Galactic Observer

John J. McCarthy Observatory

Volume 12, No. 3 March 2019

Dreamtime Deep Down in the Outback

See inside, page 19

The John J. McCarthy Observatory

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

Phone/Voice: (860) 210-4117
Phone/Fax: (860) 354-1595
www.mccarthyobservatory.org

JJMO Staff

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

Steve Barone
Colin Campbell
Dennis Cartolano
Mike Chiarella
Jeff Chodak
Bill Cloutier
Doug Delisle
Cecilia Detrich
Dirk Feather
Randy Fender
Louise Gagnon
John Gebauer
Elaine Green
Tina Hartzell
Jim Johnstone
Carly KleinStern
Bob Lambert
Roger Moore
Parker Moreland, PhD
Allan Ostergren
Marc Polansky
Joe Privitera
Monty Robson
Don Ross
Gene Schilling
Katie Shusdock
Paul Woodell
Amy Ziffer

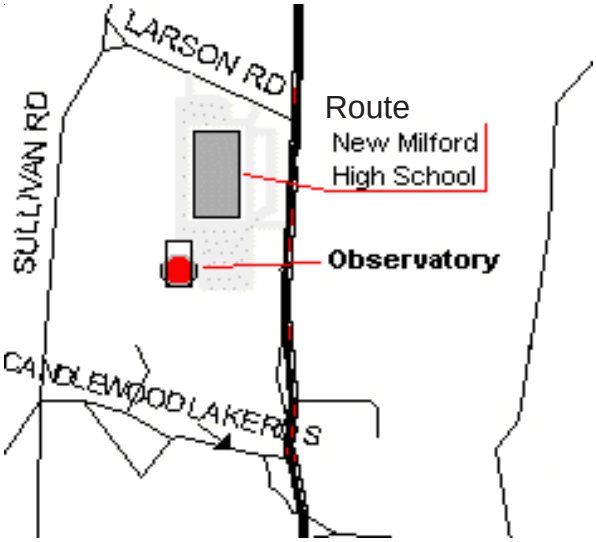
Galactic Observer Editorial Committee

Managing Editor
Bill Cloutier

Production & Design
Allan Ostergren

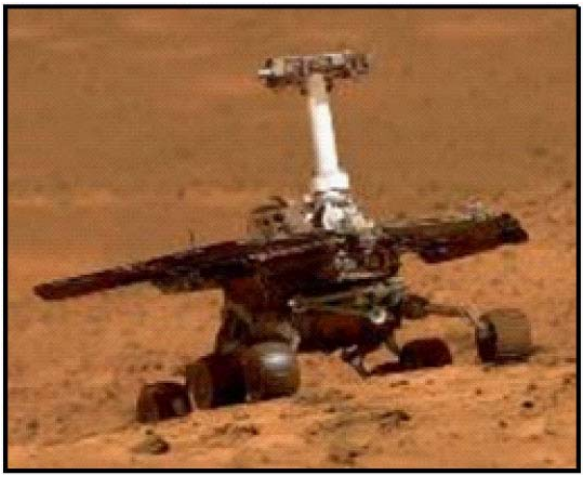
Website Development
Marc Polansky

Technical Support
Bob Lambert
Dr. Parker Moreland



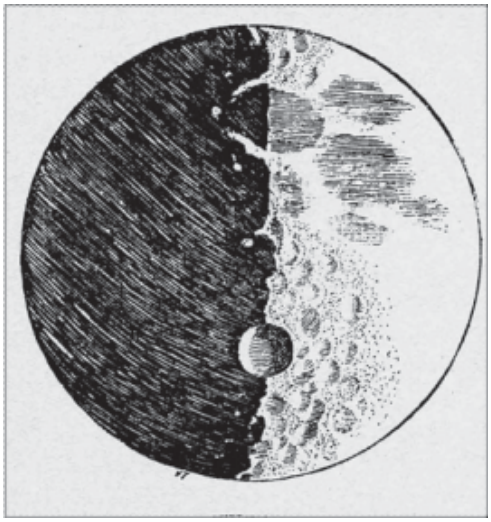
In This Issue

Farewell to Oppy! 2004-2018



"Out the Window on Your Left"

IT'S BEEN MORE than 46 years since we left the last footprint on the dusty lunar surface. Sadly, as a nation founded on exploration and the conquest of new frontiers, we appear to have lost our will to lead as a space-faring nation. But, what if the average citizen had the means to visit 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).



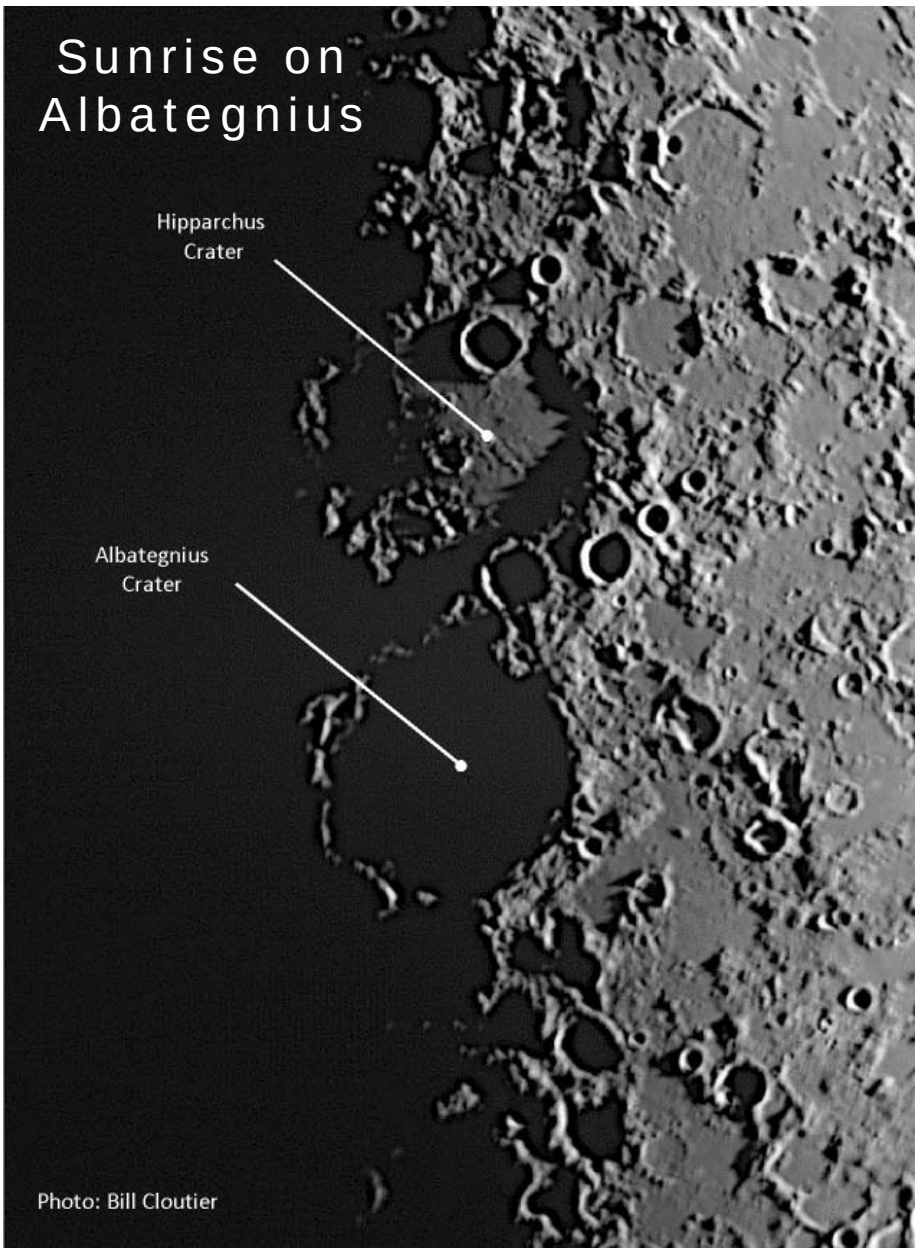
Sketch of a seven-day-old Moon with what is believed to be the crater Albategnius on the terminator, south of the lunar equator

On March 13, 1617, Galileo Galilei took receipt of his Sidereus Nuncius, or "Starry Messenger" from a printer in Venice, Italy. The 60-page treatise described his discoveries with the telescope, including the rugged surface of the Moon with prominences "loftier than those of the Earth," the moons of Jupiter in orbit around the gas giant, and the star-filled Milky Way.

The pamphlet includes drawings of the Moon in four different phases. Late selenographer Ewan Whitaker (University of Arizona), dated the drawings based upon events described by Galileo, the location of the terminator, the Sun and Moon's position in the sky, and local weather (whether the conditions were suitable for viewing).

Whitaker provided compelling evidence that Galileo started observing the Moon on November 30, 1609, producing a sketch of the four-day-old Moon. Three days later he recorded the features of the first quarter Moon, including the craters Aristoteles and Eudoxus just east of the terminator in the far north, the shadow bisecting Mare Serenitatis, and the cratered highlights in the southern hemisphere, punctuated by an exaggerated crater Albategnius. (In his analysis, Whitaker determined that the Moon would have been below the horizon, as seen from Padua, Italy, on alternative dates in early November and January when the terminator would have bisected Albategnius at sunrise.)

Galileo would sketch a third quarter moon on December 18th, again highlighting Albategnius, but with the sun setting. While Albategnius, at 85 miles (136 km) in diameter, is normally much less conspicuous than the large maria to the north, it can cast an imposing presence at sunrise (or sunset), as seen in the photo on the following page.



Another large crater in the southern hemisphere is Hipparchus at 93 miles (150 km) in diameter. However, the crater's features are considerably degraded, with its rim damaged by ejecta from the impact that created the Imbrium basin to the north, and may not have been as well-defined to Galileo through his rudimentary telescope.

A Final Farewell to Oppy

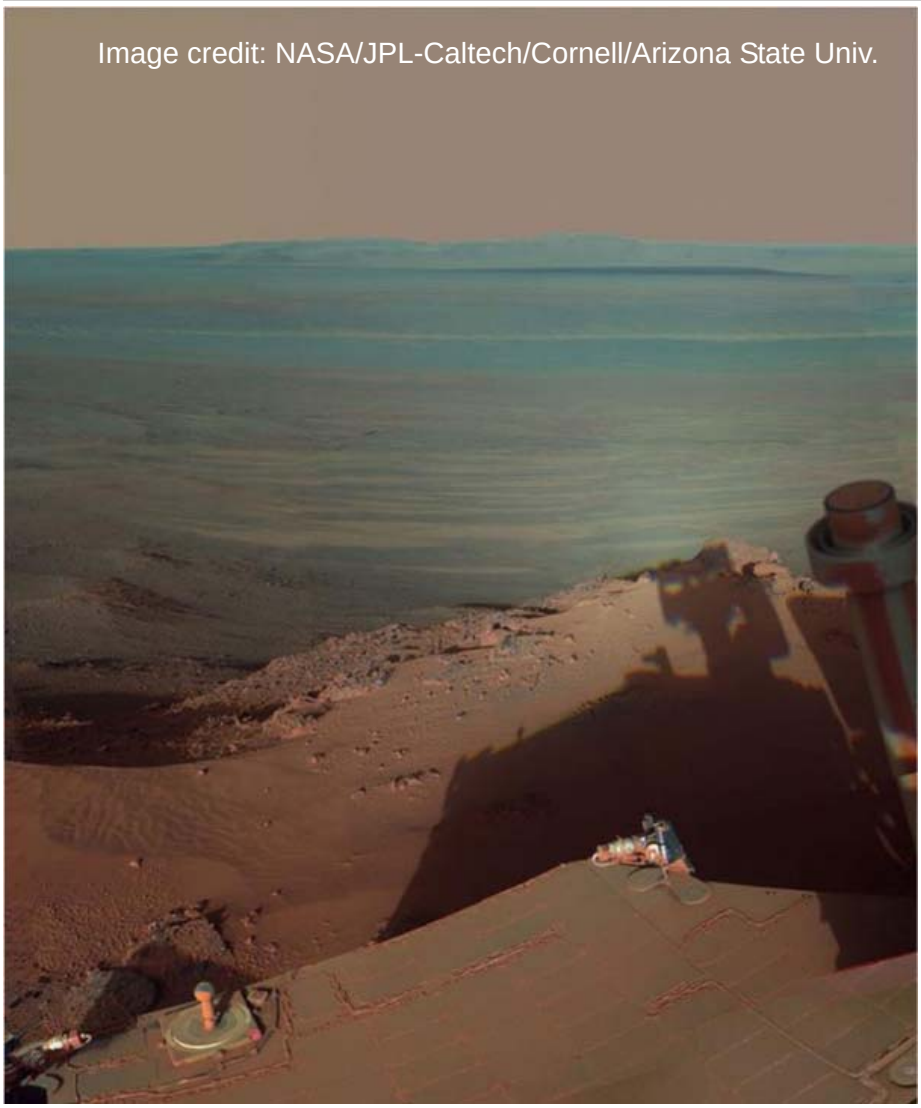
The Mars Exploration Rover Opportunity ("Oppy") now sits silently, looking out into Endeavour Crater. The intrepid little rover had been exploring Perseverance Valley, a cut through in the crater's western rim, in June of 2018 when it was engulfed by a global dust storm that turned day into night. The last communication received from the solar-powered, robotic geologist was on June 10th. While Oppy had survived dust storms before, this tempest was longer lasting and much more intense.

The golf cart size, 384-pound (174-kg) rover landed on the plains of Meridiani Planum on January 24, 2004, bouncing in its protective cocoon several times before rolling into Eagle crater. It's 90 Martian day (Sol) mission had a fortuitous start when hematite nodules were found in and among the rocky outcroppings of the crater's wall, a mineral that forms in the presence of water. Oppy would go on to find additional and conclusive evidence that Mars, long ago, was wetter and warmer.

Ninety Sols came and went and the little rover set off on an adventure that would last more than 14 years. Designed to travel 1,000 yards (1,006 meters), Oppy would set an off-world driving record, traveling over 28 miles (45 km). The engineering team at the Jet

Mars Reconnaissance Orbiter's camera spots Opportunity in Perseverance Valley (small dot in the center of the white square) as the storm ended and skies cleared.

Image credit: NASA/JPL-Caltech/Cornell/Arizona State Univ



A late afternoon sun casts Oppy's shadow on a rock outcropping overlooking Endeavour crater. The crater's eastern wall is 14 miles (22 km) away.

Propulsion Laboratory would guide and nurse the rover over obstacles and through mechanical problems with its robotic arm, the loss of steering in its two front wheels, a stuck-on heater (power drain) and the loss of use of its 256-megabyte flash memory. In the end, all the talent on Earth couldn't save the intrepid explorer. After transmitting more than 1,000 commands over an 8-month recovery campaign, in hope of eliciting a response, NASA declared the mission officially over on February 13, 2019.

Flight of the Spider

The Apollo 9 mission was the first manned test flight of all the hardware needed for a lunar landing, including the lunar module. The Saturn V, launched from the Kennedy Space Center on March 3, 1969, carried the record setting payload into low-Earth orbit. The mission was commanded by James McDivitt, with David Scott as the Command Service Module (CSM) Pilot and Russell Schweickart as the Lunar Module (LM) Pilot.

The crew would complete 152 orbits of the Earth, challenging the human physiology in ten days of weightlessness. During the first day on orbit, the CSM separated from the Saturn V's third stage. Turning around to face the rocket booster, the CSM docked with the LM nested inside. Using the CSM's thrusters, the joined pair moved a safe distance away. The third stage engine was then restarted to simulate a maneuver required for a deep space mission. It was eventually placed in a heliocentric orbit.

The crew of Apollo 9 used the CSM's propulsion system to change orbit and test the structural integrity of the joined CSM and LM under load. On Flight Day 3, McDivitt and Schweickart entered the LM through a tunnel connecting the two vehicles to test fire the LM's descent engine before returning to the CM.

Schweickart's spacewalk scheduled for Flight Day 4 was cut short because of nausea. He did spend a short time outside the LM to check out the life support system backpack which the moonwalkers would use.

McDivitt and Schweickart would enter the LM again on Flight Day 5. This time the two vehicles separated, with the LM moving 113 miles away and 12 miles above the CM. The descent stage of the LM was then jettisoned and the ascent stage engine fired for the first time. The ascent engine was used to lower the LM's altitude and rendezvous with the CM. With docking and the transfer of McDivitt and Schweickart back into the CM, the LM was jettisoned, its mission complete.

The crew of Apollo 9 accomplished all of the primary mission objectives, including rendezvous and docking of the two spacecraft, LM operations as a separate and independent spacecraft, transfer of

David Scott stands in the open hatch of the Command Module (CM). The photograph was taken by Schweickart on March 6th, from the porch of the LM during his brief excursion outside the vehicle. At that time, the CM nicknamed "Gumdrop" was docked to the LM nicknamed "Spider."

A view of the free flying LM with its landing legs extended captured on March 7th by David Scott who remained in the CM while McDivitt and Schweickart checked out the LM. The circular opening in the top of the ascent stage allowed astronauts to transfer between vehicles when docked. Credit: NASA

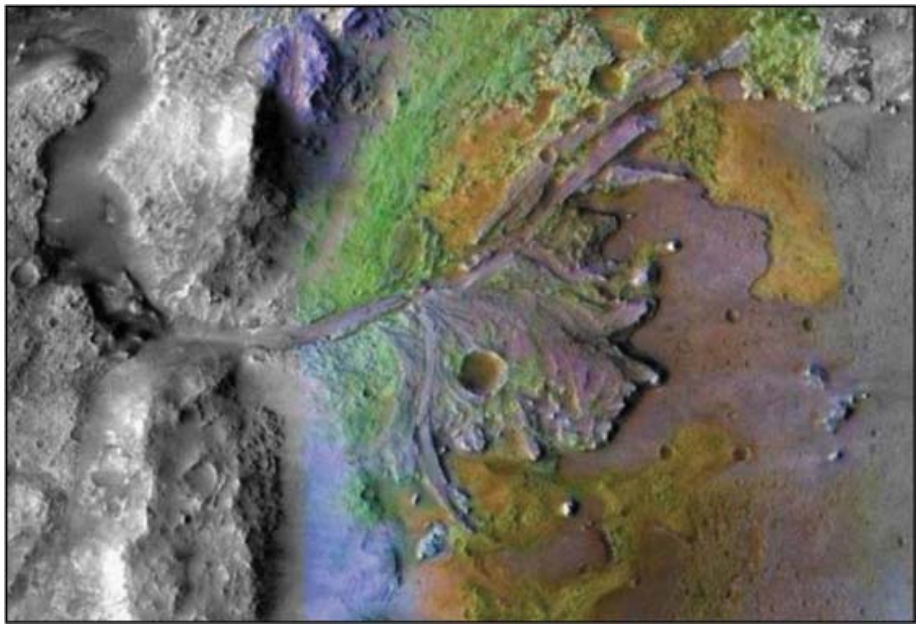
the crew between the two spacecraft, a simulated rescue operation assuming a lunar landing abort, multiple restarts of the CM's propulsion system (seven burns), and a full checkout of the CSM and LM systems. On Flight Day 10, the CM separated from the Service Module and reentered the Earth's atmosphere, splashing down in the Atlantic Ocean within three miles of the recovery ship, the USS Guadalcanal.

The near-Earth success of Apollo 9 would be repeated in lunar orbit by Apollo 10 in May of 1969, the precursor to the first Moon landing by the crew of Apollo 11 in July. Apollo 9 would also play a role in which astronaut would take that first step on Moon. McDivitt was originally selected to command Apollo 8, with the same mission objectives (full check out of the CSM and LM). However, the LM was behind schedule and wouldn't be ready so NASA decided to send the Apollo 8 CM to the Moon without the LM.

McDivitt declined the command of Apollo 8's new mission (believing it was a publicity stunt), electing to trade places with the Apollo 9 crew, commanded by Frank Borman, in anticipation that the LM would be available for that flight. McDivitt's decision resulted in the swap of the backup crews for the two missions with Pete Conrad moving to command Apollo 12 rather than 11. Had McDivitt agreed to remain with Apollo 8, it's likely that Conrad would have taken the first step.

Site Selection for Mars 2020

NASA will launch its successor to the Mars Science Laboratory (Curiosity) in 2020, with landing on Mars in early 2021. While built on the same platform as Curiosity, Mars 2020 is not a mobile laboratory – rather its instruments are designed to look for biosignatures in the rocks on Mars and cache promising samples for return to Earth on a later mission.



False color image of the Jezero Crater delta from information gathered by NASA's Mars Reconnaissance Orbiter's Compact Reconnaissance Imaging Spectrometer for Mars and the Context Camera. The landing ellipse for Mars 2020 is just to the east of the delta formation. Credits: NASA/JPL/JHUAPL/MSSS/Brown University

After a five-year search and evaluation of more than 60 potential landing sites, NASA selected the Jezero Crater delta as the target for the Mars 2020 mission. The crater, approximately 30 miles (49 km) in diameter, appears to have been filled with a 1,600 foot (500 meter) deep lake, between 3.5 to 3.9 billion years ago. Around the lake flowed a network of rivers. Orbital surveys have identified at least five different types of rocks at the site, including clays and carbonates which have the potential of preserving the signatures of ancient, microbial life. The Jezero site was selected over the other top candidate, the NE Syrtis region, just to the south of Jezero and populated by large shield volcanoes. A third site, the Columbia Hills, where the Mars Explorer Rover Spirit roamed and where signs of hydrothermal activity were found, was also under consideration. However, there was reluctance among project scientists to revisit a site that had already been explored.

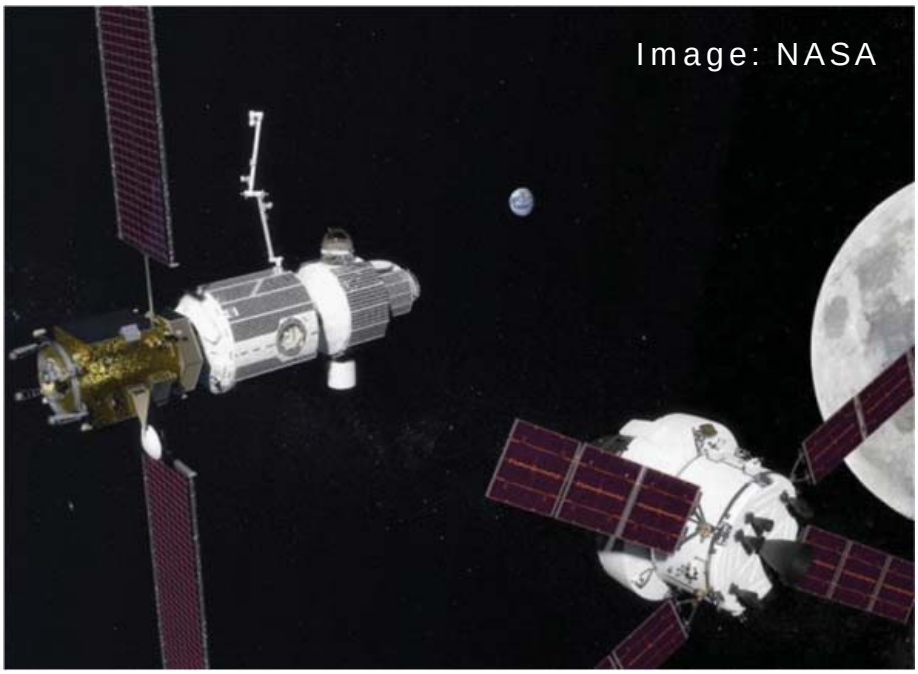
The Mars 2020 selection criteria included: 1) the probability of habitability in the past and the likelihood for preservation of biomarkers, 2) diversity of samples, 3) a terrain that allows a comprehensive survey and investigation, 4) evidence of abundant water in the past, and 5) a benign operating environment for the rover and its instrumentation.

The preferred landing site is located 19° N of the Martian equator in the Syrtis Major region and includes a delta-like formation. The Mars 2020 rover will land inside Jezero Crater using the same landing system (sky crane) that placed the Mar Science Laboratory within Gale Crater in 2012. The delta appears to have a number of obstacles that the rover will have

to negotiate including boulders and loose sediment around the delta terminus. To allow NASA to consider more challenging, and interesting, landing sites, the Mars 2020 sky crane is equipped with a Terrain Relative Navigation capability. This will enable the rocket-powered sky crane to identify and actively avoid hazards during its descent.

Return to the Moon

NASA is actively seeking partners for the development of a new lunar lander. Proposals for a Phase A study, due by March 25th, will require the successful bidder to present and evaluate options for a rapid development and flight demonstration of a "human landing system" or HLS for travel to and from the Moon. NASA is planning for an initial demonstration mission in 2024. The HLS includes both a Descent Element from a lunar orbiting outpost or "Gateway" and an Ascent Element which would return astronauts from the surface of the Moon back to the Gateway. Astronauts would access the Gateway from the Earth with the Orion spacecraft and by using NASA's Space Launch System, currently under development. In concept, NASA anticipates that the HLS would be reusable, with refueling at the Gateway to support a sustainable presence on the Moon.



Artist conception of an Orion spacecraft preparing to dock at Gateway, an orbiting lunar outpost where crews would transfer to the HLS.

NASA is currently working with nine American companies on commercial cargo deliveries to the Moon (science instruments and technology demonstrations). The first delivery task is expected to be awarded this year, with expectations that it could be completed by the end of 2020.

Space X Commercial Crew

Tentatively scheduled for launch on March 2nd, SpaceX is readying its Crew Dragon spacecraft for an uncrewed demonstration flight to the International Space Station (ISS). NASA had selected SpaceX and Boeing for development of crew-rated spacecraft that could transport U.S. astronauts to and from the ISS (NASA has relied upon Russia for ISS access since the retirement of the space shuttle in 2011). The first demonstration flight of Boeing's spacecraft, the CST-100 Starliner, to the ISS is currently scheduled for no earlier than April.


The Crew Dragon spacecraft sits atop a Falcon 9 rocket on Launch Complex 39A at the Kennedy Space Center in preparation for its first demonstration flight. Photo Credit: SpaceX

SpaceX completed a static firing of its Falcon 9 rocket with the Crew Dragon spacecraft in January. The launch in March is dependent upon the completion of hardware testing, NASA reviews and ground personnel training. If the demonstration is successful, SpaceX is anticipating that it could fly a crew aboard Crew Dragon as early as July. The company will still need to complete an in-flight abort test before its spacecraft is fully qualified to fly with a crew.

Israeli Moon Lander Takes Flight

In a rideshare arrangement, the privately-funded Israeli moon lander began its journey to the Moon on February 21st, with a trip into Earth orbit aboard a Falcon 9 rocket. Sharing the payload fairing with an Indonesian communications satellite and a U.S. Air Force surveillance satellite, the SpaceIL spacecraft was released from the Falcon's second stage approximately 33 minutes after the 8:45 pm EST launch from Cape Canaveral. The moon lander, named Beresheet (Hebrew for "genesis" or "in the beginning"), will use its engine, adapted from those used on communication satellites, to gradually raise its orbit over the next two months until it is captured by the Moon's gravity. The SpaceIL project team expects to transfer into a lunar orbit around April 4th with a landing attempt on the Moon's Mare Serenitatis (Sea of Serenity) on April 11th.

SpaceIL is a privately funded Israeli non-profit, formed in 2011 to complete for the Google Lunar X-Prize. While time expired before any of the X-Prize competitors were able to claim the prize, SpaceIL persevered with the loftier goal to inspire young Israelis to pursue careers in science, technology, engineering and math.

The lander will be sending home high-definition pictures and video. It will also be capable of "hopping" up to a third of a mile (half a kilometer) to a secondary landing site. NASA's Goddard Space Flight Center provided the project with a small laser retroreflector array for the spacecraft, something that could be used in the future as a navigation aid for orbiting spacecraft. NASA is also providing communications support, including time on its Deep Space Network, and orbital coverage with its Lunar Reconnaissance Orbiter (LRO). In turn, NASA will receive a copy of all data collected by the moon lander's magnetometer. The Soviet Union's Luna 21 lander and rover had detected magnetism in the region in 1973. Magnetism is key to understanding the Moon's early history and evolution, a time when the Moon had a global magnetic field. Today, only remnants of that field are found, locked in lunar rocks as they melted and then cooled.

The LRO will likely image the landing area, looking for changes in the regolith from the landing. Its instruments will also be searching for hydrogen and mercury in the dust stirred up by the lander's engine. If the mission is a success, Israel will join the United States, Russia and China as the only countries to soft-land on the Moon.

Dar al Gani 262 Lunar Meteorite

In the summer of 2018, the Observatory greatly expanded its meteorite teaching collection with the addition of a diverse and comprehensive set of meteoritic specimens from a reputable collector looking to convey his collection

The gold insulated 441 pound (200 kg), unfueled, Beresheet Moon Probe. Credit: SpaceIL

The intended landing area for the SpaceIL lander (yellow dot) within the white circle indicating the boundaries of Mare Serenitatis (Sea of Serenity).

to someone who would maintain its integrity and capitalize on its intrinsic educational value. The collection includes whole stones, slices and fragments, numbering more than 200, from historic and scientific-significant falls and meteorite finds dating back to 1492. From time to time, we will highlight one or more of the specimens from the collection in this newsletter.

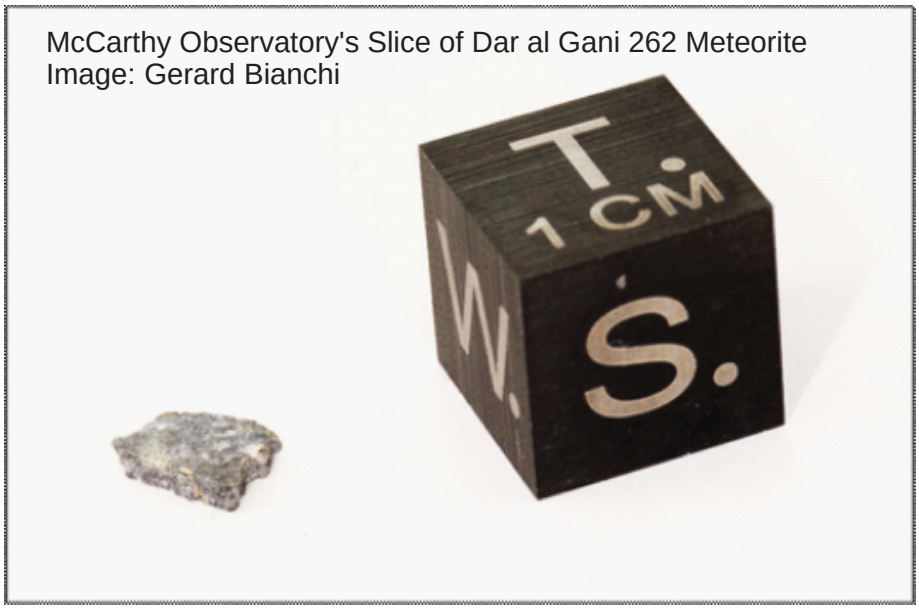
A small dark grey stone was found in the Libyan Sahara on March 23, 1997. Weighing in at just over a pound (513 g), the stone was partially covered with a brown fusion (partially melted) crust, distinctive to meteorites. A detailed chemical analysis of Dar al Gani 262, its official designation, revealed a lunar origin, based upon the stone's noble gas content, nitrogen and oxygen isotopic compositions and petrographic features. The meteorite is classified as anorthositic highland breccia with about half of the rock composed of fine grain material and the other half with larger fragments and melt veins. The rock showed signs of weathering and terrestrial contamination as several fractures were filled with calcite, likely of terrestrial origin.

To date, only 360 meteorites (0.1% of all meteorites recovered) have been identified as having a lunar origin. Dar al Gani 262 was one of the first lunar meteorites discovered in the northern hemisphere. Specific to rocks from the lunar highlands (comprised of the ancient lunar crust), Dar al Gani 262 has a low iron and a high aluminum content.

The Dar al Gani meteorite had a complex history, experiencing multiple shock or impact events. The ages of various rock fragments ranged from 1.7 to 3.5 billion years, and the stone resided on or near the surface of the Moon for some time, based upon its noble gas content (deposited by the solar wind). Based upon its exposure to cosmic rays (irradiation time), the stone is estimated to have been ejected from the Moon 160 thousand years ago. Approximately 80 thousand years ago, it succumbed to Earth's gravity, falling to the Libyan desert. The meteorite's composition is similar to several other stones recovered in the area (Dar al Gani 996, 1042 and 1048).

The McCarthy Observatory's meteoritic sample of Dar al Gani 262 is a thin slice, weighing just 0.058 grams.

McCarthy Observatory's Slice of Dar al Gani 262 Meteorite
Image: Gerard Bianchi



Taking Mars' Temperature

NASA's InSight lander has lowered the Heat and Physical Properties Package (HP3) onto the Martian surface, approximately 3 feet (1 meter) from the seismometer. If all goes according to plan, HP3 will burrow

up to 16 feet (5 meters) below the surface. The tether, connecting the mole to the lander, is equipped with temperature sensors, spaced every 14 inches (35 cm), on average. HP3 will hammer its mole to a maximum depth of 20 inches (50 cm) on the first Martian day (Sol). It will then wait two Sols for the heat generated by the burrowing to dissipate. One additional Sol will be spent measuring the thermal conductivity of the soil (the mole's metal skin is heated and the transfer efficiency of the heat to the soil is then measured), for a total of four Sols. The process is then repeated 10 times (assuming that the required daily depth is achieved) for a total of 40 Sols. The landing site appears to be sandy and relatively free of large rocks, but any subsurface obstacles could impede HP3's progress or prevent the probe from achieving its maximum depth (a minimum of 10 feet or 3 meters is desired).

New Apollo 11 Documentary

A new film on the Apollo 11 mission is being released on the IMAX screen starting on March 1st. Unlike past efforts to tell the story of humanity's grand adventure and first steps on another world from the point of view of an observer, this film is a reconstruction of events, based upon never-before-seen film footage, in concert with audio extracted from mission control voice recordings. The documentary was previewed at the 2019 Sundance Film Festival and received critical acclaim.

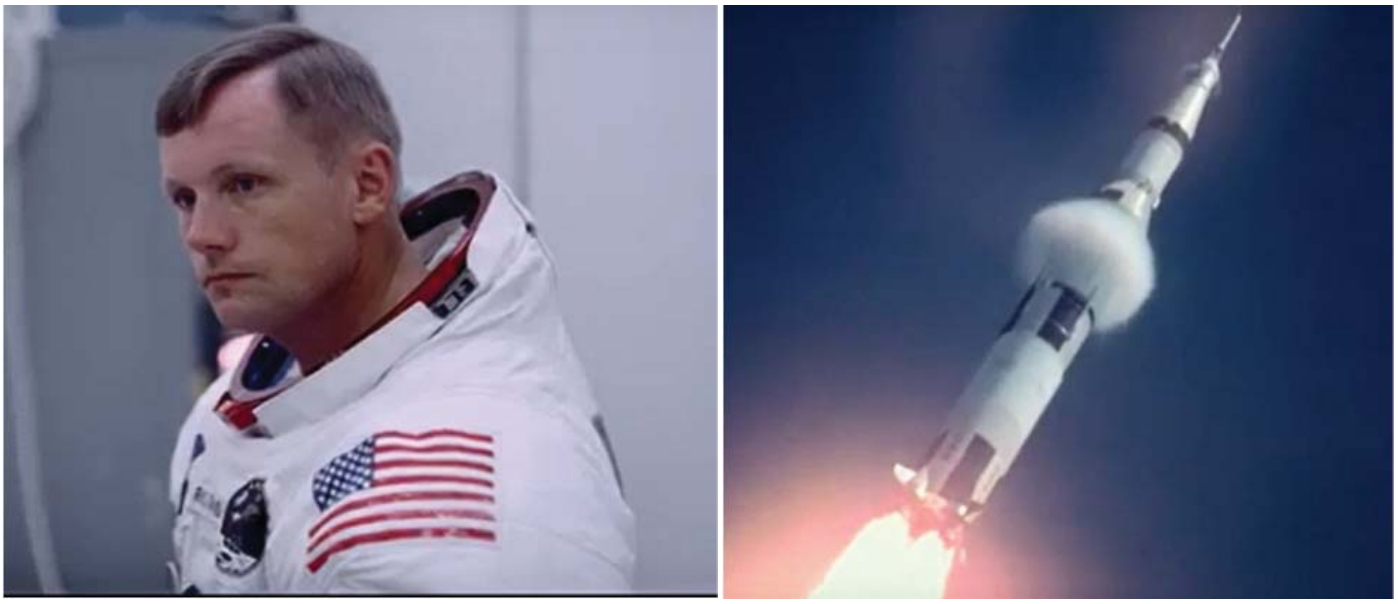
The 93-minute film was made possible by a find of 165 source reels of pristine, large format 65-mm Panavision footage of the Apollo missions, including 61 reels related to the Apollo 11 mission. The reels were left over from a project to record the Apollo story, originally by MGM Studios and later by director Theo Kamecke, after MGM backed out (Kamecke did release a documentary in 1970 called Moonwalk One). The long-forgotten reels were found in the National Archives during a search for footage of the Apollo 11 mission at the request of Todd Miller and his team working on a new biopic.

The National Archives didn't have the 60s-vintage projection equipment to screen the film for digitization and preservation, so the opportunity of having a private company willing to underwrite the effort was welcomed.

The film's audio comes from more than 11,000 hours of recordings. Relying upon work done by sound engineers at the University of Texas, the 30-track recordings were separated into their component tracks, digitized and synchronized with events depicted in the film. The result is a meticulous depiction of the proceedings that unfolded from launch to splashdown, as recorded by the participants.

From Snowman to Pancakes

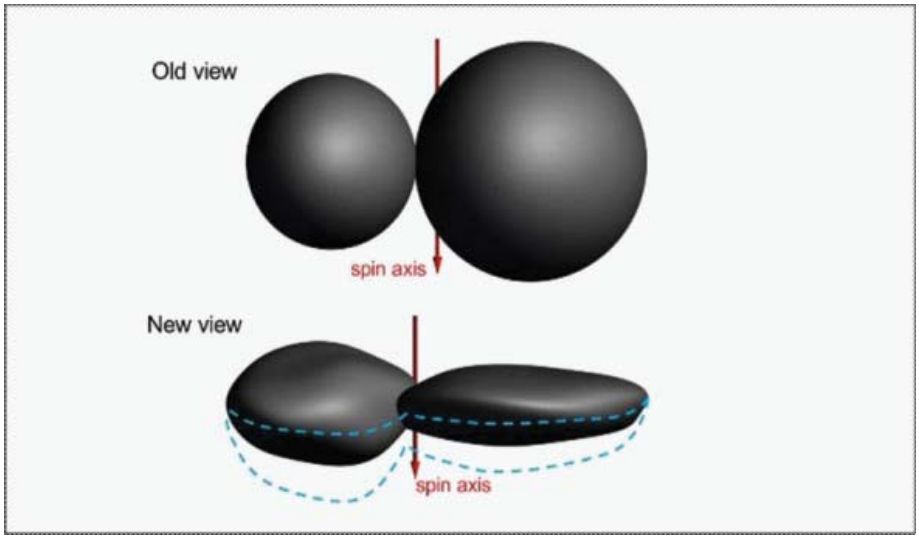
What once was construed as a contact binary of two roughly spherical bodies has been reevaluated with the transmission of several, additional post-encounter images from the New Horizons spacecraft. When New Horizons flew by the Kuiper Belt Object 2014 MU69 (nicknamed *Ultima*



Neil Armstrong suiting up and the Saturn V in flight - screenshots from "Apollo 11" trailer
Todd Douglas Miller/NEON/CNN Films

Thule) on January 1, 2019, the images received prior to the closest approach showed a snowman-shaped object with two nodes, slowly rotating face-on, like an airplane propeller. The side facing the spacecraft was fully illuminated, albeit by a very dim and distant Sun.

As New Horizons flew past Ultima Thule, its Long Range Reconnaissance Imager continued to track the object, now a weakly backlit crescent. From 14 different images captured by the spacecraft, mission scientists were able to create a departure movie. With processing to remove the blur from the spacecraft's high speed (31,000 mph or 50,000 kph) and the long exposures required due to the low-light environment, scientists were able to trace the outline of Ultima Thule against the background of stars. The departure movie revealed a geometry more akin to a deflated snowman. The two lobes are now being described as a pancake and dented walnut.



The changing shape of Ultima Thule, before and after the encounter by New Horizons. Credits: NASA/Johns Hopkins Applied Physics Laboratory/Southwest Research Institute

Hayabusa 2 Samples Ryugu

On February 22, 2019, Japan's Hayabusa 2 ("Peregrine Falcon" in Japanese) spacecraft briefly touched down on the surface of the asteroid Ryugu, after a slow, 23-hour descent from its station-keeping orbit. As the sampling arm made contact, a projectile was fired into the asteroid's surface. The projectile was designed to disturb the loose surface material which, with the asteroid's very low gravity, would float up into the arm to be stored in one of three sample chambers. Project scientists expect to be able to collect a maximum of 10 grams of material per sample attempt for return to Earth in late 2020. After completing its initial collection activities, the spacecraft returned to its home position.

Hayabusa 2 arrived at the primitive carbonaceous asteroid in June of last year (2018) after a three and one-half year journey (Ryugu was 206 million miles (341 million km) from Earth on February 22nd.) The C-type asteroid is rich in water and organic materials and approximately 3,000 feet across (900 meters). Ryugu was discovered on May 10, 1999 and is classified as a near-Earth object and a potentially hazardous asteroid of the Apollo group. Its 474-day orbit carries it across the orbit of the Earth.


Hayabusa 2 descending towards the surface, sampling arm first
Illustration by Akihiro Ikeshita (C) Japan Aerospace Exploration Agency (JAXA)

The asteroid's rock-strewn surface was unexpected and project scientists delayed the sampling originally scheduled for last October to better assess potential landing sites. The spacecraft did deploy two small, hopping rovers in September and a European-built lander.

Hayabusa2 will attempt two more sample collections over the next few months. The second attempt will be similar to the first. Later this year Hayabusa 2 will fire a large copper projectile into the asteroid to create an artificial

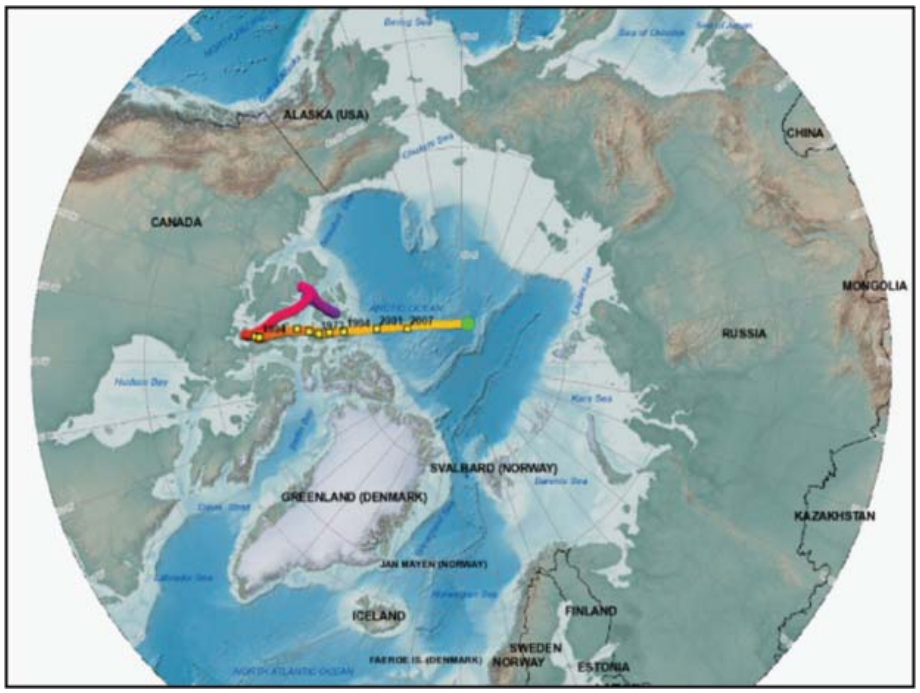
crater, approximately six feet (2 meters) in size and expose the asteroid's interior. In the third sample attempt, the spacecraft will collect material from the newly formed crater created by the copper projectile, material that has been shielded from radiation weathering by the overburden that will be removed by the impact.

The U.S. is conducting its own sampling mission on the carbonaceous asteroid. The OSIRIS-Rex spacecraft arrived at Bennu, a rock about one-half the size of Ryugu, on December 31st. NASA and JAXA signed a memorandum in 2014 to share data and a portion of the samples collected by the two missions. Project scientists for the OSIRIS-REx mission are hoping to collect and return up 2,000 grams from Bennu's surface. The spacecraft's sample container is scheduled for a return to Earth in 2023.

Earth's Magnetic Poles on the Move

The Earth has a solid inner core of iron and nickel, about three quarters the size of the Moon, and a Mars-size outer core that is liquid and rich in iron. The circulation of the liquid metal in the outer core creates electric currents, turning the Earth's core into a large electromagnet and creating a magnetic field that is strong enough to extend out into space, protecting life on Earth from galactic and solar radiation. The magnetic field has a north and a south pole, the position of each can migrate due to variations in the electric currents.

Starting in the 1990s, the movement of the north magnetic pole has accelerated, from an average of a less than 10 miles (16 km) per year to about 34 miles (55 km) per year. Once offset from the north geographical pole, the magnetic pole has been moving closer as it heads away from the Canadian arctic in the direction of Siberia.

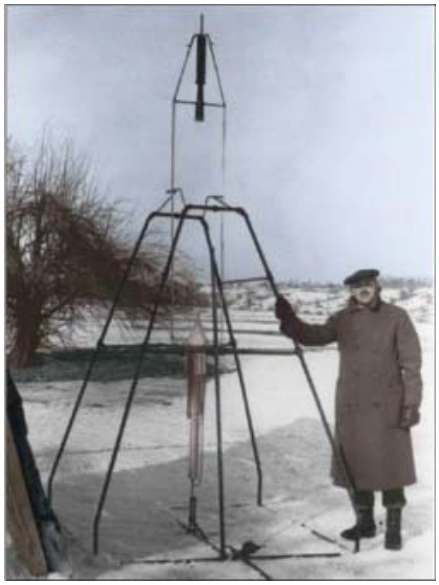


Migration of the North Magnetic Pole from 1590 to the Present
Credit: NOAA National Centers for Environmental Information

The Earth's magnetic field is not fixed, with its poles reversing every 450,000 years, on average. Based upon geologic records, the last field reversal occurred almost 800,000 years ago so it appears that a field flip is overdue. There are signs that the reversal may be underway with the Earth's magnetic field weakening. The strength of the field is approximately 14% lower today than it was 300 years ago. Data from the European Space Agency's SWARM satellites suggest that field decay is also accelerating. The duration over which the reversal takes is important, since it takes time for the field to realign and build in strength after the flip (during which time the Earth is exposed to higher levels of solar and galactic radiation). It had been thought that the process might take up to 10,000 years to complete, but there is some evidence that it could happen within 100 years.

March History

On March 16, 1926, in Auburn, Massachusetts, Robert Goddard launched the first liquid fueled rocket on a flight that lasted only 2½ seconds. A graduate of Worcester Polytechnic Institute, despite discharging a powder rocket from the basement of the physics building, the significance of Goddard's feat is compared by space flight historians to the first aircraft flight at Kitty Hawk. Among his achievements, Goddard was first to prove that rockets would work in a vacuum and to mathematically explore the practicality of using rocket propulsion to reach high altitudes and even the Moon (1912). While he was eventually banished from the fields of Auburn by the fire marshal, the site is commemorated by markers on what is now the Pakachoag Golf Course (*see next page*). The next time you are driving on the Massachusetts Turnpike towards Boston and points north, look to your left as you pass Exit 10. Just beyond the large shopping mall is where history was made.



Dr. Goddard with his liquid oxyen-gasoline rocket "Nell" in its launching frame. NASA photo

More March History

Caroline Herschel was born in Hanover, Germany on March 16, 1750, the fifth of six children. Her four brothers were brought up to be musicians like their father, a talented musician and bandmaster. Caroline's mother saw no need for a girl to be educated and preferred that Caroline become a house servant to the rest of the family. Unfortunately, Caroline contracted typhus at age 10. It permanently stunted her growth (she was just over four feet tall as an adult), further convincing her mother that she wouldn't amount to much. Caroline's brother William escaped to England during the French occupation of Hanover in 1757. Her father Isaac, who had left to fight the French, returned home in poor health. Caroline lived at home as a servant until his death in 1767. Against her mother's will, she then left Hanover to join her brother William in England.

William Herschel was an accomplished musician although he gained considerable fame with his hobby as an astronomer and telescope maker. His reputation as a craftsman allowed him to quit his job as a musician and concentrate on astronomy. Caroline became her brother's apprentice, helping him design and build larger and more powerful telescopes. She also assisted her brother in recording his observations, sitting in a window and writing by candlelight while her brother called out what he saw through the telescope's eyepiece.

Astronomy became a full-time occupation when William discovered the planet Uranus in 1781 and received an annual endowment from King George III. When her

brother was away, Caroline would use her own telescope to sweep the sky looking for comets. On August 1, 1786, Caroline discovered her first comet, the first comet to be discovered by a woman. Between 1786 and 1797 she would discover eight comets, as well as a number of deep sky objects.

With the marriage of William to Mary Pitt in 1788 and the birth of their son John in 1792, Caroline became involved in the education of her nephew. Under his father's and aunt's tutelage, John would become the first astronomer to thoroughly survey the southern hemisphere. Following William's death in 1822, Caroline continued to assist John in his astronomical work.

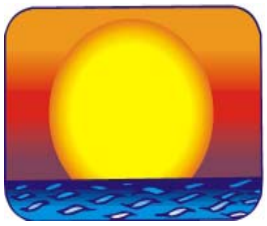
Caroline catalogued every discovery she and William made. Two of her catalogues are still in use today. She lived to be 98 and was recognized by the King of England, the Royal Astronomical Society, the King of Prussia and the King of Denmark for her life-long scientific achievements. After her death, Caroline Herschel was honored by the astronomical community by the naming of a lunar crater after her (C. Herschel) and an asteroid (281) Lucretia (her middle name).

Zodiacal Light

The solar system is filled with tiny dust particles from the passing of comets and collisions of asteroids. The dust orbits in the same plane as the Earth and the other planets. Shortly before sunrise and just after sunset, sunlight can be seen reflecting off this disk of debris. Called the zodiacal light, it is best observed when the ecliptic (the apparent path of the Sun and planets) is nearly perpendicular to the horizon (on spring evenings and autumn mornings). The best time to glimpse the zodiacal light is when the Moon is absent from the evening sky (for example, during the first week of March and around the New Moon on the 6th).

Sunrise and Sunset

March, the month named for the planet Mars, denotes the end of the long winter nights. The Sun crosses the celestial equator at 5:58 pm (EDT) on the 20th marking the Vernal Equinox and the beginning of the spring season in the northern hemisphere.



Sunrise and Sunset New Milford, CT)

Sun	Sunrise	Sunset
March 1st (EDT)	06:29	17:44
March 15th	07:06	19:00
March 31st	06:39	19:18

Astronomical and Historical Events

1st Aten Asteroid 2016 EO84 near-Earth flyby (0.056 AU)
1st Apollo Asteroid 65803 *Didymos* closest approach to Earth (0.971 AU)
1st Atira Asteroid 418265 (2008 EA32) closest approach to Earth (1.216 AU)
1st Apollo Asteroid 6489 *Golevka* closest approach to Earth (1.423 AU)
1st Plutino 90482 Orcus at Opposition; discovered on February 17, 2004 by American astronomers Michael Brown of Caltech, Chad Trujillo of the Gemini Observatory, and David Rabinowitz of Yale University; the plutino has one large moon called Vanth (47.136 AU)
1st History: U.S. astronaut Scott Kelly and Russian cosmonaut Mikhail Kornienko return to Earth after a one-year stay on the International Space Station (2016)
1st History: Soviet spacecraft Venera 13 lands on Venus and records first color panoramic views of the surface (1982)
1st History: discovery of Saturn's moon *Helene* by Pierre Laques and Jean Lecacheux from the Pic du Midi Observatory in the French Pyrenees; named after Helen of Troy (1980)
1st History: Soviet spacecraft Venera 3 lands (crashes) on Venus, becoming first spacecraft to impact the surface of another planet (1966)
2nd Currently scheduled launch date for SpaceX's Crew Dragon first demonstration flight to the International Space Station. The unscrewed test flight will launch from the Kennedy Space Center, Florida
2nd History: launch of the Rosetta spacecraft (2004); rendezvoused with *Comet 67 P/Churyumov-Gerasimenko* in May 2014, sending a lander to its surface in November 2014
2nd History: launch of Pioneer 10, a Jupiter flyby mission (1972)
3rd History: Chinese National Space Agency announces the Chang'e lunar exploration program (2003)
3rd History: launch of Apollo 9 with astronauts James McDivitt, David Scott and Russell Schweickart in the first manned flight test of the lunar module (1969)
3rd History: launch of the Pioneer 4 spacecraft towards the Moon; first U.S. spacecraft to escape the Earth's gravity (1959)
4th Moon at apogee (furthest distance from Earth)
4th Aten Asteroid 2015 EG near-Earth flyby (0.003 AU)
4th Aten Asteroid 1996 BG1 near-Earth flyby (0.052 AU)
4th History: discovery of Jupiter's rings by the Voyager 1 spacecraft (1979)
5th Apollo Asteroid 101955 *Bennu* closest approach to Earth (0.552 AU)
5th Kuiper Belt Object 523671 (2013 FZ27) at Opposition (47.172 AU)
5th History: discovery of Jupiter moon *Thebe* by Steve Synnott (1979)
5th History: Soviet spacecraft Venera 14 lands on Venus and uses a screw drill to obtain a surface sample that was determined to be similar to oceanic basalts on Earth (1982)
5th History: flyby of Jupiter by the Voyager 1 spacecraft (1979)
6th New Moon
6th Apollo Asteroid 2008 RR24 near-Earth flyby (0.068 AU)
6th Apollo Asteroid 2018 TD4 near-Earth flyby (0.071 AU)
6th History: Valentina Tereshkova's birthday (1937), Soviet cosmonaut became the first woman to fly to space in 1963
6th History: the Dawn spacecraft enters orbit around the dwarf planet *Ceres* (2015)
6th History: launch of the Kepler telescope from Cape Canaveral Air Force Station aboard a Delta II rocket (2009); designed to survey nearby stars for Earth-size and smaller planets; as of February 2019, Kepler discovered 2,337 confirmed planets with another 2,424 candidates yet to be confirmed
6th History: flyby of Comet Halley by Vega 1, a Soviet spacecraft (1986)
7th Kuiper Belt Object 2013 FY27 at Opposition (79.011 AU)
7th History: John Herschel born, first astronomer to survey the southern hemisphere (1792)
8th Apollo Asteroid 2016 ED86 near-Earth flyby (0.087 AU)

Astronomical and Historical Events (continued)

8th History: maiden voyage of Europe's first unmanned cargo ship to the International Space Station; the Jules Verne was launched from Kourou, French Guiana aboard an Ariane 5 rocket; in addition to delivering supplies to the ISS, the cargo ship contained a manuscript by the 19th century French author and science fiction pioneer with computations of distances from Earth to several astronomical destinations, as well as to the center of the planet (2008)
8th History: flyby of *Comet Halley* by Susei, a Japanese spacecraft (1986)
8th History: discovery of rings around Uranus by NASA's airborne observatory (1977)
9th **Second Saturday Stars - Open House at McCarthy Observatory**
9th Aten Asteroid 2017 GO5 near-Earth flyby (0.066 AU)
9th History: Space Shuttle Discovery (STS-133) makes its final landing (2011)
9th History: flyby of *Comet Halley* by Vega 2, a Soviet spacecraft (1986)
9th History: launch of the Soviet spacecraft Sputnik 9, with dog Chernushka (1961)
9th History: Yuri Gagarin born; first person to orbit the Earth in 1961 (1934)
10th Daylight Saving - Set Clock Ahead 1 Hour (United States)
10th Apollo Asteroid 24761 *Ahau* closest approach to Earth (1.325 AU)
10th Amor Asteroid 6050 *Miwablock* closest approach to Earth (2.044 AU)
10th Amor Asteroid 3271 Ul closest approach to Earth (2.210 AU)
10th Amor Asteroid 9950 ESA closest approach to Earth (2.755 AU)
10th History: Mars Reconnaissance Orbiter arrives at Mars (2006)
10th History: flyby of *Comet Halley* by Sakigake, a Japanese spacecraft (1986)
10th History: Uranus' rings discovered by astronomers James Elliot, Edward Dunham, and Jessica Mink using the Kuiper Airborne Observatory while observing a stellar occultation (1977)
11th History: launch of Pioneer 5 into solar orbit between the Earth and Venus; confirmed the existence of interplanetary magnetic fields (1965)
11th History: Urbain Leverrier born, mathematician and astronomer, predicted existence of Neptune (1811)
12th Atira Asteroid 434326 (2004 JG6) closest approach to Earth (1.277 AU)
13th Apollo Asteroid 88254 (2001 FM129) near-Earth flyby (0.087 AU)
13th History: flyby of *Comet Halley* by Giotto, a European Space Agency spacecraft (1986)
13th History: discovery of Saturn's moon *Calypso* by Dan Pascu, P.K. Seidelmann, William Baum and D. Currie (1980)
13th History: Percival Lowell born, established observatory in Flagstaff, AZ to observe Schiaparelli's Martian "canali" and look for other signs of life (1855)
13th History: William Herschel discovers the planet Uranus; originally named Georgium Sidus by Herschel in honor of his patron, King George III of England (1781)
13th History: Galileo Galilei publishes "Sidereus Nuncius" (Starry Messenger), the first scientific treatise based on observations made through a telescope; it described Galileo's early observations of the Moon, the stars, and the moons of Jupiter (1610)
14th First Quarter Moon
14th Scheduled launch of a Russian Soyuz spacecraft from the Baikonur Cosmodrome, Kazakhstan, to the International Space Station with the next Expedition crew.
14th Pi Day
14th Apollo Asteroid 2016 CK31 near-Earth flyby (0.093 AU)
14th History: launch of ESA's ExoMars Trace Gas Orbiter and Schiaparelli lander aboard a Russian Proton rocket from the Baikonur Cosmodrome in Kazakhstan (2016)
14th History: Stardust passes within 112 miles (181 km) of the nucleus of *Comet Tempel 1* (2011)
14th History: John J. McCarthy Observatory issued Observatory Code Number 932 by the Minor Planet Center of the International Astronomical Union (2001)
14th History: first European launch of a liquid-fueled rocket by Johannes Winkler (1931)
14th History: Albert Einstein born, developed theories of mass to energy conversion and the curvature of space and time in large gravitational fields (1879)
14th History: Giovanni Schiaparelli born, director of the Milan Observatory and first to describe faint features on Mars as "canali" (1835)
15th Apollo Asteroid 2015 EF7 near-Earth flyby (0.052 AU)
15th Aten Asteroid 483656 (2005 ES70) near-Earth flyby (0.056 AU)
15th Amor Asteroid 2368 *Beltrovata* closest approach to Earth (1.888 AU)
15th History: Alan Bean born; astronaut, moonwalker and artist (1932)
16th History: third and final flyby of Mercury by the Mariner 10 spacecraft (the last of the Mariner probes); Mariner 10 was also the first spacecraft to use solar radiation pressure on its solar panels and the antenna for attitude control during flight (1975)

Astronomical and Historical Events (continued)

16th History: launch of Gemini 8 with astronauts Neil Armstrong and David Scott; first docking with another space vehicle, an unmanned Agena stage (1966)
16th History: launch of the first Titan II Intercontinental Ballistic Missile, also used as the launch vehicle for the manned Gemini spacecraft in the early 1960's (1962)
16th History: Robert Goddard launches first liquid-fuel rocket in Auburn, MA (1926)
16th History: Caroline Herschel born (1750)
17th History: discovery of Asteroid 16 *Psyche* by Annibale de Gasparis (1852)
17th History: launch of the Gravity Recovery And Climate Experiment (GRACE) spacecraft (2002)
17th History: launch of Vanguard 1, 4th artificial satellite and oldest still orbiting Earth (1958)
17th History: discovery of Saturn's moon *Phoebe* by William Pickering (1899)
18th Apollo Asteroid 2016 ED1 near-Earth flyby (0.096 AU)
18th 50th Lunar and Planetary Science Conference, The Woodlands, Texas (18th - 22nd)
18th History: MESSENGER enters orbit around Mercury (2011)
18th History: New Horizons spacecraft (on its way to Pluto) crosses the orbit of Uranus (2011)
18th History: explosion during launch of a Vostok rocket carrying a military spy satellite kills 48 members of the Soviet Missile Troop; likely cause of explosion was an oxygen peroxide leak caused by the poor quality of the rocket's fuel filters (1980)
18th History: Alexei Leonov performs first spacewalk from Soviet Voskhod spacecraft (1965)
19th Moon at perigee (closest distance from Earth)
19th Apollo Asteroid 38086 *Beowulf* closest approach to Earth (1.194 AU)
19th History: Tenham meteorite fall; fragments of a large meteor rain down on a remote area of western Queensland, Australia (1879)
19th History: Moon flyby by the Hiten spacecraft; Japan's first lunar flyby, orbiter and surface impactor (1990)
20th Full Moon (Full Worm Moon)
20th Vernal Equinox (beginning of the Spring season in the northern hemisphere) at 5:58 pm EDT (21:58 UT)
20th Apollo Asteroid 2015 BY310 near-Earth flyby (0.059 AU)
21st Amor Asteroid 16912 *Rhiannon* closest approach to Earth (1.172 AU)
21st History: launch of Ranger 9, Moon impact mission; transmitted the highest resolution imagery obtained to that date before impacting the floor of Alphonsus crater on the 24th (1965)
21st History: discovery of Saturn's moons *Tethys* and *Dione* by Giovanni Cassini (1684)
22nd Apollo Asteroid 4581 *Asciepius* closest approach to Earth (0.138 AU)
22nd Amor Asteroid 3199 *Nefertiti* closest approach to Earth (1.062 AU)
22nd Apollo Asteroid 1685 *Toro* closest approach to Earth (1.265 AU)
22nd History: launch of space shuttle Atlantis (STS-76), third mission to Russian space station Mir and transfer of the first American woman, Shannon Lucid, to the station (1996)
23rd Mars Spring Equinox (northern hemisphere where InSight is operating)
23rd Apollo Asteroid 1864 *Daedalus* closest approach to Earth (1.017 AU)
23rd History: launch of Gemini 3 with astronauts Virgil Grissom and John Young, first manned Gemini flight (1965)
23rd History: Wernher von Braun born, German rocket scientist and leader of the U.S. moon program (1912)
24th History: discovery of Comet Shoemaker-Levy 9 (1993)
25th Aten Asteroid 3554 *Amun* closest approach to Earth (1.281 AU)
25th History: launch of the IMAGE spacecraft, first mission dedicated to mapping the Earth's magnetosphere (2000)
25th History: close approach of Comet Hyakutake (0.10 AU) to Earth (1996)
25th History: launch of Soviet spacecraft Sputnik 10 with dog Zvezdochka (1961)
25th History: Christiaan Huygens discovers *Titan*, Saturn's largest moon (1655)
26th Amor Asteroid 8034 *Akka* closest approach to Earth (1.088 AU)
26th Dwarf Planet 136472 *Makemake* at Opposition (51.671 AU)
26th History: American astronomer J.W. Draper takes first photograph of the Moon (1840)
27th Apollo Asteroid 2014 TL near-Earth flyby (0.057 AU)
27th Aten Asteroid 2004 BY1 near-Earth flyby (0.063 AU)
27th Amor Asteroid 3908 *Nyx* closest approach to Earth (1.706 AU)
27th History: U.S. astronaut Scott Kelly and Russian cosmonaut Mikhail Kornienko arrive at the International Space Station for a year-long mission (2015)
27th History: launch of the Soviet atmospheric probe and lander Venera 8 to Venus (1972)
27th History: launch of Mariner 7, Mars flyby mission (1969)
27th History: President Eisenhower approves the military lunar program to be managed by the Advanced Research Projects Agency (1958)

Astronomical and Historical Events (continued)

28th	Last Quarter Moon
28th	Neptune Trojan 316179 (2010 EN65) at Opposition (25.989 AU)
28th	History: flyby of Comet Halley by the ICE spacecraft (1986)
28th	History: Heinrich Olbers discovers the asteroid 2 *Pallas* (1802)
29th	Amor Asteroid 7480 *Norwan* closest approach to Earth (1.071 AU)
29th	Amor Asteroid 3988 *Huma* closest approach to Earth (1.756 AU)
29th	Amor Asteroid 4954 *Eric* closest approach to Earth (1.918 AU)
29th	Amor Asteroid 2202 *Pele* closest approach to Earth (2.340 AU)
29th	History: First flyby of Mercury by the Mariner 10 spacecraft (1974)
29th	History: Heinrich Olbers discovers the asteroid 4 *Vesta* (1807)
31st	Apollo Asteroid 163081 (2002 AG29) near-Earth flyby (0.099 AU)
31st	History: launch of Soviet spacecraft Luna 10, first man-made object to go into orbit around another planetary body; detected evidence of mass concentrations on the Moon called "mascons" (1966)

Commonly Used Terms

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

References on Distances

• The apparent width of the Moon (and Sun) is approximately one-half a degree (½°), less than the width of your little finger at arm's length which covers approximately one degree (1°); three fingers span approximately five degrees (5°)

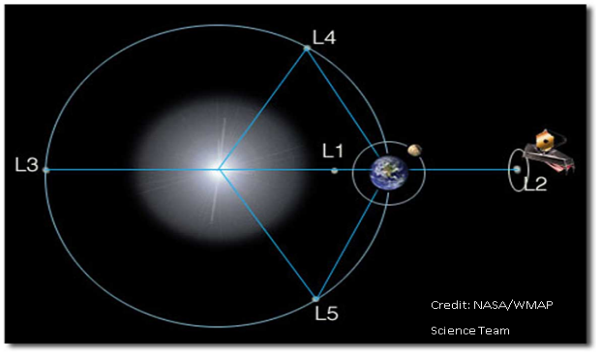
• One astronomical unit (AU) is the distance from the Sun to the Earth or approximately 93 million miles

International Space Station and Iridium Satellites

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

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).



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.*

Front Page

Dreamtime Deep Down in the Outback

About 150 million years ago, in the transition between the Jurassic and Cretaceous periods, an asteroid or comet broke through Earth's atmosphere and impacted an area in central Australia, about 132 miles (212 km) from Alice Springs.

Dubbed *Gosses Bluff* after a member of the expedition that explored it, the impact crater and its cosmic origine were already enshrined in the annals of the Arandic native culture of central Australia as *Tnorala*, a celestial event thet occurred during the *dreamtime*, a supernatural period before humans, when a celestial woman left her baby in a basket to go dancing and the baby fell to earth, causing an upwelling of the rocks to form a circular mountain range.

Aboriginal cultures were acutely aware of the night sky above them and incorporated rare sightings and events into their collective oral heritage. In 2010, astronomers Duane Hamacher and David Frew from Macquarie University in Sydney showed that the Boorong Aboriginal people of northwestern Victoria, Australia, witnessed the outburst of Eta Carinae in the 1840s and incorporated it into their oral traditions as *Collowgulloric War, the wife of War*.

The impact crater rim has eroded over time, from about 14 miles (22 km), leaving a 5 km (3.1 miles) central uplift area which in turn has eroded to resemble its original bowl shape.

The image is in false-color, to reveal the mineral composition of the crater and vegetation. Among the rare minerals with celestial origins are azurite (dark blue), reidite (bright red).

Sources

http://aboriginalastronomy.blogspot.com/2011/03/impact-craters-inaboriginaldreamings_28.html;
http://www.esa.int/spaceinimages/Images/2018/06/Australian_crater;
https://aus.worldpeacefull.com/2011/08/custodians-arrernte-people-of-alice-springs-mparntwe/.
https://arxiv.org/ftp/arxiv/papers/1010/1010.4610.pdf .
https://mine.nridigital.commine_australia_jan19mining_the_world_s_rarest_mineral_in_meteor_craters;
https://en.wikipedia.orwikiAustralian_Aboriginal_astronomy.
https://theconversation.com/worlds-largest-asteroid-impact-site-could-be-right-here-in-australia-37744
https://theconversation.com/target-earth-how-asteroids-made-an-impact-on-australia-92836
https://en.wikipedia.org/wiki/Dreamtime

Source: NASA/ISS Expedition 7 crew member - NASA Earth Observatory

Image Credits

Front page design and graphic calendar: Allan Ostergren

Second Saturday Stars poster: Marc Polansky

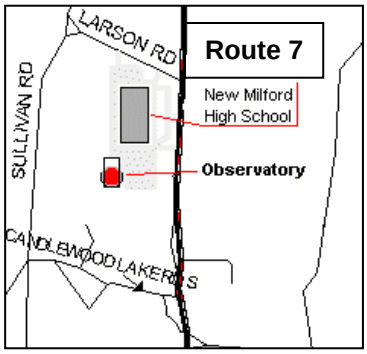
All other non-credited photos were taken by the author: Bill Cloutier

Contact Information

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

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

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



www.mccarthyobservatory.org

@McCarthy Observatory

@McCarthy Observatory

mccarthy.observatory@gmail.com

@JJMObservatory

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

March 9th

7:00 - 9:00 pm

Search for Life in the Solar System

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

Map

March 2019

Celestial Calendar

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday

Phases of the Moon

1

Soviet spacecraft Venera 3 crashes on Venus (1966)

Venera 13 makes successful landing (1982)

Saturn's moon Helene discovered by Pierre Laques and Jean Lecheux (1980)

2

Launch of Pioneer 10 Jupiter flyby mission (1972)

Launch date for SpaceX's Crew Dragon first demo flight to the iss ISS from the Kennedy Space Center,

Launch of Rosetta spacecraft to comet 67 P/ Churyumov-Gerasimenko (2004)

3

Launch of Apollo 9; first test of lunar module (1969)

ESA's Mars Express spacecraft close flyby of Martian moon Phobos (2010)

4

Moon at apogee (farthest from Earth)

Giovanni Schiaparelli, born, first to describe Martian "canali" (1835)

5

Soviet spacecraft Venera 14 lands on Venus (1982)

launch of the Air Force's second robotic space plane (X-37B) from the Cape Canaveral Air Force Station

Voyager 1 flyby of Jupiter (1979)

6

Flyby of comet Halley by Soviet Vega 1 spacecraft (1986)

Launch of Kepler telescope, to search for exoplanets (2009)

Dawn spacecraft arrives at the dwarf planet Ceres

7

John Herschel born, first astronomer to survey southern hemisphere (1792)

8

Flyby of Comet Halley by Japanese Suisei spacecraft (1986)

Discovery of Uranus' rings by NASA Airborne Observatory (1977)

Maiden voyage of the Jules Verne, Europe's first unmanned cargo ship to International Space station (2008)

9

Flyby of comet Halley by Vega 2, Soviet spacecraft (1986)

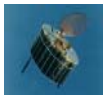
Sputnik 9, with dog Chernushka (1961)

Yuri Gagarin born - first to orbit Earth (1934)

2nd Saturday Stars Open House McCarthy Observatory

10

Daylight Saving Time



Flyby of Comet Halley by Japanese Sakigake spacecraft (1986)

Mars Reconnaissance Orbiter arrives at Mars (2006)

11

Urbain Leverrier born - Predicted existence of Neptune (1811)

Launch of Pioneer 5 into solar orbit to study interplanetary magnetic fields (1965)

12

Simon Newcomb born - Canadian-American astronomer, studied planetary motion (1855)

13

Percival Lowell born (1855)

Discovery of Uranus by William Herschel (1781)

Flyby of Comet Halley by ESA spacecraft, Giotto (1986)

14

Happy Pie Day!

Albert Einstein born (1879)

Giovanni Schiaparelli born, first to observe Martian "canali" (1835)

JJMO earns Observatory Code 932 from IAU's Minor Planet Center for tracking of asteroid Geographos (2001)

15

Abbé Nicolas Louis de Lacaille born, French astronomer, catalogued southern hemisphere stars and constellations (1713)

San Juan Capistrano Meteorite Fall (1973)

16

Robert Goddard First liquid fuel rocket (1926)

First Titan 2 ICBM (1962)

Caroline Herschel born. first woman astronomer (1750)

17

Vanguard 1 artificial satellite (1958)

Publication of *Sidereus Nuncius* on Galileo's astronomical observations (later taken on 2008 Hubble repair mission) (1610)

18

Alexei Leonov First Spacewalk (1965)

Soviet Vostok rocket explodes during launch, killing 48 (1980)

19

Moon at perigee (closest distance to Earth)

Moon flyby by Japan's Hiten orbiter and impactor (1990)

20

Vernal Equinox 12:15 PM EDT (16.15 UT)

21

Launch of Ranger 9 Moon impact mission (1965)

22

Shannon Lucid, first American woman on Russian Space Station (1996)

23

Launch of Gemini 3 (Grissom, Young) (1965)

Wernher von Braun born (1912)

First photo of Moon by J.W. Draper (1840)

24

Planet Pluto (now *dwarf* planet) officially named by Lowell Observatory, on suggestion of Oxford schoolgirl, Venetia Burney (1930)

25

Launch of IMAGE spacecraft, first to study Earth's magnetosphere (2000)

Comet Hyakutake 1996

Christiaan Huygens, discovers Saturn's moonTitan (1655)

26

John Draper takes first photograph of the Moon (1840)

French mathematician and discoverer of Neptune, Urban Jean Joseph Le Verrier, proposes existence of a new planet Vulcan within orbit of Mercury (1859)

27

Eisenhower approves military lunar program (1958)

Launch of Mariner 7 Mars flyby mission (1969)

28

Flyby of Halley's Comet by ICE spacecraft (1986)

29

First flyby of Mercury by the Mariner 10 spacecraft (1974)

Heinrich Olbers discovers the asteroid 4 Vesta (1807)

30

Bernhard Voldemar Schmidt born - German astronomer and inventor of the Schmidt telescope, known for its high definition and wide field of view (1879)

31

Launch of Soviet spacecraft Luna 10, first to orbit Moon (1966)