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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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#### July and August Calendar and Space Exploration Almanac



#### "Out the Window on Your Left"

Fifty years ago, on July 16, 1969, astronaut Neil Armstrong rode the high-speed elevator to the 320foot level of the mobile launch pad and crossed the access walkway on Swing Arm 9, entering the White Room. Assisted by a team of technicians, Commander Armstrong



entered through the Command Module's (CM) hatch approximately 2-1/2 hours before liftoff, taking the left seat. He was followed by CM Pilot Michael Collins, who took the right seat and Lunar Module (LM) Pilot Buzz Aldrin, who took the center seat.

Inside the spacecraft, Astronaut Fred Haise, the back-up CM Pilot, was in the lower equipment bay, assisting the prime crew through the preliminary checks. Haise exited the spacecraft around 7:30 am (EDT) and the technicians began the process of closing the spacecraft's hatch about 2 hours prior to launch.

The countdown proceeded with only minor problems reported - none with the spacecraft. A communication problem with the pad was quickly remedied. Another problem involved a leaky valve in a system that replenished hydrogen fuel for the third stage. Technicians working on the third stage, 120 feet (37 meters) below the CM, were able to bypass the valve so that the countdown could proceed.

Approximately one hour prior to launch, the crew in the White Room departed, and Swing-Arm 9 was moved back 5 feet (1.5 meters). The swing arm maintained this relatively-close position until the 5-minute mark (before launch) in the event that the astronauts had to rapidly exit the spacecraft.

At T-9 seconds, the valves on the liquid oxygen feed lines opened. Liquid oxygen entered the Saturn V's F-1 engine's main thrust chamber first, followed by the kerosene fuel (the fuel tank's 10 fuel-suction lines were capable of releasing 1,350 gallons of kerosene every second to the five engines). The center F-1 engine was started first, followed by engines 1 and 3, and then engines 4 and 2. Within seconds all five engines were up and running, producing a combined thrust of 7.5 million pounds. Once released by the launch pad's restraining hold-down arms, the Saturn V began to slowly rise, taking 10 seconds to clear the launch tower. The six-million-pound rocket accelerated as it climbed into the Florida sky. Approximately 2-1/2 minutes later, the five F-1 engines had carried the rocket to an altitude of 38 miles, exhausting more than 500,000 gallons of fuel and oxidizer. After the expended first stage dropped off, the five J-2 engines on the rocket's second stage were ignited. Fueled by liquid hydrogen and liquid oxygen, the second stage carried the remaining payload to an altitude of 115 miles in about six minutes. With its fuel consumed, the second stage dropped off. The rocket's third stage single J-2 engine then ignited for the first time, acceler-



ating the spacecraft to an orbital velocity (17,500 mph).

Once in orbit, the three astronauts and the engineers and technicians in mission control, completed a thorough checkout of the spacecraft. On the second orbit of the Earth, approximately 3 hours after liftoff, mission control approved trans-lunar injection. The third stage's J-2 engine restarted, and burned for slightly over 5 minutes. This increased the spacecraft's velocity from 17,500 mph to 24,500 mph and raised its orbit so as to intercept the moon (the moon at launch was approximately 240,000 miles away and traveling at 38 miles per minute through space).

Fifteen minutes later, the Command/Service Module (CSM) separated from the third stage, turned around, and docked with the LM stowed inside a conical adapter atop the third stage. The CSM/LM then moved away from the third stage and the third stage's engine restarted for the second time to send the rocket stage into a heliocentric orbit.

Two and one-half days after liftoff, the CSM/LM passed the point in its trajectory where the Earth's gravitational influence diminished and the moon's gravitational influence grew. Fourteen hours later, the CSM/LM passed behind the moon. The Service Module's engine was then used to slow the spacecraft, allowing it to be captured by the moon.

Almost a day after entering orbit around the moon, Armstrong and Aldrin undocked the LM from the CSM. Less than 90 minutes later, a 30-second burn of the LM's descent stage engine transferred the spacecraft into a 50,000-foot descent orbit. At 4:05 pm (EDT), the LM's descent stage engine was ignited again, initiating a 12minute descent to the lunar surface. Five seconds into the descent, the first of five alarms sounded within the cabin, indicating that the spacecraft's navigation computer was overloaded and rebooting. (Due to an error in the checklist, the astronauts had placed the switch for the rendezvous radar in the wrong position – placing demands on the computer that interfered with the computer's other, more critical landing tasks).

At 500 feet, Armstrong took manual control of the LM once it was clear that the LM's automatic landing system was carrying the spacecraft towards a large crater

with a boulder-covered floor. Flying past the crater, Armstrong looked for a safe place to set the LM down while Aldrin called out critical instrument data (including remaining fuel). The Sun was climbing into the pitch-black sky and was just 12.5 degrees above the horizon. The low Sun cast long shadows that accented the rugged terrain. At 250 feet, Buzz Aldrin spotted the LM's shadow on the lunar landscape below. At 100 feet above the surface. Aldrin called out to Armstrong that the fuel indicator was at 5% which triggered the 90 second abort clock back at Mission Control in Houston. Less than



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a minute later, the sensory probes hanging from the LM's footpads touched the surface and the contact light came on inside the cabin. Armstrong shut down the descent engine and the LM settled to the surface, coming to rest at 4:17:39 P.M. (EDT) on Sunday, July 20, 1969. A few seconds later Armstrong called out "Houston - Tranquility Base here. The Eagle has landed."

After securing the descent stage and preparing the ascent stage for an emergency departure (if required), Armstrong exited the LM at 10:51 pm (EDT), setting his left foot on the moon five minutes later. The first step on the moon was a major technological achievement and the culmination of an eightyear effort by more than 400,000 people and tens of thousands of companies.

It had begun eight years earlier. With only 15 minutes of manned flight experience (the suborbital flight of astronaut Alan Shepard), President Kennedy went before Congress on May 25, 1961 and asked for funding for an ambitious program of lunar exploration: "I believe that this nation should commit itself to achieving the goal, before this decade is out, of landing a man on the moon and returning him safely to the earth." Four

#### Saturn at Opposition

Saturn joins Jupiter in the evening sky in the month of July as the ringed-planet approaches opposition on the 9th. (Opposition occurs for a planet further from the Sun than the Earth, when it is opposite the Sun in the Earth's sky, rising at sunset and setting at sunrise). At the start of July, Saturn months later, the President told the crowd at Rice University "We choose to go to the moon. We choose to go to the moon in this decade and do the other things, not because they are easy, but because they are hard, because that goal will serve to organize and measure the best of our energies and skills, because that challenge is one that we are willing to accept, one we are unwilling to postpone, and one which we intend to win, and the others, too."

Every month, approximately six days after a New Moon, the Sun rises upon the undisturbed footprints left behind at Tranquility Base.

rises in the southeast just before sunset. By month's end, Saturn is above the horizon almost ninety minutes before the sun sets. Saturn will be visible all night on the 9th and at its highest in the sky around 1 am local time. With an orbital period of 29.5 years, Saturn aligns with the Earth and Sun



The evening sky on the night of Opposition, looking south-southeast from the Danbury, Connecticut area. Graphics: In-the-Sky.org, © Dominic Ford

Photo: Bill Cloutier

every 376 days. This year, the gas giant can be found in the constellation Sagittarius, to the east of Jupiter, and shinning at a relatively bright +0.1 magnitude.

Saturn's axial tilt is almost 27° (as compared to Earth's 23.5° or Jupiter's 3°). The axial tilt produces seasons which last more than 7 years, since it takes Saturn almost 291/2 years to complete an orbit around the Sun. It was summer in the southern hemisphere when the Cassini spacecraft arrived in 2004, with the planet's north pole in perpetual darkness. Saturn's Vernal equinox occurred in August 2009 with both hemispheres experiencing equal amounts of sunlight (at equinox, the rings appear almost edge on). Since that time, our view of the rings has improved. With the northern summer solstice in May 2017, the rings were wide open, with the planet's north pole sunlit and tipped towards Earth. This year the ring tilt is less, but still impressive at 24.3° (slightly less than in 2018).

#### The Search for Snoopy

Apollo 10 was a dress rehearsal for a moon landing with astronauts Gene Cernan and Tom Stafford flying the Lunar Module (LM) to an altitude of less than 47,000 feet (14,326 meters) above the lunar surface. With two passes over the future landing site in the Sea of Tranquility, the LM's descent stage was discarded (crashing into the moon) and the ascent stage engine used to rendezvous with the Command Module (CM). NASA's nicknames for the CM and LM were "Charlie Brown" and "Snoopy," respectively, after the characters in the Peanuts comic strip, by Charles Schulz.

Once the ascent stage rendezvoused with the CM, and the crew had transferred back into the CM, the ascent stage was sent into orbit around the sun. Forgotten, Snoopy remained lost until eight years ago when a group of amateur astronomers in the United Kingdom began a search for the spacecraft. With limited orbital data, the odds of finding the spacecraft were estimated to be 235 million to one. However, after 8 years, the search led by amateur astronomer Nick Howes, may have beaten the odds. Howes, in a report on Sky News, is almost certain (98%) that they have found Snoopy, saying that the artificial object that they found is about the right size and in a heliocentric orbit consistent with expectations. Confirmation of the discovery will have to wait until the spacecraft is closer to earth.



Tom Stafford, Apollo 10 Commander, pats Snoopy on the snout as he heads to the pad. Image Credit: NASA

#### Mole Rescue

NASA's InSight lander deployed two instrument packages on the Martian soil – a seismometer and a heat probe. The Heat Flow and Physical Properties Package (HP<sup>3</sup>) included a self-burrowing "mole" designed to measure the temperature above and below the surface, to a depth of up to 15 feet (5 meters). However, soon after it was activated on February 28th, the mole's progress was halted after only advancing 12 inches (30 centimeters).

For the past several months, NASA's Jet Propulsion Laboratory and the German Aerospace Center (which provided HP<sup>3</sup>) have been analyzing the situation and exploring potential options to get the mole digging again. While a rock could be blocking the mole's progress, the two teams now believe that the mole may be in a pocket of loose soil. The mole relies on the friction provided by the soil to prevent recoil from the hammer. otherwise, the mole will "bounce in place." The mole is covered by a support structure which NASA now plans to remove to better assess the situation. The process of removing the structure will be done in three stages (starting in late June). This slow and deliberate

process, which will take about a week to accomplish, is designed to minimize the chance that the mole is removed from the soil – if removed it can't be reinserted. One potential solution, depending upon what they find when they remove the housing, is to use InSight's robotic arm to apply a force on the ground around the mole to increase soil pressure.

#### Lunar Mantle Revealed?

On January 3, 2019, the Chinese National Space Administration (CNSA) successfully landed their Chang'e-4 spacecraft in Von Kármán crater, located in the South Pole-Aitken (SPA) impact basin on the far side of the moon. The SPA is the largest known crater on the moon with a diameter of 1,550 miles (2,500 km). Believed to have formed 3.9 billion years ago, during the Late Heavy Bombardment period, the crater is more than 5 miles (8 km) in depth. The impactor (an asteroid or planetoid fragment) that created the basin had been thought to have penetrated the moon's crust and upper layers of the moon's mantle. Scientists may now have the evidence.

Chang'e-4's Yutu-2 rover has found, what appear to be, rocks from the moon's mantle on the surface of the crater. Preliminary results from the rover's spectrometer have identified the minerals known as low-calcium pyroxene and olivine – minerals expected to be found in the mantle of a differentiated planetoid.

If current lunar evolution theories are correct, the moon was covered by a magma ocean shortly after it formed from debris left over from a collision between the earth and a mars-sized planetoid. As the molten ocean began to cool and solidify, dense minerals crystallized at the deepest depths of the



The support structure of HP3. Credit: NASA/JPL-Caltech



The Yutu-2 rover is captured in a segment of a panorama taken by the Chang'e 4 lander. Image Credit: CNSA.

ocean while less dense minerals "floated" to the surface, forming the moon's crust. This process produced layers or strata, each with a unique chemical signature. Scientists believe that the largest impacts could punch through the layers, distributing rocky material from deep within the moon across the surface. Olivine is common in the earth's upper mantle. If the olivine detected by Yutu-2's spectrometer is confirmed to be from the mantle, its abundance will provide new insight into the moon's formation and evolution.

#### **Deep Impact**

Data from NASA's Gravity Recovery and Interior Laboratory (GRAIL) mission, combined with topographical data from the Lunar Reconnaissance Orbiter, may have revealed the remnant of the impactor that carved out the moon's South Pole-Aitken basin, the largest crater on the moon. In a study: "Deep Structure of the Lunar South Pole-Aitken Basin," published in the journal Geophysical Research Letters, the authors describe a large mass "five times larger than the Big Island of Hawaii" extending more than 180 miles (300 km) underneath the basin.

One explanation for the mass is that it represents the iron-nickel core of the asteroid that impacted the moon. Under the right conditions, computer simulations show that the remnant would remain suspended in the moon's mantle (rather than sinking to the core). Another explanation attributes the mass to oxides (for example, FeTiO3 or ilmenite) from the last stage of magma ocean crystallization. However, its location underneath the impact basin appears to support the impact relationship.

### Demise of the Red Spot?

Amateur and professional astronomers have been monitoring recent changes in Jupiter's Great Red Spot (GRS). The GRS is an earth-sized anticyclone that has been churning away for hundreds of years (since first observed after the invention of the telescope) in the upper atmosphere of the gas giant's southern hemisphere.

Recent observations of the GRS (appearing as a bright, white oval in the infrared) show that the storm appears to be interacting with the adjacent South Equatorial Belt (SEB), with the SEB pulling material out from the storm. These large filaments, some spanning thousands of miles, have been observed to be peeling away from the GRS, before dispersing. A new filament then forms, sparking speculation that the GRS is unraveling. The GRS has been shrinking over



Topographical image of the moon with warmer colors (yellow and reds) indicating higher elevations and colder (blue) colors indicating lower elevations. The image is centered on the South Pole-Aitken (SPA) basin shown in shades of blue. The dashed circle shows the location of the mass anomaly under the basin. Credit: NASA/Goddard Space Flight Center/University of Arizona



A composite color infrared image taken by Gemini North's Near-InfraRed Imager. Credit: Gemini Observatory/AURA/NSF/JPL-Caltech/NASA

the past 150 years, constantly changing in size and shape. It has also started to drift westward faster than before. If the end is near, NASA's Juno spacecraft should have a front row seat for the show.

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#### Mars Helicopter

NASA has completed the testing of its Mars helicopter, certifying the rotorcraft for flight on the Red Planet. As a demonstration, the small, four-pound (1.8 kg) rotorcraft will accompany the 2020 rover to Mars (mounted underneath the rover's chassis).

The twin, 48-inch (1.21 meter) counter-rotating blades will spin at a rate 10 times faster than their earthly counterparts to provide lift in the thin Martian atmosphere (equivalent to flying at an altitude of 100,000 feet on Earth). NASA has been subjecting the rotorcraft to a wide range of temperatures (as low as -130°F or -90°C) in anticipation of the harsh conditions to be encountered on Mars. Engineers have also been simulating the Red Planet's lower gravity (Mars' gravity is approximately 1/3 that of Earth's). Solar cells, mounted on top of the rotor mast, will recharge the helicopter's lithiumion batteries which in turn power

#### First Wheeled Vehicle on Moon

Forty-eight 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



Technicians inspect the helicopter that will fly on Mars, mounted on a test stand inside the vacuum chamber at the Jet Propulsion Laboratory.. Image Credit: NASA/JPL-Caltech

the rotorcraft's instruments, systems, and a heater for the cold nights.

The rotorcraft, once deployed, will be capable of autonomous operations due to the communication lag between Earth and Mars. A 30-day test flight is being planned, with incrementally longer flights and distances. In its first flight, the rotorcraft will hover for 30 seconds at a height of 10 feet (3 meters).

If the demonstration is successful, rotorcrafts could be included in other missions to greatly expand the areas explored, scout targets and access areas generally inaccessible to other vehicles or too dangerous for humans. The mission is scheduled to launch in July 2020 and will reach Mars in February 2021.



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

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 expansive 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 terminated in Jvanuary 1970, followed by two additional cancelations by September. One-by-one, cancelation 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 redesign 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 shortduration-capture missions (capturing

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

#### Space Shuttle Legacy

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.

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  $8\frac{1}{2}$ 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 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.

and July 21, 2011, the five spaceworthy 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 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 Udvar-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



Astronaut David Scott (center) watches as technicians fit check the folded Lunar Rover 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 pulleys, ropes and cloth tapes.



Enterprise

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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.



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



Discovery

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The California Science Center was selected to display the Endeavour, based, in part, on its proximity to Palmdale. The orbiter was delivered 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. Endeavor 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 2022.



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#### 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 Institute 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

#### 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,



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).

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 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.

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 breech the external tank. Seventythree seconds after liftoff, the orbiter was destroyed in an explosion from the failure of the hydrogen and oxygen fuel inner tanks.

#### Space Shuttle Memorial

In June 2015, a permanent memorial, "Forever Remebered," 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.

Space Shuttle	Enterprise	Discovery	Endeavour	Atlantis
Location	Intrepid Sea, Air & Space Museum, NYC	Smithsonian Udvar-Hazy Center, Chantilly, Virginia	California Science Center, <sup>[1]</sup> Los Angeles	Kennedy Space Center, Florida
General Admission <sup>[2]</sup>				
Adult	\$33.00	Free	Free <sup>[3]</sup>	\$50.00
Seniors	\$31.00	Free	Free <sup>[3]</sup>	\$46.00
Child	\$24.00	Free	Free <sup>[3]</sup>	\$40.00
Child (under 4)	Free	Free	Free <sup>[3]</sup>	-
Retired Military	Free	Free	Free <sup>[3]</sup>	-
Active Duty	Free	Free	Free <sup>[3]</sup>	\$46.00
Museum Members	Free	Free	Free <sup>[3]</sup>	-
Parking	-	\$15.00	\$12.00	\$10.00
Summer Hours (M-F)	10:00 am - 5:00 pm	10:00 am - 5:30 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 - 5:30 pm	10:00 am - 5:00 pm	9:00 am - 6:00 pm

#### **Planning Your Visit**

<sup>[1]</sup> Endeavour is on temporary display while its permanent home is under construction

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

<sup>[3]</sup> \$2 timed reservation required for Endeavour

#### **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/

#### **Summer Activities**

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

- 1. <u>Attend a star party</u>. 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 13<sup>th</sup> and August 10<sup>th</sup> 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 any time, August 12<sup>th</sup> 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. A waxing gibbous moon will interfere until the early morning hours.
- 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:

4 **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).

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.



5. **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



Jupiter reached Opposition (and closest approach) in early June. During the months of July and August, Jupiter is still well placed in evening sky after sunset. Jupiter will be at its highest around 11 pm (2 hours earlier by month's end. As the Earth moves ahead of

#### **Jupiter and its Moons**

Jupiter on its inside orbit, Jupiter will diminish slightly in brightness and apparent size. As one of the brightest star-like objects in the night sky, Jupiter can be found in the constellation Ophiuchus.

One of the more interesting and easier events to observe

through a telescope is the projection of a shadow from one of Jupiter's moons on the Jovian disk as the moon passes in front of (or transits) the planet. On nights of good visibility, the following events should be visible through a moderately-sized telescope.

JJMO

#### Jovian Moon Transits

The Red Spot is a large cyclone in the upper Jovian atmosphere. The rapid rotation of this gas giant (10 hours) may be responsible for the longevity of this storm, which has been observed for over 300 years. The Red Spot will cross the center line of the planetary disk on the following evenings during the hours between 8 pm to midnight local time.

Date	Moon	Transit Begins	Transit Ends
July 4 <sup>th</sup>	Io	10:36 pm	12:48 am (5 <sup>th</sup> )
July 9 <sup>th</sup>	Europa	6:33 pm	9:02 pm
July 13 <sup>th</sup>	Io	6:59 pm	9:11 pm
July 16 <sup>th</sup>	Europa	9:09 pm	11:38 pm
July 17 <sup>th</sup>	Ganymede	7:27 pm	9:54 pm
July 20 <sup>th</sup>	Io	8:54 pm	11:16 pm
July 23rd	Europa	11:45 pm	2:14 am (24 <sup>th</sup> )
July 24 <sup>th</sup>	Ganymede	11:26 pm	1:54 am (25 <sup>th</sup> )
July 27 <sup>th</sup>	Io	10:49 pm	1:01 am (28 <sup>th</sup> )
August 5 <sup>th</sup>	Io	7:12 pm	9:24 pm
August 10 <sup>th</sup>	Europa	6:16 pm	8:46 pm
August 12 <sup>th</sup>	Io	9:07 pm	11:19 pm
August 17 <sup>th</sup>	Europa	8:53 pm	11:23 pm
August 19 <sup>th</sup>	Io	11:02 pm	1:14 am (20 <sup>th</sup> )
August 24 <sup>th</sup>	Europa	11:30 pm	2:01 am (25 <sup>th</sup> )
August 28 <sup>th</sup>	Io	7:26 pm	9:37 pm
August 29 <sup>th</sup>	Ganymede	7:22 pm	9:54 pm

#### **Jovian Moon Transits**

#### **Red Spot Transits**

Date	Transit Time	Date	Transit Time
July 1 <sup>st</sup>	11:46 pm	August 4 <sup>th</sup>	9:37 pm
July 4 <sup>th</sup>	9:15 pm	August 6 <sup>th</sup>	11:15 pm
July 6 <sup>th</sup>	10:53 pm	August 7 <sup>th</sup>	8:45 pm
July 9 <sup>th</sup>	8:23 pm	August 9 <sup>th</sup>	10:24 pm
July 11 <sup>th</sup>	10:01 pm	August 11 <sup>th</sup>	9:33 pm
July 13 <sup>th</sup>	11:39 pm	August 16 <sup>th</sup>	11:11 pm
July 16 <sup>th</sup>	9:09 pm	August 18 <sup>th</sup>	8:41 pm
July 18 <sup>th</sup>	10:47 pm	August 23rd	10:20 pm
July 21 <sup>th</sup>	8:17 pm	August 25 <sup>th</sup>	11:59 pm
July 23rd	9:55 pm	August 28 <sup>th</sup>	9:29 pm
July 25 <sup>th</sup>	11:34 pm	August 30 <sup>th</sup>	11:08 pm
July 28 <sup>th</sup>	9:03 pm		
July 30th	10:42 pm		

	Sunrise and	Sunset (from New Mi	lford, CT)
	<u>Sun</u> July 1st (EDT) July 15th July 31st August 1st August 15th	<u>Sunrise</u> 05:23 05:33 05:47 05:48 06:02	<u>Sunset</u> 20:32 20:26 20:12 20:11 19:53
000000	August 31st	06:18	19:28

#### **Astronomical and Historical Events**

#### July

- 1<sup>st</sup> Centaur Object 10370 Hylonome at Opposition (23.011 AU)
- 1st History: opening of the Smithsonian National Air & Space Museum (1976) 1stHistory: 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 New Moon
- 2nd Apollo Asteroid 10563 Izhdubar closest approach to Earth (0.785 AU)
- 2nd History: launch of the Orbiting Carbon Observatory-2 (OCO-2) (2014)
- 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 Earth at Aphelion furthest from the Sun (1.017 AU or 94.5 million miles)
- 4th Centaur Object 330836 Orius at Opposition (16.997 AU)
- 4th History: Juno spacecraft enters orbit around Jupiter (2016)
- 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 Moon at Perigee (closest distance to Earth)
- 5th Apollo Asteroid 471926 Jormungandr closest approach to Earth (1.776 AU)
- 5th Centaur Object 10370 Hylonome at Opposition (23.332 AU)
- 5th Kuiper Belt Object 307261 (2002 MS4) at Opposition (45.615 AU)
- 5th History: Isaac Newton's "Mathematical Principles of Natural Philosophy" published, describing the laws of motion (1687)
- 6th Apollo Asteroid 10145 (1994 CK1) near-Earth flyby (0.099 AU)
- 6th History: discovery of Jupiter's moon Lysithea by Seth Nicholson (1938)
- 7th Apollo Asteroid 2016 NO56 near-Earth flyby (0.009 AU)

- 7th Apollo Asteroid 2016 OF near-Earth flyby (0.033 AU)
- 7th Aten Asteroid 2013 ND15 (Venus Trojan) closest approach to Earth (0.482 AU)
- 7th History: launch of the Mars Exploration Rover B (Opportunity) (2003)
- 8th Apollo Asteroid 85585 Mjolnir closest approach to Earth (0.744 AU)
- 8th Aten Asteroid 398188 Agni closest approach to Earth (1.018 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 First Quarter Moon
- 9th Saturn at Opposition
- 9th Apollo Asteroid 3200 Phaethon closest approach to Earth (0.810 AU)
- 9th History: closest pass of Jupiter's cloud tops by the Voyager 2 spacecraft (1979)
- 10th Centaur Object 55576 Amycus at Opposition (20.375 AU)
- 10th Kuiper Belt Object 486958 (2014 MU69) at Opposition (42.199 AU)
- 10th Kuiper Belt Object 2014 PN70 at Opposition (42.883 AU)
- 10th History: flyby of Comet Grigg-Skjellerup by the European Space Agency's Giotto spacecraft following its close encounter of Halley's Comet (1992)
- 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 History: launch of the Soviet Gamma Observatory (1990)
- 11th History: Skylab re-enters into the Earth's atmosphere (1979)
- 12th Amor Asteroid 2016 NJ33 near-Earth flyby (0.038 AU)
- 12th Apollo Asteroid 2019 KD3 near-Earth flyby (0.040 AU)
- 12th Apollo Asteroid 4034 Vishnu closest approach to Earth (1.180 AU)
- 12th History: launch of the High Energy Astronomical Observatory (HEAO-1), designed to survey the entire sky for x-ray emissions (1977)
- 12th History: launch of Soviet Mars orbiter Phobos 2 (1988)
- 13th Second Saturday Stars Open House at the McCarthy Observatory
- 13th History: Soviet Union launches Luna 15, a lunar lander and sample return mission, in an attempt to upstage Apollo 11; crashes during landing (1969)
- 13th History: Langley Research Center's birthday (1917)
- 14th Aten Asteroid 2018 BF5 near-Earth flyby (0.098 AU)
- 14th Scheduled launch of Chandrayaan 2, India's second moon mission. Chandrayaan 2 will consist of an orbiter, the Vikram lander and a rover. Launch will be from the Satish Dhawan Space Center, Sriharikota, India
- 14th History: flyby of the dwarf plant 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 Dwarf Planet 134340 Pluto at Opposition (32.823 AU)
- 15th Centaur Object 10199 Chariklo at Opposition (15.188 AU)

- 15th History: Dawn spacecraft enters orbit around the asteroid 4 Vesta (2011)
- 15th History: Pioneer 10 becomes the first spacecraft to enter the main asteroid belt (1972)
- 16th Full Moon (sometimes called Buck Moon)
- 16th History: over twenty fragments of comet Shoemaker-Levy 9, up to 2 km in diameter, 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 Apollo Asteroid 2014 MJ6 near-Earth flyby (0.091 AU)
- 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 Amor Asteroid 5653 Camarillo closest approach to Earth (2.249 AU)
- 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 McCarthy Observatory Apollo 11 Landing Celebration (12-3 pm)
- 20th Moon at Apogee (furthest distance from Earth)
- 20th Scheduled launch of a Russian Soyuz spacecraft from Baikonur Cosmodrome, Kazakhstan to the International Space Station with the next Expedition crew
- 20th Amor Asteroid 481984 Cernunnos closest approach to Earth (0.947 AU)
- 20th Apollo Asteroid 4257 Ubasti closest approach to Earth (1.539 AU)
- 20th Amor Asteroid 887 Alinda closest approach to Earth (2.768 AU)
- 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)
- 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 2016 KO near-Earth flyby (0.095 AU)
- 21st Plutino 2014 JR80 at Opposition (39.936 AU)

- 21st Schedule launch of a SpaceX Dragon cargo-carrying spacecraft to the International Space Station from the Cape Canaveral Air Force Station, Florida
- 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 Apollo Asteroid 3752 Camillo closest approach to Earth (1.504 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 Amor Asteroid 18106 Blume closest approach to Earth (0.619 AU)
- 23rd Amor Asteroid 1943 Anteros closest approach to Earth (1.061 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 Last Quarter Moon
- 24th Apollo Asteroid 2015 HM10 near-Earth flyby (0.031 AU)
- 24th History: launch of the Geotail spacecraft, a joint JAXA/NASA mission to study the magnetic environs of Earth (1992)
- 24th History: first rocket launch from Cape Canaveral (Bumper/V-2 rocket) in 1950
- 25th Apollo Asteroid 4341 Poseidon closest approach to Earth (1.552 AU)
- 25th History: Svetlana Savitskaya becomes the first woman to walk in space (1984)
- 25th History: launch of Soviet Mars orbiter Mars 5 (1973)
- 26th Aten Asteroid 2010 PK9 near-Earth flyby (0.021 AU)
- 26th Atira Asteroid 2018 JB3 closest approach to Earth (0.434 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)
- 28th History: discovery of Neptune's moons Despina and Galatea by Stephen Synnott (1989)
- 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 Apollo Asteroid 5011 Ptah closest approach to Earth (1.799 AU)
- 29th Plutino 2017 OF69 at Opposition (42.626 AU)
- 29th History: deorbit and destruction of the Salyut 6 space station; first of the Soviet's secondgeneration space station design (1982)

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29th	History:	Deep Space	1 flyby o	f asteroid	Braille (	(1999)
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- 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)
- 31st New Moon
- 31st Scheduled launch of a Russian Progress cargo-carrying spacecraft from Baikonur Cosmodrome, Kazakhstan to the International Space Station
- 31st Apollo Asteroid 2135 Aristaeus closest approach to Earth (1.751 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 Apollo Asteroid 2012 DT32 near-Earth flyby (0.084 AU)
- 1st History: discovery of Martian meteorite (shergottite class) SAU 051 in Oman (2000)
- 1st History: launch of Lunar Orbiter 5, 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 Moon at Perigee (closest distance to Earth)
- 2nd 84th Convention of Amateur Telescope Makers (Stellafane), Springfield, Vermont (through the 4th), see https://stellafane.org/convention/2019/index.html
- 2nd Apollo Asteroid 4197 Morpheus closest approach to Earth (3.075 AU)
- 3rd Plutino 2014 JP80 at Opposition (41.147 AU)
- 3rd Kuiper Belt Object 2013 AT183 at Opposition (64.078 AU)
- 3rd History: launch of the MESSENGER spacecraft to Mercury (2004)
- 4th Apollo Asteroid 5786 Talos closest approach to Earth (0.324 AU)
- 4th History: launch of the Phoenix polar lander spacecraft to Mars (2007)
- 5th Apollo Asteroid 2018 AG12 near-Earth flyby (0.059 AU)
- 5th History: launch of the Juno spacecraft to Jupiter (2011); arrived 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

oun	Apollo Asteroid 1865 Cerberus closest approach to Earth (0.501 AU)
6th	Aten Asteroid 136818 Selqet closest approach to Earth (0.749 AU)
6th	Amor Asteroid 5751 Zao closest approach to Earth (2.205 AU)
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	First Quarter Moon
7th	Apollo Asteroid 37655 Illapa closest approach to Earth (0.926 AU)
7th	Centaur Object 83982 Crantor at Opposition (18.241)
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	Kuiper Belt Object 2008 OG19 at Opposition (37.763 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	Mercury at its greatest western elongation - apparent separation from the Sun in the early morning (19°)
9th	History: discovery of Remus, moon of Asteroid 87 Sylvia by Franck Marchis, et al's (2004)
9th	History: launch of the Soviet Luna 24 spacecraft, third attempt (and only successful attempt) to
	recover a sample from Mare Crisium (1976)
9th	recover a sample from Mare Crisium (1976) History: Henry Draper obtains the first spectrum photograph of a star (Vega) to show distinct lines (1872)
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- 12th Apollo Asteroid 454094 (2013 BZ45) near-Earth flyby (0.044 AU)
- 12th Atira Asteroid 2013 JX28 closest approach to Earth (0.640 AU)
- 12th History: launch of NASA's Parker Solar Probe aboard a Delta 4 Heavy rocket from the Cape Canaveral Air Force Station (2018)
- 12th History: launch of the International Sun-Earth Explorer-3 (ISEE-3) satellite into a heliocentric orbit. Renamed International Comet Explorer, (ICE), it became the first spacecraft to visit a comet, passing through the plasma tail of comet Giacobini-Zinner in 1985 (1978)
- 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 Aten Asteroid 2017 QK18 near-Earth flyby (0.076 AU)
- 13th Apollo Asteroid 5143 Heracles closest approach to Earth (0.673 AU)
- 13th Aten Asteroid 5381 Sekmet closest approach to Earth (1.292 AU)
- 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)
- 14th Centaur Object 365756 ISON at Opposition (7.598 AU)
- 14th Kuiper Belt Object 2015 UH87 at Opposition (80.619 AU)
- 15th Full Moon (sometimes called Sturgeon Moon)
- 16th Amor Asteroid 3757 Anagolay closest approach to Earth (1.237 AU)
- 16th History: launch of Explorer 12 spacecraft, measured cosmic-ray particles, solar wind protons, and magnetospheric and interplanetary magnetic fields (1961)
- 17th Moon at Apogee (furthest distance from Earth)
- 17th Atira Asteroid 481817 (2008 UL90) closest approach to Earth (0.577 AU)
- 17th Apollo Asteroid 141593 (2002 HK12) near-Earth flyby (0.062 AU)
- 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 History: launch of Suisei; Japan's Comet Halley mission (1985)
- 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 4503 Cleobulus closest approach to Earth (2.883 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 Aten Asteroid 2008 PR9 near-Earth flyby (0.044 AU)
- 21st Apollo Asteroid 2201 Oljato closest approach to Earth (2.393 AU)
- 21st Centaur Object 52872 Okyrhoe at Opposition (9.895 AU)
- 21st History: discovery of Dar al Gani 975 Mars meteorite in Libya (1999)
- 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)
- 23rd Last Quarter Moon
- 23rd History: Lunar Orbiter 1 takes first photo of the Earth from the Moon (1966)
- 24th Apollo Asteroid 162173 Ryugu closest approach to Earth (1.566 AU)
- 24th History: Pluto reclassified as a Dwarf Planet (2006)
- 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 Aten Asteroid 2003 YG136 near-Earth flyby (0.051 AU)
- 25th Aten Asteroid 66146 (1998 TU3) near-Earth flyby (0.074 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 2016 PD1 near-Earth flyby (0.029 AU)
- 26th Apollo Asteroid 2015 TY237 near-Earth flyby (0.086 AU)
- 26th Apollo Asteroid 2005 QQ87 near-Earth flyby (0.091 AU)
- 26th Atira Asteroid 413563 (2005 TG45) closest approach to Earth (0.822 AU)
- 26th History: flyby of the planet Saturn by the Voyager 2 spacecraft (1981)
- 27th Aten Asteroid 2002 JR100 near-Earth flyby (0.050 AU)
- 27th Apollo Asteroid 153814 (2001 WN5) near-Earth flyby (0.098 AU)
- 27th History: launch of the Mariner 2 spacecraft to Venus; first successful planetary encounter (1962)
- 28th Apollo Asteroid 54509 YORP closest approach to Earth (0.755 AU)
- 28th Amor Asteroid 1915 Quetzalcoatl closest approach to Earth (2.980 AU)
- 28th Kuiper Belt Object 225088 (2007 OR10) at Opposition (87.294 AU)
- 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 Apollo Asteroid 2008 SJ82 near-Earth flyby (0.068 AU)
- 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 New Moon

- 30th Moon at Perigee (closest distance to Earth)
- 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 Asteroid 130 Elektra (2 Moons) closest approach to Earth (1.615 AU)
- 31st History: President Kennedy signs the Communications Satellite which created the Communications Satellite Corporation (COMSAT) and committed the U.S. to building a global communications system (1962)
- 31st History: first photo showing Moon's shadow on the Earth during Solar Eclipse taken by stratospheric balloonist Captain Albert Stevens (1932)

#### **Tentatively Scheduled for August**

- ?? Launch (first) of SpaceX's Crew Dragon spacecraft aboard a Falcon 9 rocket from the Kennedy Space Center (unmanned)
- 27<sup>th</sup> Launch (first) of Boeing's CST-100 Starliner spacecraft aboard an Atlas 5 rocket from the Cape Canaveral Air Force Station (unmanned)

#### **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

#### **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°)

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

#### International Space Station/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.

#### 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.

#### 28 July-Aug 2019

#### http://www.mccarthyobservatory.org

#### 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).



#### 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

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# ebrates FREE EVENT

arth

Observation John J. McCarthy Observatory Behind the New Milford High School 860.946.0312 www.mccarthyobservatory.org

## July 20th 7:00 - 9:00 pm

50th Anniversary of Moon

Raffles Refreshments Lunar Meteorite Display Classroom Presentations \* Re-enactments \* Scale outline of Saturn Rocket Handicapped Accessible **Rain or Shine** \* Weather Permitting

**Meeting Moved** to 7:30 PM, due to heat wave



## July 2019 Celestial Calendar

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
	Image: Provide stress of the stress of th	2 Launch of European Space Agenccy's 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) Fahfrinder (1997) Henrietta Leavitt born; measured distances to far galaxies (1868)	5 Moon at perigee (closest) (closet) (c	5 Isaac Newton's published (1687) Discovery of Jupiter's moon Lysithea by Seth Nicholson (1938)
7 Launch of Mars Exploration Rover B Opportunity (2003)	8 Alvan Graham Clark born, telescope maker (1832) Flyby of Asteroid 21 Lutetia by European Space Agency's Rosetta spacecaft (2010) Iaunch of Telstar 1, prototype communication satellite designed and built by Bell Telephone Laboratories (1962)	9Probe of cometTempel 1 by Deep Impactor (2005)Impactor (2005)Impactor (2005)Impactor (2005)Skylab re- enters into the Earth's atmosphere (1979)	10 Soviet Mars orbiter Phobos 2 launched (1988)	11 Langley Research Center Birthday (1917) Soviet spacecraft Luna 15 launched, lander to crash on Moon (1969)	12 First close-up view of Mars by Mariner 4 Spacecraft (1965)	Launch of Apollo 18 11 3 and Soyuz 19 in joint U.S./Soviet mission (1975) The Dawn spacecraft enters orbit around the asteroid 4 Vesta (2011) Stars Open House McCarthy Observatory
14 Launch of the Space Shuttle Atlantis (STS- 135) to the International Space Station; final space shuttle flight to low Earth orbit (2011)	15Apollo 11 Moon mission Armstrong, Aldrin, Collins (1969)Schoemaker/ Levy Comet fragments (1922, 1994)Image: Construction (1969)Image: Construction of a star other than ouniversity (1850)Image: Construction mission (1969)	16 Monsignor Georges matire born: adgraup riese and astronomer was first to propose expanding universe and Big Bang theory (1894)	17 Launch of Zond 5,1*successful Moon flyby 1965) Allan Standage born, cosmologist (1926) Rohini I, India's 1* aatellite, failed at aunch (1980)	18 Launch of Explorer 35 spacecraft into an elliptical lumar of the spacecraft into an elliptical lumar of the state spacecraft into particles, and solar X-rays (1967) For the spacecraft into particles, and solar X-rays (1967) For the spacecraft into and physicist who discovered the first spectroscopic binary stars, later used to measure cosmic distances. (1846)	19Image: Second systemImage: Second systemViking I lands on Mars (1976)Image: Second systemImage: Second sys	20Moon at apogee (farthest from Earth)Launch of Soviet Mars 4 mission (1973)Image: Construction (1973)Image: Construction of the second
21 Close pass of Jupiter's cloud tops by Voyager 2 spacecraft (1979)	Alan Hale and Tom Bopp announce discovery of comet Hale-Bopp (1995) 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)	23 Fundamental content of the second	24 Svetlana Savitskaya becomes first woman to walk in space (1984) Launch of Soviet orbiter Mars 5 (1973)	25 Discovery (STS-114) "return to flight" (2005) Launch of Syncom 2, first geosynchronous satellite (1963) launch of Apollo 15, fourth lunar landing (1971)	26 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)	27 Launch of Ranger 7, Moon impact mission (1964) Launch of Skylab 3 (Bean, Pogue, Garriott) (1973)
28 Landing of Soviet spacecraft Venera 8 on Venus (1972) South Delta- Aquarids meteor shower peak	29 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)	30 Impact of the Lunar Prospector (1999) Mariner 6 Mars flyby (1969)	31 Death of 3 cosmonauts in Soyuz 11 when capsule depressurizes in reentry (1971) Tunguska explosion event (1908)	Ph New Moon July 2 Waxing Gibbors July	ases of the Moon	faxing bboos July 16

## August 2019 Celestial Calendar

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
	Phases of a	the Moon Waxing Fell Moon Aug 12 Waning Waning Keecent Aug 3		Peak of the Alpha Capricornids meteor shower Launch of Lunar Orbiter the last of the Lunar Orbiter series (1967) Maria Mitchell bom, first woman elected as an astronomer to the American Academy of Arts and Sciences (1818)	2 Valery Fyodorovich Bykovsky three manned space mission space flights, spending five days in orbit aboard Vostok 5 in 1963 - a record for a solo flight. (1934)	3
4	5	6	7	8	9	10
Launch of Phoenix Spacecraft to Mars (2007)	Astronaut Neil Armstrong born (1930) Launch of the Juno spacecraft to Jupiter (2011) Flyby of Mars by the Mariner 7 spacecraft (1969)	Gherman Titov, 2nd man in space (1961) Cassiopeia Supernova observed by Chinese (1181) Chinese (1181) Chinese Landing of Mars Science Lab (MSL or Curiosity) inside Gale Crater (2012)	Viking 2 on Mars (1976)	Launch of Genesis Spacraft (2001) Launch of Pioneer Venus 2 (1978) Launch of Soviet Zond 7 moon probe (1969)	Launch of Soviet Luna 24 spacecraft, third (and only successful attempt) to recover a sample from Mare Crisium (1976)	Launch of Mars Reconnaissance Orbiter (2005) Magellan spacecraft orbits Venus (1990) <b>2nd Saturday Stars</b> Open House McCarthy Observatory
11	12	13	14	15	16	Moon at apogee (farthest
Asaph Hall discovers Martian Moon Deimos(1877)	Perseid meteor showers at peakLaunch of the High Energy Astronomical Observatory (HEAO-1) to monitor x-ray sources (1977)Image: Comparison of the strengt communi- cations satellite in 2ND attempt (1960)	Discovery of long- period variable star Mira, Omicron Ceti by David Fabricius (1596) Mars' south polar cap by Christiaan Huygens (1642)	Educator astronaut Barbara Morgan leads a Q&A session with children in Boise, Idaho from the space shuttle Endeavour, fulfilling legacy of Christa McAultiffe, who died in the 1986 Challenger disaster (2007)	President Reagan announced his support for the construction of an orbiter to replace Challenger (1986)	Launch of Explorer 12 spacecraft, measured cosmic-ray particles, solar wind protons, and magnetospheric and interplanetary magnetic fields (1961)	from Earth) Asaph Hall discovers Martian Moon Phobos (1877) Launch of Soviet Venus Inder (1970) Launch of Pioneer 7 (1966)
18	19	20	21	22	23	24
Launch of Suisei, Japan's Comet Halley mission (1985)	Launch of Sputnik 5, with dogs Belka and Strejka (1960) Birth of Orville Wright (1871) Sir John Flamsteed born, English astronomer (1646) Dmitri Ivanovich Mendeleev rises to 11,500 feet (3.5 km) to observe an eclipse in Russia (1887)	Launch of Mars orbiter/ lander Viking 1 (1975) Launch of Voyager 2 to outer planets (1977)	Launch of demini V with astronauts Gordon Cooper and Charles Conrad (1965)	Neptune was found to have a continuous ring system by the Voyager 2 spacecraf (1989)	Lunar Orbiter 1 takes first photograph of Earth from Moon (1966)	Pluto reclassified as a dwarf planet (2006) Launch of the Soviet Luna 11 spacecraft to analyze the Moon's chemistry, gravitation and radiation levels (1966)
25	26	27	28	29	Moon at perigee (closest 30	31
flyby of Neptune by the Voyager 2 spacecraft (1989)	Flyby of Saturn by Voyager 2 spacecraft (1981)	launch of the Mariner 2 spacecraft to Venus; first successful planetary encounter (1962)	Discovery of Nova Cygni in the constellation Cygnus (1975)	Flyby of asteroids Ida and Dactyl by the Galileo spacecraft (1993)	distance to Earth) Discovery of first Kuiper Belt object, 1992 QB1, by David Jewet and Jane Luu Launch of STS-8 and astronaut Guy Bluford, 1 <sup>st</sup> African-American in space (1983) First recorded occurrence - comet Michelis impacts sun (energy of 1 million hydrogen bombs) (1979)	US Naval Observatory authorized by an act of Congress (1842)