the 1870s.

Challenger made her maiden voyage on April 4, 1983. That mission included the first spacewalk from an orbiter, as well as the deployment of the first satellite in the Tracking and Data Relay Satellite System (TDRSS) constellation. Several spacelabs were carried into orbit in Challenger's payload bay. Sally Ride, the first American woman in space, rode to orbit aboard the Challenger.

Challenger was the first orbiter to be launched at night and the first to land at the Kennedy Space Center (prior missions had landed at either the Edwards Air Force Base in California or at White Sands, New Mexico).

The orbiter and crew (including high school teacher Sharon Christa McAuliffe) were lost when a seal failed in the right rocket booster. The open joint allowed burning fuel to escape from the rocket booster and breach the external tank. Seventy-three seconds after liftoff, the orbiter was destroyed in an explosion from

the failure of the hydrogen and oxygen fuel inner tanks.

Space Shuttle Memorial

Last year (June 2015), a permanent memorial, "Forever Remembered," opened at the Kennedy Space Center Visitor Complex. The memorial honors the crews lost on the Challenger (1986) and Columbia (2003) space shuttles. Personal items from the crew members are included, as well as debris from both orbiters never before displayed in public.

Planning Your Visit

Space Shuttle	Enterprise	Discovery	Endeavour	Atlantis
Location	Intrepid Sea, Air & Space Museum, NYC	Smithsonian Udvar-Hazy Center, Chantilly, Virginia	California Science Center, ^[1] Los Angeles	Kennedy Space Center, Florida
General Admission ^[2]				
Adult	\$33.00	Free	Free ^[3]	\$50.00
Seniors	\$31.00	Free	Free ^[3]	\$46.00
College Students	\$31.00	Free	Free ^[3]	-
Child	\$24.00	Free	Free ^[3]	\$40.00
Child (under 5)	Free	Free	Free ^[3]	-
Retired Military	Free	Free	Free ^[3]	-
Active Duty	Free	Free	Free ^[3]	\$46.00
Museum Members	Free	Free	Free ^[3]	-
Parking	-	\$15.00	\$12.00	\$10.00
Summer Hours (M-F)	10:00 am - 5:00 pm	10:00 am - 6:30 pm	10:00 am - 5:00 pm	9:00 am - 6:00 pm
Summer Hours (Weekends)	10:00 am - 6:00 pm	10:00 am - 6:30 pm	10:00 am - 5:00 pm	9:00 am - 6:00 pm

^[1] Endeavour is on temporary display while its permanent home is under construction

^[2] Best available information and subject to change. Does not include special attractions, tours or access to traveling exhibits

^[3] \$2 timed reservation is required on weekends, holidays, and the high attendance periods

Reference Websites for Additional Information:

Enterprise <http://www.intrepidmuseum.org/>

/Discovery <https://airandspace.si.edu/visit/udvar-hazy-center/>

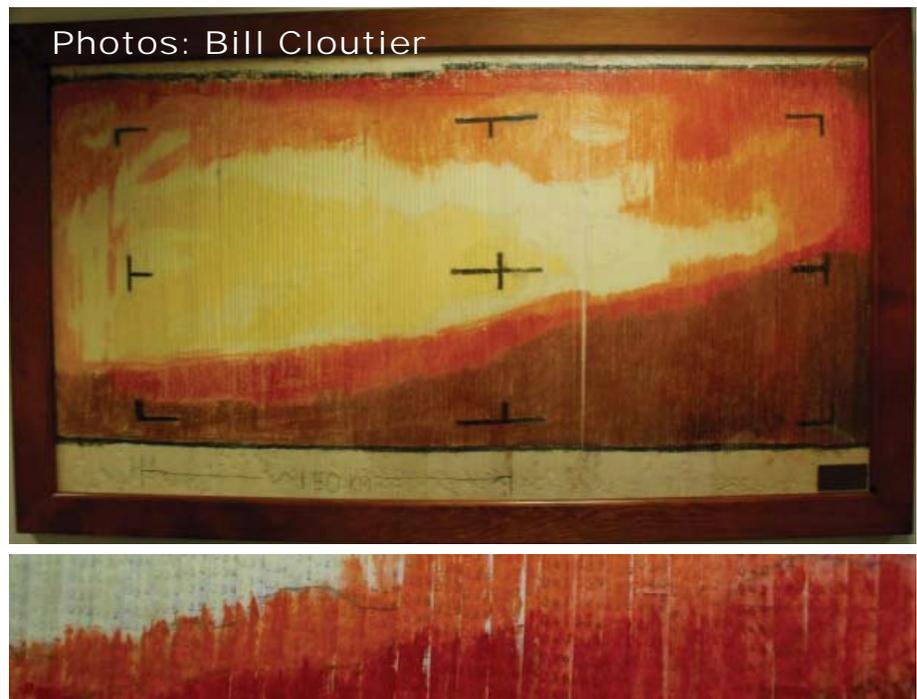
Endeavour <http://californiasciencecenter.org/>

Atlantis <https://www.kennedyspacecenter.com>

Mariner 4 – The First Photograph

In a nondescript hallway at NASA's Jet Propulsion Laboratory (JPL) hangs a framed picture that could pass for modern art or a preschool art project. A closer inspection reveals its composition: 3-inch wide strips of ticker tape arranged in columns and containing streams of seemingly random numbers, colored like a paint-by-numbers picture.

The picture is actually the first television image of Mars (in pastels), as transmitted from a small tape recorder on the Mariner 4 spacecraft as it flew past Mars on July 14, 1965. The digital data transmitted from the recorder was converted into numbers and printed on strips of paper at JPL (JPL built the Mariner 4 spacecraft and its unsuccessful twin, Mariner 3). JPL personnel, anxious to see if the tape recorder was working (it was a spare recorder that flew on Mariner 4), stapled the strips to the wall and hand colored the numbers with pastels purchased from a local art



store based upon the brightness of the individual pixels.

The resulting picture shows the limb of Mars, with brown representing space. The completed picture was eventually cut out of the wall, framed and presented to then JPL director, William H. Pickering. Mari-

ner 4 transmitted a total of 22 black and white photographs during its encounter with Mars, passing as close as 6,118 miles (9,846 km) to the Red Planet. The images revealed a barren and cratered planet - much to the disappointment of those hoping for a more hospitable environment.

Summer Activities

Summer is a great time to enjoy the night sky. Some suggestions for this summer:

1. Attend a star party. Star parties are gatherings of amateur astronomers where the general public is invited to share the wonders of the night skies with skilled observers and through telescopes of every size and shape. A calendar of dates and locations across the United States is available at www.skyandtelescope.com. Closer to home, the McCarthy Observatory hosts a star party on the second Saturday of each month. Please join us on July 9th and August 13th with your family and friends for a memorable evening under the stars.
2. Take in a meteor shower. With no telescope required, this naked-eye activity can be enjoyed in a lawn chair and a warm blanket. While an occasional meteor can be spotted at anytime, August 12th is the night to catch the Perseids meteor shower. A meteor shower occurs when the Earth passes through a cloud of debris usually left behind by a comet. Comet Swift-Tuttle is the source of the small grains of dust that create the Perseid shower. As one of the most famous showers, the Perseids meteor shower usually delivers an impressive display. Expect dark skies as moonlight will not be a problem this year.
3. Locate the Summer Milky Way. Our solar system resides in one of the outer arms of a very large, rotating pinwheel of 200-300 billion stars called the Milky Way Galaxy. During the summer, we can see the inner arms of the pinwheel in the direction of the galactic core. Unfortunately, a dark sky is required, as excessive lighting is ruining the natural inky black of the celestial sphere. However, it can be seen from parts of New Milford, late at night and once the moon has set. If you have never seen the Milky Way:

- Locate the Big Dipper (the most prominent asterism in the northern sky). The last two stars in the bowl of the Dipper point to the North Star.
- Imagine a line extended from the two Dipper stars, through the North Star and an equal distance beyond. You should now be between the constellations Cepheus and Cassiopeia. Cassiopeia is shaped like a W or and is the starting point for our journey down the Milky Way.
- The Milky Way flows from Cassiopeia south to Cygnus (the Swan or Northern Cross). Cygnus can be recognized by its brightest star Deneb (at the tail) and the three bright stars that form the wing.
- Continuing south, the bright star Altair provides the next navigation aid, directing us to Sagittarius, an asterism shaped like a teapot. On a dark night, the star clouds of the Milky Way appear like steam from the spout of the teapot. The spout is also in the general direction of the center of our galaxy (26,000 light years away).

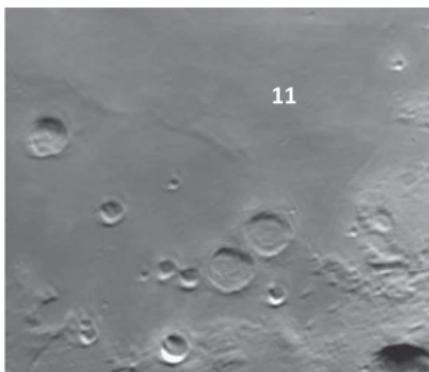


"Teapot" asterism in Sagittarius and star clouds of the Milky Way. Photo: Bill Cloutier

- From a good observing site, you should see a band of cloudiness through this area of the sky. Through binoculars, the "clouds" can be resolved into bright areas populated by stars and darker areas with few or no stars. The darker patches are regions of gas and dust that obscure our view of the galactic center.
4. Find the Apollo landing sites. July marks the anniversaries of two moon landings. Apollo 11 landed on the southwestern shore of the Sea of Tranquility on July 20, 1969. Apollo 15 landed in the foothills of the Apennine Mountains on July 30, 1971. The southwestern shore of the Sea of Tranquility is visible 5 days after a New Moon. The Sun rises on the Apennine Mountains around the First Quarter Moon.



Sea of Tranquility and Apollo 11 landing site



Apennines Mountains and Apollo 15 landing site

Sunrise and Sunset

July			August		
<u>Sun</u>	<u>Sunrise</u>	<u>Sunset</u>	<u>Sun</u>	<u>Sunrise</u>	<u>Sunset</u>
April 1 st (EST)	06:36 am	7:19 pm	August 1st	05:49	20:11
April 15 th	06:13 am	7:35 pm	August 15th	06:03	19:52
April 30 st	05:51 am	7:51 pm	August 31st	06:19	19:28

Astronomical and Historical Events

July

- 1st Moon at Perigee (closest distance to Earth)
- 1st History: opening of the Smithsonian National Air & Space Museum (1976)
- 1st History: NASA officially activates the Launch Operations Center on Merritt Island, Florida; later renamed the Kennedy Space Center (1962)
- 1st History: 100 inch diameter mirror for the Hooker Telescope arrives on Mt. Wilson (1917)
- 1st History: discovery of asteroid 6 *Hebe* by Karl Hencke (1847)
- 2nd History: launch of European Space Agency's Giotto spacecraft to Comet Halley (1985)
- 3rd History: launch of the ill-fated Nozomi spacecraft to Mars by Japan (1998)
- 3rd History: launch of the Solar Anomalous and Magnetospheric Particle Explorer (SAMPEX) by a Scout rocket (1992)
- 4th New Moon
- 4th Earth at Aphelion, furthest distance from Sun (1.017 AU)
- 4th Juno enters orbit around Jupiter
- 4th Mars Express flyby of Mars' largest moon, *Phobos*, at a distance of 217 miles (350 km)
- 4th Mars Spring Equinox (southern hemisphere)
- 4th History: impact of Comet Tempel 1 by Deep Impact's impactor (2005)
- 4th History: Pathfinder spacecraft, with rover Sojourner, lands on Mars (1997)
- 4th History: Chinese astronomers record a "guest star" (supernova) in the constellation Taurus; visible for 23 days and 653 nights (1054); the remnant (Crab Nebula) later catalogued by Charles Messier as Messier 1 or M1
- 5th Kuiper Belt Object 2014 MU69 at Opposition (42.313 AU), potential target for January 1, 2019 flyby by the New Horizons spacecraft
- 5th Kuiper Belt Object 2014 PN70 at Opposition (43.028 AU)
- 6th Scheduled launch of an Orbital ATK Cygnus cargo-carrying spacecraft to the International Space Station from Wallops Island, Virginia
- 6th Scheduled launch of a Russian Soyuz spacecraft carrying members of the next expedition crew to the International Space Station from the Baikonur Cosmodrome, Kazakhstan
- 6th History: discovery of Jupiter's moon *Lysithea* by Seth Nicholson (1938)
- 6th History: Isaac Newton's "Principia" published (1687)
- 7th Atira Asteroid 413563 (2005 TG45) closest approach to Earth (1.186 AU)
- 7th History: launch of the Mars Exploration Rover B (Opportunity) (2003)
- 8th Dwarf Planet 134340 Pluto at Opposition (32.115 AU), rising with the setting Sun and visible (with a telescope) all night
- 8th Apollo Asteroid 11885 *Summanus* Closest Approach to Earth (1.558 AU)
- 8th History: launch of the Space Shuttle Atlantis (STS-135) to the International Space Station; final space shuttle flight to low-Earth orbit (2011)
- 9th Second Saturday Stars – Open House at the McCarthy Observatory
- 9th Apollo Asteroid 101955 *Bennu* closest approach to Earth (1.375 AU)

- 9th History: closest pass of Jupiter's cloud tops by the Voyager 2 spacecraft (1979)
- 10th History: flyby of asteroid *21 Lutetia* by the European Space Agency's Rosetta spacecraft (2010).
- 10th History: launch of Telstar 1, prototype communication satellite designed and built by Bell Telephone Laboratories (1962)
- 10th History: Alvan Graham Clark born, optician and telescope maker (1832)
- 11th First Quarter Moon
- 11th Apollo Asteroid 2010 WT8 near-Earth flyby (0.093 AU)
- 11th History: launch of the Soviet Gamma Observatory (1990)
- 11th History: Skylab re-enters into the Earth's atmosphere (1979)
- 12th History: launch of Soviet Mars orbiter Phobos 2 (1988)
- 13th Moon at Apogee (furthest distance from Earth)
- 13th History: Soviet Union launches Luna 15, a lunar lander and sample return mission, in an attempt to upstage Apollo 11; crashed during landing (1969)
- 13th History: Langley Research Center's birthday (1917)
- 14th History: flyby of the dwarf planet Pluto by the New Horizons spacecraft dwarf planet and its largest moon Charon (2015)
- 14th History: flyby and first close-up view of Mars by the Mariner 4 spacecraft (1965)
- 15th Apollo Asteroid 1566 *Icarus* closest approach to Earth (0.655 AU)
- 15th History: the Dawn spacecraft enters orbit around the asteroid 4 *Vesta* (2011)
- 16th Scheduled launch of a Russian Progress cargo-carrying spacecraft to the International Space Station from the Baikonur Cosmodrome, Kazakhstan
- 16th Apollo Asteroid 2009 BD closest approach to Earth (0.442 AU)
- 16th Amor Asteroid 153591 (2001 SN263) (2 moons) closest approach to Earth (1.972 AU)
- 16th History: over twenty fragments of comet Shoemaker-Levy 9, with diameters estimated at up to 2 kilometers, collide with Jupiter between July 16th and the 22nd (1994); the comet had been discovered a year earlier by astronomers Carolyn and Eugene Shoemaker and David Levy
- 16th History: launch of Badr-A, first Pakistan satellite (1990)
- 16th History: launch of Apollo 11, with astronauts Neil Armstrong, Edwin "Buzz" Aldrin and Michael Collins, first manned lunar landing (1969)
- 16th History: first launch of a Proton rocket by the Soviet Union (1965)
- 16th History: first photo of a star other than our Sun (Vega) taken at the Harvard College Observatory (1850)
- 17th History: docking (and crew handshake) of an Apollo spacecraft with astronauts Thomas Stafford, Vance Brand, and "Deke" Stayton with a Soyuz spacecraft with cosmonauts Alexei Leonov and Valeri Kubasov (the Apollo-Soyuz Test Project (ASTP)) (1975)
- 17th History: William Bond and John Adams Whipple take the first photograph of a star (Vega) at the Harvard College Observatory (1850)
- 18th Scheduled launch of a SpaceX Dragon cargo-carrying spacecraft to the International Space Station from Cape Canaveral Air Force Station, Florida
- 18th History: John Glenn born, first American to orbit the Earth in 1962 (1921)
- 18th History: launch of Rohini 1, India's first satellite (1980)
- 18th History: launch of Gemini X, with astronauts John Young and Michael Collins (1966)
- 18th History: launch of Soviet Zond 3 spacecraft; first successful flyby of Moon; transmitted photographs that included the far side (1965)
- 18th History: Allan Sandage born, astronomer specializing in observational cosmology (1926)
- 19th Full Moon (sometimes called the Full Buck, Thunder or Hay Moon)
- 19th History: launch of the Explorer 35 spacecraft into an elliptical lunar orbit; designed to study interplanetary plasma, magnetic field, energetic particles, and solar X-rays (1967)
- 20th History: discovery of Jupiter's moon *Callirrhoe* (2000)
- 20th History: Gus Grissom's Mercury capsule (Liberty Bell 7) retrieved from the Atlantic Ocean floor at a depth of 15,000 feet, 38 years after it had sunk after splashdown (1999)

Astronomical and Historical Events for July (continued)

- 20th History: Viking 1 lands on Mars (1976)
- 20th History: Apollo 11 lands on Moon at 4:17 pm EDT; first step onto the lunar surface at 10:56 pm (1969)
- 21st Aten Asteroid 2014 BT8 near-Earth flyby (0.048 AU)
- 21st History: launch of the Soviet Mars mission Mars 4 (1973)
- 21st History: launch of Mercury-Redstone 4 with astronaut Virgil (Gus) Grissom; second suborbital flight by the United States (1961)
- 21st History: discovery of Jupiter's moon *Sinope* by Seth Nicholson (1914)
- 22nd Amor Asteroid 154244 (2002 KL6) near-Earth flyby (0.068 AU)
- 22nd History: first dogs (Dezik and Tsygan) to make a suborbital flight aboard a Soviet R-1 rocket (wore pressure suits and acrylic glass bubble helmets) (1951)
- 22nd History: landing of Soviet spacecraft Venera 8 on Venus (1972)
- 23rd Apollo Asteroid 4660 *Nereus* closest approach to Earth (1.958 AU)
- 23rd History: launch of Space Shuttle Columbia (STS-93) and the Chandra X-ray Observatory (1999); first mission commanded by a woman, Eileen Collins
- 23rd History: discovery of Comet Hale-Bopp by Alan Hale and Tom Bopp (1995)
- 23rd History: discovery of Neptune's rings (1984)
- 23rd History: launch of Landsat 1 into a near-polar orbit to obtain information on Earth's resources, environmental pollution, and meteorological phenomena (1972)
- 24th Centaur Object 52872 *Okyrhoe* at Opposition (9.275 AU)
- 24th Centaur Object 83982 *Crantor* at Opposition (16.999)
- 24th History: first rocket launch from Cape Canaveral (Bumper/V-2 rocket) in 1950
- 25th Scheduled flyby of Saturn's largest moon, *Titan*, by the Cassini spacecraft
- 25th Apollo Asteroid 217628 *Lugh* closest approach to Earth (3.261 AU)
- 25th Apollo Asteroid 162173 *Ryugu* closest approach to Earth (0.396 AU) (Hayabusa 2 target in July 2018)
- 25th History: Svetlana Savitskaya becomes the first woman to walk in space (1984)
- 25th History: launch of Soviet Mars orbiter Mars 5 (1973)
- 26th Last Quarter Moon
- 26th Apollo Asteroid 2135 *Aristaeus* closest approach to Earth (1.506 AU)
- 26th History: launch of the Space Shuttle Discovery (STS-114) "Return to Flight," 907 days after the loss of Space Shuttle Columbia (2005)
- 26th History: launch of Apollo 15 with astronauts David Scott, James Irwin and Alfred Worden; fourth lunar landing (1971)
- 26th History: launch of Syncom 2, first geosynchronous satellite (1963)
- 27th Moon at Perigee (closest distance to Earth)
- 27th Centaur Object 944 *Hidalgo* at Opposition (5.450 AU)
- 28th History: launch of Skylab-3 astronauts Alan Bean, Jack Lousma and Owen Garriott (1973)
- 28th History: launch of Ranger 7; Moon impact mission (1964)
- 29th South Delta-Aquarids Meteor Shower peak
- 29th History: deorbit and destruction of the Salyut 6 space station; first of the Soviet's second-generation space station design (1982)
- 29th History: Deep Space 1 flyby of asteroid *Braille* (1999)
- 30th Apollo Asteroid 5011 *Ptah* closest approach to Earth (1.429 AU)
- 30th History: discovery of the asteroid 951 *Gaspra* by Grigory Neujmin (1916); the Galileo spacecraft passed within 1,000 miles (1,600 km) of Gaspra on October 29, 1991 on its way to Jupiter
- 30th History: the Cassini spacecraft arrives at Saturn after a seven year journey (2004)
- 30th History: launch of the Wilkinson Microwave Anisotropy Probe (WMAP); mapped the Cosmic Microwave Background radiation and determined the age of the universe to be 13.73 billion years old to within one percent (2001)
- 30th History: Apollo 15 lands on Moon at 6:16 pm EDT (1971)
- 30th History: discovery of Jupiter's moon *Carme* by Seth Nicholson (1938)
- 30th History: Galileo observes Saturn's rings (1610)

Astronomical and Historical Events for July (continued)

- 31st Atira Asteroid 2010 XB11 closest approach to Earth (0.741 AU)
- 31st History: impact of the Lunar Prospector (1999)
- 31st History: flyby of Mars by Mariner 6 (1969)

August

- 1st Peak of the Alpha Capricornids meteor shower
- 1st History: discovery of Martian meteorite (shergottite class) SAU 051 in Oman (2000)
- 1st History: launch of Lunar Orbiter 5, the last of the Lunar Orbiter series; photographed potential Apollo and Surveyor landing sites and captured the first image of a nearly full Earth from space (1967)
- 1st History: Maria Mitchell born, first woman to be elected as an astronomer to the American Academy of Arts and Sciences (1818)
- 2nd New Moon
- 2nd Comet 9P/Tempel at perihelion (closest distance to the Sun) (1.542 AU)
- 2nd Apollo Asteroid 3103 *Eger* closest approach to Earth (0.189 AU)
- 3rd Amor Asteroid 2005 OH3 near-Earth flyby (0.015 AU)
- 3rd Kuiper Belt Object 2008 OG19 at Opposition (37.613 AU)
- 3rd History: launch of the MESSENGER spacecraft to Mercury (2004)
- 4th 81st Convention of Amateur Telescope Makers (Stellafane), Springfield, Vermont (through the 7th), see <https://stellafane.org/convention/2016/index.html>
- 4th History: launch of the Phoenix polar lander spacecraft to Mars (2007)
- 5th Centaur Object 37117 *Narcissus* at Opposition (5.228 AU)
- 5th History: launch of the Juno spacecraft to Jupiter (2011); scheduled to arrive on July 4, 2016
- 5th History: flyby of Mars by the Mariner 7 spacecraft (1969)
- 5th History: astronaut Neil Armstrong born (1930); Commander of Apollo 11 and first person to step out on the lunar surface
- 6th Southern Iota Aquarids meteor shower peak
- 6th History: the Rosetta spacecraft and her robotic lander companion Philae arrive in orbit around Comet 67P/Churyumov–Gerasimenko after a 10-year journey (2014)
- 6th History: landing of the Mars Science Laboratory (MSL or Curiosity) at the base of Mount Sharp inside Gale Crater (2012)
- 6th History: launch of Vostok 2 and cosmonaut Gherman Titov; second man in Space (1961)
- 6th History: Chinese astronomers first observe supernova in Cassiopeia; remained visible for more than 6 months (1181)
- 7th History: Brett Gladman, et al's discovery of Saturn moons *Ymir*, *Paaliaq* and *Kiviuq* (2000)
- 7th History: announcement of possible microfossils found in Martian meteorite ALH84001 (1996)
- 7th History: Viking 2 arrives at Mars (1976)
- 8th Apollo Asteroid 2016 CL264 near-Earth flyby (0.058 AU)
- 8th History: launch of Genesis spacecraft, solar particle sample return mission (2001)
- 8th History: launch of Pioneer Venus 2 (1978)
- 8th History: launch of the Soviet Zond 7 Moon probe (1969)
- 9th Moon at Apogee (furthest distance from Earth)
- 9th Atira Asteroid 418265 (2008 EA32) closest approach to Earth (0.599 AU)
- 9th History: launch of the Soviet Luna 24 spacecraft, third attempt (and only successful attempt) to recover a sample from Mare Crisium (1976)
- 10th First Quarter Moon
- 10th Scheduled flyby of Saturn's largest moon, *Titan*, by the Cassini spacecraft
- 10th Apollo Asteroid 306367 *Nut* closest approach to Earth (1.658 AU)
- 10th History: launch of Mars Reconnaissance Orbiter to Mars (2005)
- 10th History: launch of Kitsat A, first South Korean satellite (1992)
- 10th History: the Magellan spacecraft enters orbit around Venus; radar mapped 98% of the planet over the following two years (1990)

Astronomical and Historical Events for August (continued)

- 10th History: launch of the Lunar Orbiter 1 spacecraft; photographed smooth areas of the lunar surface for assessing future landing sites and captured iconic image of the Earth rising above the lunar surface (1966)
- 11th History: Asaph Hall discovers Martian moon *Deimos* (1877)
- 12th Peak of the Perseids meteor shower
- 12th History: launch of the High Energy Astronomical Observatory (HEAO-1) to monitor x-ray sources (1977)
- 12th History: Soviet spacecraft Vostok 4 launched one day after Vostok 3 - first time multiple manned spacecraft in orbit, although they did not rendezvous (1962)
- 12th History: launch of Echo 1, the first experimental communications satellite (1960)
- 13th Second Saturday Stars – Open House at the McCarthy Observatory
- 13th History: discovery of Mars' south polar cap by Christiaan Huygens (1642)
- 13th History: discovery of long-period variable star Mira, (Omicron Ceti) by David Fabricius (1596)
- 16th Mercury at its greatest eastern elongation – apparent separation from the Sun in the early evening sky (27°)
- 16th History: launch of Explorer 12 spacecraft, measured cosmic-ray particles, solar wind protons, and magnetospheric and interplanetary magnetic fields (1961)
- 17th History: launch of Venera 7; Soviet Venus lander (1970)
- 17th History: launch of Pioneer 7 (1966)
- 17th History: Asaph Hall discovers Martian moon *Phobos* (1877)
- 18th Full Moon (sometimes called Sturgeon, Green Corn or Grain Moon)
- 18th History: launch of Suisei; Japan's Comet Halley mission (1985)
- 19th Distant flyby of Saturn's largest moon *Titan* by the Cassini spacecraft
- 19th History: launch of first Philippine communications satellite Agila 2 (also known as Mabuhay 1 or ABS 5) (1997)
- 19th History: launch of Soviet Sputnik 5 spacecraft with dogs Belka and Strelka (1960)
- 19th History: discovery of S Andromedae (SN 1885A), supernova in the Andromeda Galaxy and the first discovered outside the Milky Way Galaxy; discovered by Irish amateur astronomer Isaac Ward in Belfast on the 19th and independently the following day by Ernst Hartwig at Dorpat (Tartu) Observatory in Estonia (1885)
- 19th History: Orville Wright born (1871)
- 19th History: John Flamsteed born; English astronomer known for his accurate astronomical observations and first Astronomer Royal (1646)
- 20th Amor Asteroid 2014 RW22 near-Earth flyby (0.056 AU)
- 20th Apollo Asteroid 54509 YORP closest approach to Earth (0.596 AU)
- 20th Apollo Asteroid 1863 *Antinous* closest approach to Earth (0.767 AU)
- 20th History: launch of Voyager 2 to the outer planets (1977)
- 20th History: launch of Mars orbiter/lander Viking 1 (1975)
- 20th History: Ernst Hartwig's discovery of S Andromedae Supernova (1885)
- 21st Asteroid 2 Pallas at Opposition (8.7 Magnitude)
- 21st Apollo Asteroid 4197 *Morpheus* closest approach to Earth (2.841 AU)
- 21st History: launch of the Orbiting Astronomical Observatory-3, Copernicus, with a UV telescope and X-ray detector (1972)
- 21st History: launch of Gemini V with astronauts Gordon Cooper and Charles Conrad (1965)
- 22nd Moon at Perigee (closest distance to Earth)
- 22nd Apollo Asteroid 3361 *Orpheus* closest approach to Earth (1.647 AU)
- 23rd History: Lunar Orbiter 1 takes first photo of the Earth from the Moon (1966)
- 24th Last Quarter Moon
- 24th Aten Asteroid 326290 *Akhenaten* closest approach to Earth (0.494 AU)
- 24th History: Pluto reclassified as a Dwarf Planet (2006)

Astronomical and Historical Events for August (continued)

- 24th History: launch of the Soviet Luna 11 spacecraft to analyze the Moon's chemical composition, study gravitational anomalies and measure radiation levels (1966)
- 25th Northern Iota Aquarids Meteor Shower Peak
- 25th Apollo Asteroid 2005 QQ87 near-Earth flyby (0.085 AU)
- 25th Kuiper Belt Object 2004 NT33 at Opposition (38.053 AU)
- 25th History: flyby of Neptune by the Voyager 2 spacecraft (1989)
- 25th History: launch of the Spitzer Space Telescope (2003)
- 25th History: launch of the Advanced Composition Explorer spacecraft to study energetic particles from the solar wind, the interplanetary medium, and other sources (1997)
- 26th Amor Asteroid 433 *Eros* closest approach to Earth (0.725 AU)
- 26th Atira Asteroid 2007 EB26 closest approach to Earth (0.882 AU)
- 26th Kuiper Belt Object 225088 (2007 OR10) at Opposition (86.591 AU)
- 26th History: flyby of the planet Saturn by the Voyager 2 spacecraft (1981)
- 27th Venus passes 0.1 degrees from Jupiter in the early evening sky
- 27th Centaur Object 7066 *Nessus* at Opposition (26.173 AU)
- 27th Kuiper Belt Object 307982 (2004 PG115) at Opposition (36.953 AU)
- 27th History: launch of the Mariner 2 spacecraft to Venus; first successful planetary encounter (1962)
- 28th History: flyby of the asteroids *Ida* and *Dactyl* by the Galileo spacecraft (1993)
- 28th History: discovery of Saturn's moon *Enceladus* by William Herschel (1789)
- 29th History: discovery of a bright nova in the constellation Cygnus (Nova Cygni 1975); visible to the unaided eye for about a week (1975)
- 30th Distant flyby of Saturn's largest moon *Titan* by the Cassini spacecraft
- 30th Binary Apollo Asteroid 69230 *Hermes* closest approach to Earth (1.197 AU)
- 30th Plutino 175113 (2004 PF115) at Opposition (40.541 AU)
- 30th Kuiper Belt Object 2003 QX113 at Opposition (58.936 AU)
- 30th History: discovery of first Kuiper Belt Object (1992 QB1) by David Jewitt and Jane Luu
- 30th History: launch of Japanese satellite Yohkoh (Sunbeam) to observe phenomena taking place on the Sun (1991)
- 30th History: launch of STS-8 and astronaut Guy Bluford; first African-American in space and first night launch and landing by a shuttle (1983)
- 31st Apollo Asteroid 2201 *Oljato* closest approach to Earth (2.607 AU)
- 31st Kuiper Belt Object 120178 (2003 OP32) at Opposition (41.166 AU)

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 ($\frac{1}{2}^\circ$), 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

International Space Station/Space Shuttle/Iridium Satellites

Visit www.heavens-above.com for the times of visibility and detailed star charts for viewing the International Space Station, the Space Shuttle (when in orbit) and the bright flares from Iridium satellites.

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.

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

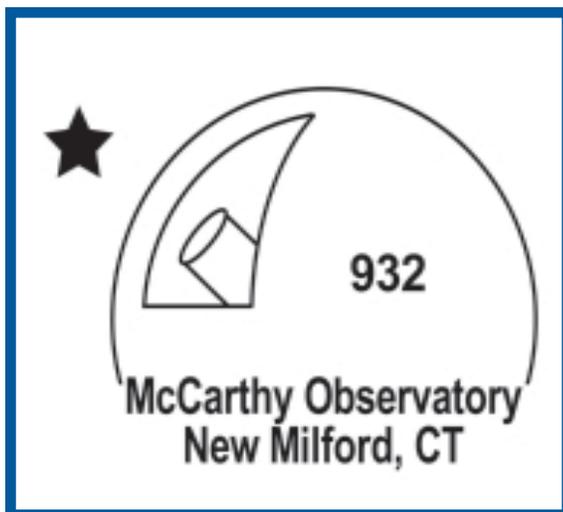
Cover image: This image was taken on August 2, 2005 by the MESSENGER spacecraft at the conclusion of a gravity assist maneuver and systems check a year after its launch.

An acronym for MErcury Surface, Space ENvironment, GEochemistry, and Ranging, Its mission, was to orbit our closest planet to the sun. In addition to its revisit to Earth, it would perform two subsequent flybys of Venus and three of Mercury—each with the purpose of using the planets' gravity as a sling shot to boost its speed and to achieve an orbit of Mercury.

On its exit from Earth's orbit, MESSENGER directed its wide-angle multispectral cameras back toward Earth. The red component of the image is in the near infrared (750 nm) and emphasizes the rich vegetation of the Brazillian jungle. Multispectral imaging is now used routinely by orbiting satellites and ground-based telescopes to explore the complex inner cores of stars and their galaxies.

MESSENGER achieved orbit around Mercury in March 2011, completing its planned mission in 2012. After two mission extensions, the spacecraft successfully broke orbit and crashed onto the planet's surface in April 2015.

For more information on this image, [click here](#).



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

July 9th
8:00 - 10:00 pm



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



July 2016

Celestial Calendar

Sunday Monday Tuesday Wednesday Thursday Friday Saturday

Phases of the Moon July 2016



July 4

July 11

July 19

July 26



1 Smithsonian Air & Space Museum birthday (1976)

100-inch mirror for Hooker telescope arrives at Mt Wilson (1917)



NASA officially activates the Launch Operations Center on Merritt Island, Florida; later renamed the Kennedy Space Center (1962)



2 Launch of European Space Agency' Giotto spacecraft to Comet Halley (1985)



3

Launch of ill-fated Japanese Nozomi spacecraft to Mars (1998)



Launch of the Solar Anomalous and Magnetospheric Particle Explorer (SAMPEX) by a Scout rocket (1992)



4 Crab nebula viewed by Chinese astronomers (1054)



Mars Pathfinder landing (1997)



Henrietta Leavitt born; measured distances to far galaxies (1868)



5

A. E. (Andrew Ellicott) Douglass, an American astronomer who discovered a correlation between tree rings and the sunspot cycle. (1867)



6

Isaac Newton's *Principia* published (1687)

Discovery of Jupiter's moon Lysithea by Seth Nicholson (1938)



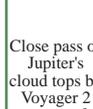
7

Launch of Mars Exploration Rover B *Opportunity* (2003)



8

Launch of the Space Shuttle Atlantis (STS-135) to the International Space Station; final space shuttle flight to low Earth orbit (2011)



9

Close pass of Jupiter's cloud tops by Voyager 2 spacecraft (1979)



2nd Saturday Stars Open House
McCarthy Observatory



10

Alvan Graham Clark born telescope maker (1832)



Flyby of Asteroid 21 Lutetia by European Space Agency's Rosetta spacecraft (2010)



launch of Telstar 1, prototype communication satellite designed and built by Bell Telephone Laboratories (1962)



Probe of comet Tempel 1 by Deep Impact impactor (2005)



Launch of Soviet Gamma Observatory (1990)



Skylab re-enters into the Earth's atmosphere (1979)



12

Soviet Mars orbiter Phobos 2 launched (1988)



Moon at Apogee (furthest distance from Earth)



Langley Research Center Birthday (1917)



Soviet spacecraft Luna 15 launched, lands to crash on Moon (1969)



14

First close-up view of Mars by Mariner 4 Spacecraft (1965)



15

Launch of Apollo 18 and Soyuz 19 in joint U.S./Soviet mission (1975)



The Dawn spacecraft enters orbit around the asteroid 4 Vesta (2011)



16 Apollo 11 Moon mission Armstrong, Aldrin, Collins (1969)



Schoemaker/Levy Comet fragments impact Jupiter (July 16-22, 1994)



first photo of a star other than our Sun (Vega) by Harvard University (1850)



17

Monsignor Georges Lemaitre born; Belgian priest and astronomer was first to propose expanding universe and Big Bang theory (1894)



Docking and handshakes of Apollo 18 and Soyuz 19 crews (1975)



18 Allan Stogdole born, cosmologist (1926)



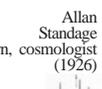
Rohini I, India's 1st satellite, failed at launch (1980)



Gemini X with John Young and Michael Collins (1966)



19 Launch of Explorer 35 spacecraft into an elliptical lunar orbit, to study interplanetary plasma, magnetic field, energetic particles, and solar X-rays (1967)



Edward Charles Pickering born - Harvard astronomer and physicist who discovered the first spectroscopic binary stars, later used to measure cosmic distances. (1846)



20

Viking 1 lands on Mars (1976)



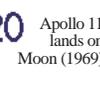
Gus Grissom's capsule Liberty Bell raised after 30 years on ocean floor (1999)



21 Apollo 11 lands on Moon (1969)



Launch of Soviet Mars 4 mission (1973)



22 Virgil (Gus) Grissom, 2nd U.S. suborbital flight (1961)



Landing of Soviet spacecraft Venera 8 on Venus (1972)



23

Launch of Shuttle Columbia and Chandra X-ray Observatory; first mission commanded by a woman, Eileen Collins (1999)



Launch of Landsat 1 into a near-polar orbit to study Earth's resources and meteorological phenomena (1972)



24

Deep Space I encounter with asteroid Braille (1999)



President Eisenhower signs Public Law 85-568, creating the National Aeronautics and Space Administration (1958)



25 Impact of the Lunar Prospector (1999)



Launch of the Wilkinson Microwave Anisotropy Probe (WMAP); mapped the Cosmic Microwave background radiation and determined the age of the universe (2001)



24

Bumper V-2, first rocket launch from Cape Canaveral (1950)



78th Convention of Amateur Telescope Makers (Stellafane), Springfield, Vt (through the 27th)



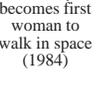
25 Svetlana Savitskaya becomes first woman to walk in space (1984)



Launch of Soviet orbiter Mars 5 (1973)



26 Shuttle Discovery (STS-114) "return to flight" (2005)



Launch of Syncom 2, first geosynchronous satellite (1963)



27 Moon at Perigee (closest distance to Earth)

launch of Apollo 15, fourth lunar landing (1971)



Sir George Biddell Airy born - an English mathematician and Astronomer Royal who worked on planetary orbits, measuring the mean density of the Earth, and establishing Greenwich as the prime meridian (1801)



28 Launch of Ranger 7, Moon impact mission (1964)



Launch of Skylab 3 (Bean, Pogue, Garriott) (1973)



29 South Delta-Aquarids meteor shower peak



30 Impact of the Lunar Prospector (1999)



31

Impact of the Lunar Prospector (1999)



Mariner 6 Mars flyby (1969)

Phases of the Moon August 2016



Aug 2

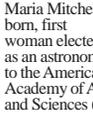
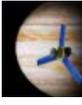
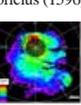
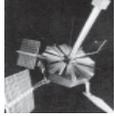
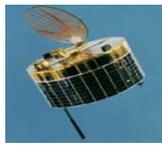
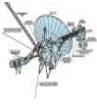
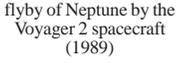
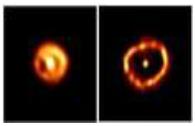
Aug 10

Aug 18

Aug 24

August 2016

Celestial Calendar

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday																																																																																																								
	<p>1</p>  <p>Launch of Lunar Orbiter 5, the last of the Lunar Orbiter series (1967)</p>  <p>Maria Mitchell born, first woman elected as an astronomer to the American Academy of Arts and Sciences (1818)</p>	<p>2</p>  <p>Valery Fyodorovich Bykovsky born; Soviet cosmonaut flew three manned space mission space flights, spending five days in orbit aboard Vostok 5 in 1968 - a record for a solo flight. (1934)</p>	<p>3</p>  <p>Launch of MESSENGER spacecraft to Mercury (2004)</p>	<p>4</p>  <p>Launch of Phoenix Spacecraft to Mars (2007)</p>	<p>5</p>  <p>Astronaut Neil Armstrong born (1930)</p>  <p>Launch of the Juno spacecraft to Jupiter (2011)</p>  <p>Flyby of Mars by the Mariner 7 spacecraft (1969)</p>	<p>6</p>  <p>Gherman Titov, 2nd man in space (1961)</p>  <p>Cassiopeia Supernova observed by Chinese (1181)</p>  <p>Landing of Mars Science Lab (MSL or Curiosity) inside Gale Crater (2012)</p>																																																																																																								
<p>7</p>  <p>Viking 2 on Mars (1976)</p>  <p>Martian meteorite found to contain possible life (1996)</p>	<p>8</p>  <p>Launch of Genesis Spacraft (2001)</p>  <p>Launch of Pioneer Venus 2 (1978)</p>  <p>Launch of Soviet Zond 7 moon probe (1969)</p>	<p>9</p>  <p>Moon at Apogee (furthest distance from Earth)</p>  <p>Launch of Soviet Luna 24 spacecraft, third (and only successful attempt) to recover a sample from Mare Crisium (1976)</p>	<p>10</p>  <p>Launch of Mars Reconnaissance Orbiter (2005)</p>  <p>Magellan spacecraft orbits Venus (1990)</p>	<p>11</p>  <p>Asaph Hall discovers Martian Moon Deimos (1877)</p>	<p>12</p>  <p>Perseid meteor showers at peak</p>  <p>Launch of the High Energy Astronomical Observatory (HEAO-1) to monitor x-ray sources (1977)</p>  <p>Launch of Echo 1A, communications satellite in 2nd attempt (1960)</p>	<p>13</p>  <p>Discovery of long-period variable star Mira, Omicron Ceti by David Fabricius (1596)</p>  <p>Discovery of Mars' south polar cap by Christiaan Huygens (1642)</p>  <p>2nd Saturday Stars Open House McCarthy Observatory</p>																																																																																																								
<p>14</p>  <p>Educator astronaut Barbara Morgan leads a Q&A session with children in Boise, Idaho from the space shuttle Endeavour, fulfilling legacy of Christa McAuliffe, who died in the 1986 Challenger disaster (2007)</p>	<p>15</p>  <p>President Reagan announced his support for the construction of an orbiter to replace Challenger (1986)</p>	<p>16</p>  <p>Launch of Explorer 12 spacecraft, measured cosmic-ray particles, solar wind protons, and magnetospheric and interplanetary magnetic fields (1961)</p>	<p>17</p>  <p>launch of Venera 7; Soviet Venus lander (1970)</p>  <p>Asaph Hall discovers Martian Moon Phobos (1877)</p>  <p>Launch of Pioneer 7 (1966)</p>	<p>18</p>  <p>Launch of Suissei, Japan's Comet Halley mission (1985)</p>	<p>19</p>  <p>Launch of Sputnik 5, with dogs Belka and Strelka (1960)</p>  <p>Birth of Orville Wright (1871)</p>  <p>Sir John Flamsteed born, English astronomer (1646)</p>  <p>Dmitri Ivanovich Mendeleev rises to 11,500 feet (3.5 km) to observe an eclipse in Russia (1887)</p>	<p>20</p>  <p>Launch of Mars orbiter/lander Viking 1 (1975)</p>  <p>Launch of Voyager 2 to outer planets (1977)</p>																																																																																																								
<p>21</p>  <p>Launch of Gemini V with astronauts Gordon Cooper and Charles Conrad (1965)</p>  <p>Launch of the Orbiting Astronomical Observatory-3 Copernicus, with a UV telescope and X-ray detector (1972)</p>	<p>22</p>  <p>Moon at Perigee (closest distance to Earth)</p>  <p>Neptune was found to have a continuous ring system by the Voyager 2 spacecraft (1989)</p>	<p>23</p>  <p>Lunar Orbiter 1 takes first photograph of Earth from Moon (1966)</p>	<p>24</p>  <p>Pluto reclassified as a dwarf planet (2006)</p>  <p>Launch of the Soviet Luna 11 spacecraft to analyze the Moon's chemistry, gravitation and radiation levels (1966)</p>	<p>25</p>  <p>flyby of Neptune by the Voyager 2 spacecraft (1989)</p>  <p>Meteor shower (Northern Iota Aquarids peak)</p>	<p>26</p>  <p>Flyby of Saturn by Voyager 2 spacecraft (1981)</p>	<p>27</p>  <p>launch of the Mariner 2 spacecraft to Venus; first successful planetary encounter (1962)</p>																																																																																																								
<p>28</p>  <p>Discovery of Nova Cygni in the constellation Cygnus (1975)</p>	<p>29</p>  <p>Discovery of Saturn's moon Enceladus by William Herschel (1789)</p>  <p>Flyby of asteroids Ida and Dactyl by the Galileo spacecraft (1993)</p>	<p>30</p>  <p>Discovery of first Kuiper Belt object, 1992 QB1, by David Jewet and Jane Luu</p>  <p>Launch of STS-8 and astronaut Guy Bluford, 1st African-American in space (1983)</p>  <p>First recorded occurrence - comet Howard Koomen-Michels impacts sun (energy of 1 million hydrogen bombs) (1979)</p>	<p>31</p>  <p>US Naval Observatory authorized by an act of Congress (1842)</p>	<table border="1"> <thead> <tr> <th colspan="7">Jul 2016</th> </tr> <tr> <th>S</th> <th>M</th> <th>T</th> <th>W</th> <th>T</th> <th>F</th> <th>S</th> </tr> </thead> <tbody> <tr> <td></td> <td></td> <td></td> <td></td> <td></td> <td>1</td> <td>2</td> </tr> <tr> <td>3</td> <td>4</td> <td>5</td> <td>6</td> <td>7</td> <td>8</td> <td>9</td> </tr> <tr> <td>10</td> <td>11</td> <td>12</td> <td>13</td> <td>14</td> <td>15</td> <td>16</td> </tr> <tr> <td>17</td> <td>18</td> <td>19</td> <td>20</td> <td>21</td> <td>22</td> <td>23</td> </tr> <tr> <td>24</td> <td>25</td> <td>26</td> <td>27</td> <td>28</td> <td>29</td> <td>30</td> </tr> <tr> <td>31</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> </tbody> </table>	Jul 2016							S	M	T	W	T	F	S						1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31							<table border="1"> <thead> <tr> <th colspan="7">Sep 2016</th> </tr> <tr> <th>S</th> <th>M</th> <th>T</th> <th>W</th> <th>T</th> <th>F</th> <th>S</th> </tr> </thead> <tbody> <tr> <td></td> <td></td> <td></td> <td></td> <td>1</td> <td>2</td> <td>3</td> </tr> <tr> <td>4</td> <td>5</td> <td>6</td> <td>7</td> <td>8</td> <td>9</td> <td>10</td> </tr> <tr> <td>11</td> <td>12</td> <td>13</td> <td>14</td> <td>15</td> <td>16</td> <td>17</td> </tr> <tr> <td>18</td> <td>19</td> <td>20</td> <td>21</td> <td>22</td> <td>23</td> <td>24</td> </tr> <tr> <td>25</td> <td>26</td> <td>27</td> <td>28</td> <td>29</td> <td>30</td> <td></td> </tr> </tbody> </table>	Sep 2016							S	M	T	W	T	F	S					1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	
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