Galactic Observer
John J. McCarthy Observatory
Volume 12, No. 5
Mat 2019

Galactic Mergers - Dancing with the STARS or Deadly Dos-I-Dos?

See inside: page 20

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
Peter Gagne
Louise Gagnon
John Gebauer
Elaine Green
Jim Johnstone
Carly KleinStern
Bob Lambert
Roger Moore
Parker Moreland, PhD
Allan Ostergren
Marc Polansky
Joe Privitera
Danielle Ragonnet
Monty Robson
Don Ross
Gene Schilling
Katie Shusdock
Jim Wood
Paul Woodell
Amy Ziffer

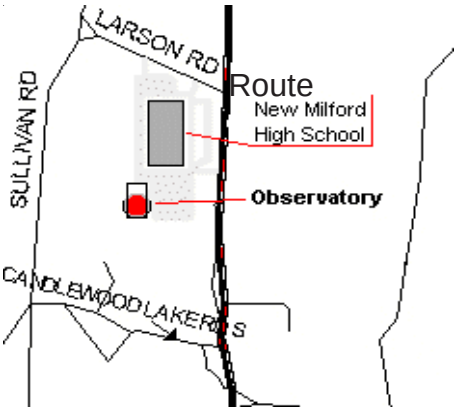
Galactic Observer Editorial Committee

Managing Editor
Bill Cloutier

Production & Design
Allan Ostergren

Website Development
Marc Polansky

Technical Support
Bob Lambert
Dr. Parker Moreland



In This Issue

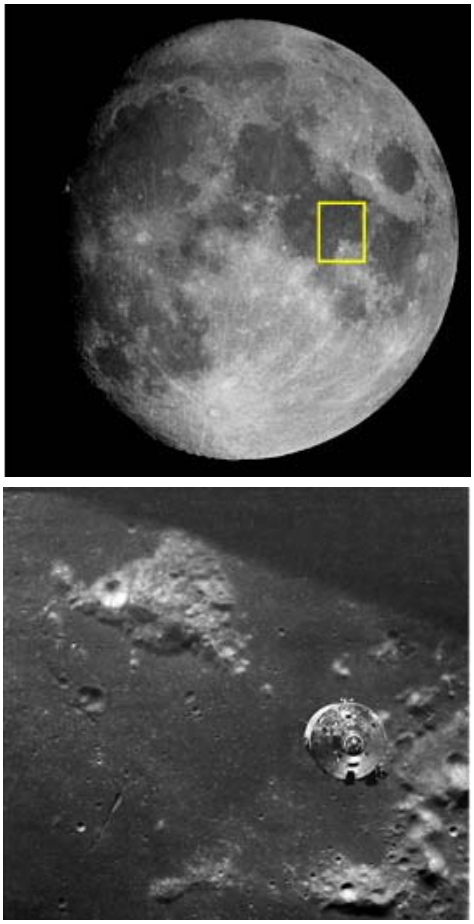
May Astronomy Calendar and Space Exploration Almanac

STS-125, Final Hubble Serving Mission, May 2009

Photo: Bill Cloutier

"Out the Window on Your Left"

It's been more than 46 years since we left the last footprint on the dusty lunar surface. As a nation founded on exploration and the conquest of new frontiers, today's leadership has been indifferent, commitments short-lived and funding fleeting. 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).

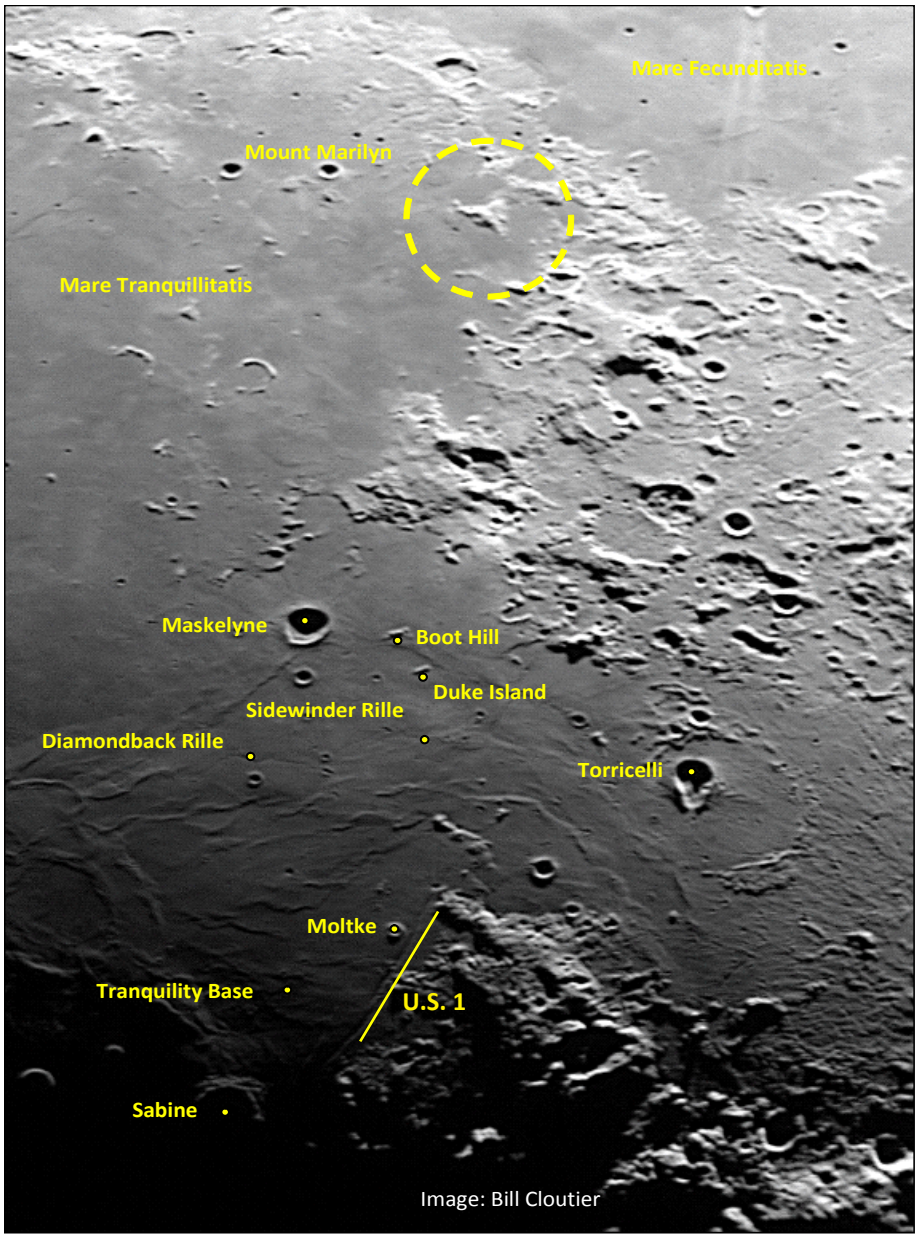


NASA Photo: Apollo 10 Command Module as seen from the Lunar Module with Mt. Marilyn visible in the background.

Prior to 1968, a triangular - shaped outcrop of rock located between two dark patches of lava (Mare Tranquillitatis and Mare Fecunditatis, the Sea of Tranquility and Sea of Fertility , respectively) was noteworthy only for a small crater (Theta Secchi) located on its flank. Jim Lovell, the Command Module Pilot on the crew of Apollo 8, was one of the first people to circumnavigate the Moon. He named that ancient rock outcrop "Mount Marilyn" as a tribute to his wife. After 49 years, the informal name was of ficially adopted by the InternationalAstronomical Union in August 2017.

Apollo 10 was a dress rehearsal for Apollo 11, with astronauts Thomas Stafford and Eugene Cernan flying the Lunar Module to within 9 miles (14 km) of the lunar sur - face. Along the way the Apollo 10 crew identified dozens of informal landmarks that could be used by Armstrong and Aldrin as waypoints to check their progress against the nominal descent timeline. The names appear on the charts used by the astronauts, in technical reports, and in transcripts of communications between the astronauts and the ground.

The 4,593 foot (1,400 m) high Mt. Marilyn was likely created over 4 billion years ago in the aftermath of the impacts that



formed the nearby basins. The crew of Apollo 10 passed over the triangular outcrop before heading down "U.S. 1" on their first orbit of the Moon, as they replicated the approach that Apollo 11 would take to Tranquility Base.

Black Hole Revealed

The Event Horizon Telescope (EHT) is a collaboration and coordination of eight radio telescopes located around the world (operating as one planet-size telescope). Data collected from observations of the black hole at the center of the galaxy Messier 87 (M87), were combined to produce the first image of the shadow of a black hole cast against the hot disk of material encircling its event horizon (the distance from the center of the black hole from which light cannot escape due to its intense gravity).The M87 galaxy resides in the Virgo galaxy cluster, approximately 55 million light years from Earth. Its galactic black hole is estimated at 6.5 billion solar masses (6.5 billion times more massive than our Sun).

The telescopes that participated in the project were the Atacama Large Millimeter/submillimeter Array (ALMA) and Atacama Pathfinder Experiment (APEX) telescopes (Atacama Desert, Chile), the James Clerk MaxwellTelescope and the Submillimeter Array (Maunakea, Hawaii), the IRAM 30-meter telescope (Pico Veleta, Spain), the Large Millimeter Telescope Alfonso Serrano (Volcán Sierra Negra, Mexico), the Submillimeter Telescope (Mt. Graham, Arizona), and the South Pole Telescope. The data was processed by super-computers hosted by the Max Planck Institute for Radio Astronomy and the MIT Haystack Observatory.

Astronomers targeted a particular wavelength of light to build the image (1.3 millimeters). At this wavelength, the very edge of the event horizon is illuminated without obscuring the black hole. The brighter part of the ring is relativistic light moving towards us. The light in the dimmer segment is receding.

The image, three years in the making, was released on April 10th and shows the shadow of the black hole at the center of M87, illuminated by superheated, luminous plasma swirling around its event horizon.

Several of NASA's telescopes monitored M87 during EHT's observing campaign, including the Chandra X-ray Observatory, Nuclear Spectroscopic Telescope Array (NuSTAR), Neil Gehrels Swift Observatory space telescope and the Fermi Gamma-ray Space Telescope. Had EHT detected unusual activity or something unexpected, the data from the telescopes monitoring the different wavelengths would have been invaluable to identifying the source of any anomaly.

The results of EHT (including the shape of the shadow) are consistent with the predictions of Einstein's theory of general relativity and expectations for the shadow of a spinning Kerr black hole. Future observations by EHT will attempt to achieve a higher resolution. The telescopes will also target the much smaller black hole at the center of our Milky Way Galaxy (1,000 times less massive than the galactic black hole in M87).

M87's black hole now has a formal name, although unofficial. Prior to making the image public, the EHT team asked Larry Kimura, a Hawaiian language professor at the University of Hawaii at Hilo, to suggest a name for the surreal object. Kimura, drawing from a eighteenth century Hawaiian chant, created the name "Pôwehi," meaning "embellished dark source of unending creation" – a more appropriate name for a galactic powerhouse than M87*.

Close Call

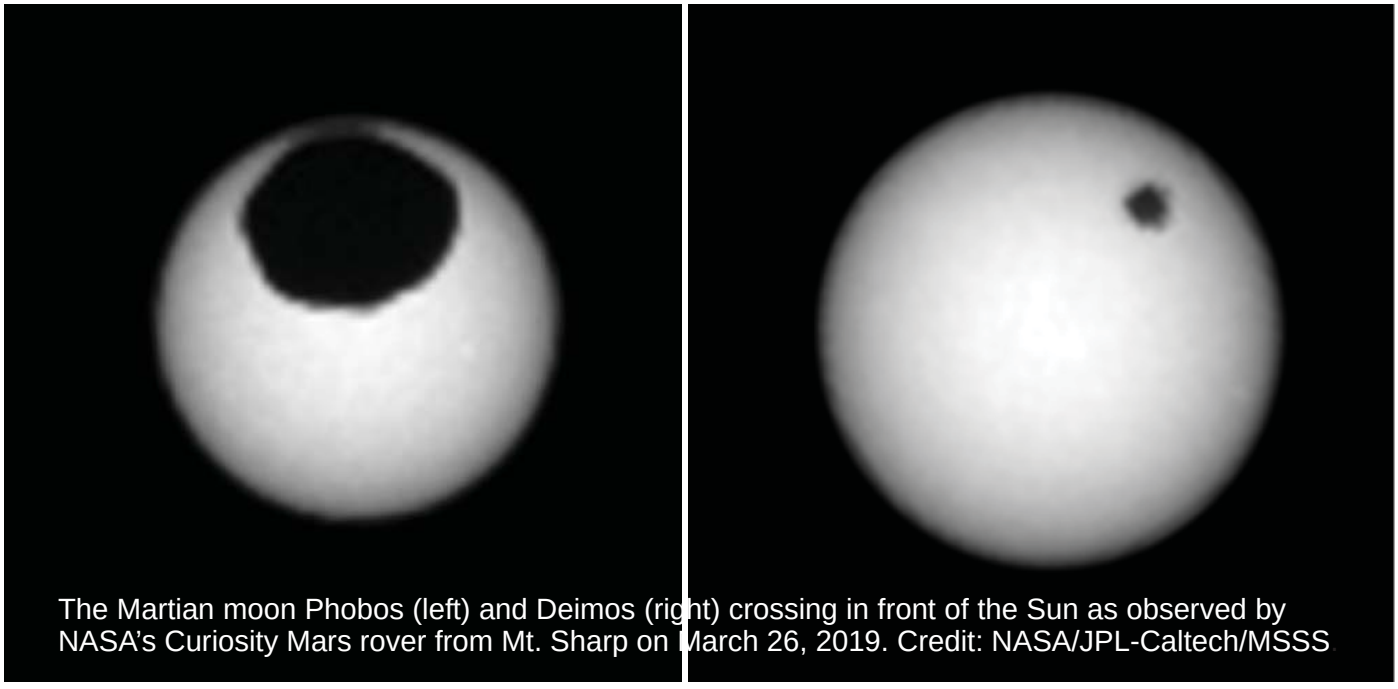
On May 6, 1969, a little over two months before NeilArmstrong was scheduled to take the commander's left seat in the Apollo 11 capsule for its epic voyage, he was flying the Lunar Landing Research Vehicle (LLRV) in a lunar landing simulation. The ungainly contraption was built around a turbofan engine upon which the astronaut sat. Engine thrust was used to offset five-sixths of the vehicle's weight, which the astronauts would experience when on the Moon. Thrusters, similar to

those used on the Lunar Module (LM) provided attitude control. The LLRV, and its successor, were built by Bell Aerosystems of Buffalo, New York, and provided the astronauts experience in flying the LM, a spacecraft solely designed to operate in the lunar environment.

On that day in May, Armstrong took off from the Ellington Air Force Base near the Manned Spacecraft Center in Houston, as he had done for 21 previous flights of the LLRV. Five minutes into the flight, the vehicle became unresponsive when the loss of helium pressure in a thruster subsystem resulted in a loss of flight controls. Unable to stabilize the vehicle, Armstrong ejected just 200 feet above the ground. The LLRV exploded on contact, after which, Armstrong went back to the office to finish up some work. That is where astronaut Alan Bean found him. "I can't think of another person," Bean recalls, "let alone another astronaut, who would have just gone back to his of fice after ejecting a fraction of a second before getting killed."

Armstrong flying the LLRV on May 6, 1969 (left) and ejecting (right) seconds before the crash). Credit: NASA video.

Armstrong parachutes back to Earth on May 6, 1969 after ejecting from the LLRV. Credit: NASA video.



The Martian moon Phobos (left) and Deimos (right) crossing in front of the Sun as observed by NASA's Curiosity Mars rover from Mt. Sharp on March 26, 2019. Credit: NASA/JPL-Caltech/MSSS

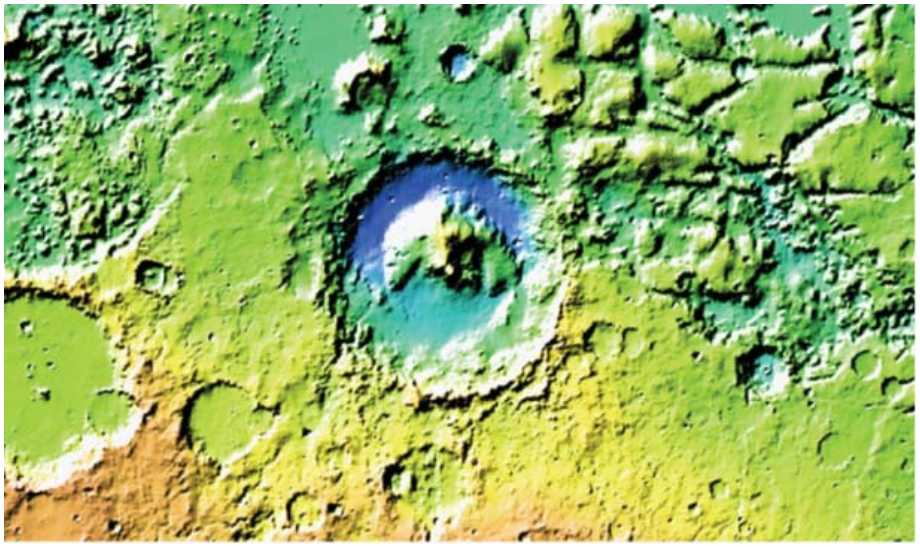
Martian Solar Transits

Timing the passage of Mars' two diminutive moons as they cross in front of the Sun is a technique used by scientists to improve the accuracy of the moon's orbits. The rovers Spirit, Opportunity and Curiosity have observed Deimos transiting the Sun a total of 8 times and Phobos 40 times. The first attempt by one of the rovers found Deimos 25 miles (40 km) from its predicted position. Subsequent transits have refined the orbits, but some uncertainty still remains.

Phobos orbits Mars 3,700 miles (6,000 km) above the planet' s surface, crossing the sky three time a day as it travels from west to east. Being so close, Phobos' orbit is decaying by about 6.6 feet (2 meters) every hundred years. Scientist predict the structural breakup of the moon in 30 to 50 million years. The breakup of the moon will create a ring of debris around the planet.

Even at such a close distance, Phobos, at 16 miles (26 km) across, doesn't cover the entire solar disk, as seen from the surface.

Deimos, 12,500 miles (20,000 km) above the surface, takes a little over 30 hours to complete an orbit of Mars. At only 10 miles (16 km) across, and much further away than Phobos, the diminutive moon presents a much smaller profile as it transits.



Topographical map of the 96 mile (155 km) diameter Gale Crater (center) and the surrounding landscape, created from data gathered by the Mars Global Surveyor's Mars Orbiter Laser Altimeter (MOLA). The color blue is used to represent the lowest elevations with yellows and red, higher ground. NASA / JPL / Goddard Space Flight Center

Now You See It, Now You ...

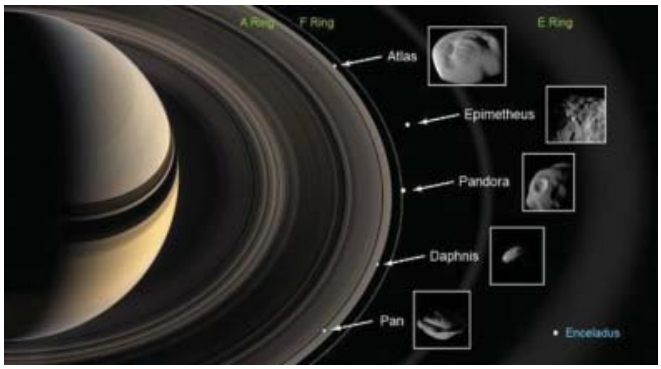
The search for life on Mars (past or present) has been bolstered by recent discoveries of what are believed to be subsurface pockets of liquid water. In addition, data collected by the Mars Science Laboratory, Curiosity, revealed a seasonal methane cycle on the surface (at Gale Crater) with higher concentrations in late summer and early autumn and lower concentrations in the winter and spring.As a biomarker, methane (and liquid water) can indicate the presence of life, at least at a microbial level. Methane gas can also be generated by chemical interactions (for example, from rock and water or from the interaction of or ganics with ultraviolet radiation), so its presence in the Martian atmosphere may have other sources (than biological). Reports of methane have also been sporadic and, until recently, unconfirmed.

On June 15, 2013, Curiosity reported a spike in the concentration of methane in Gale Crater. Researchers, in reviewing data from the spectrometer on the European Space Agency's Mars Express spacecraft during the same period found methane present in the atmosphere during a pass over Gale Crater on the following day. This is the first independent confirmation of a methane detection.

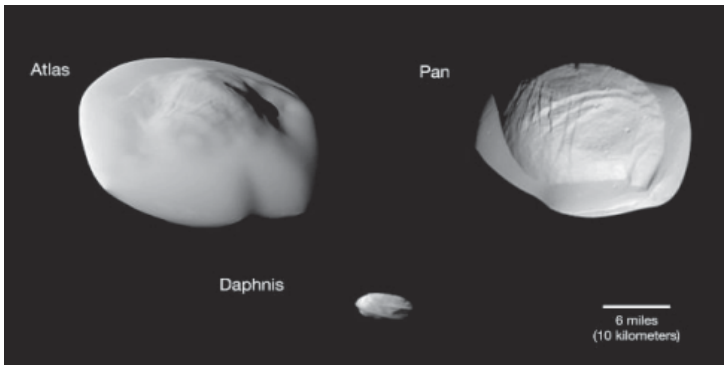
Researchers point to a fault region near the Gale Crater as the most likely source for the methane. The area is suspected to contain shallow deposits of ice that could release methane from seasonal melting episodes, seismic events or meteoritic impacts.

In an interesting twist on the search for methane, the science team for the ExoMars Trace Gas Orbiter (TGO) presented their initial results from the spacecraft's two spectrometers – instruments with the sensitivity to detect trace levels of methane in the atmosphere. The team reported no detection of methane, not even trace amounts.

Methane does have a finite lifetime in the atmosphere, about 12 years, before chemical reactions break down the gas, but researchers are puzzled as to why TGO's instruments have come up empty, taking into consideration the data gathered by the Curiosity rover and now confirmed by the Mars Express spacecraft.



Saturn, it ring moons and Enceladus-generated E-Ring
Credits: NASA/JPL-Caltech



Material around their equators, giving them the appearance of flying saucers

The Cassini mission ended in 2017, but the data gathered by the spacecraft during 13 years of exploring Saturn and its moons continues to reveal new details that have added to our understanding of how the gas giant and its satellites have evolved.

Between December 2016 and April 2017, the Cassini spacecraft executed six close flybys of the ring moons (Pan, Atlas, Daphnis,Pandora and Epimetheus). Cassini's instruments analyzed the moons at multiple wavelengths and their interactions with the planet's plasma and magnetic field. Researchers found that the moons are coated with material from the rings (ice and dust) and from icy particles from Enceladus' geysers and E-Ring. They also found that the surfaces of the moons are porous, suggesting that they may have accreted from material left over from the breakup of larger bodies. The irregular geometries are due to their low mass, not having enough mass for gravity to pull them into spherical shapes). Moons Atlas and Pan have also accumulated material around their equators, giving them the appearance of flying saucers.

A Shapshot of a Global Catastrophy

Sixty-six million years ago, an asteroid approximately 6 miles (10 km) across slammed into the Earth in the waters around, whatis today, Mexico's Yucatan peninsula. The 100 million megaton blast created a crater about 1 10 miles (180 km) across, generated a thermal pulse that would have set the forests ablaze and sent a shock wave radiating outward from the impact site. The impact site has been well documented as well as the geological evidence of the cataclysm found worldwide (including deposits of iridium in the rock layer from that time period, a metal common in asteroids, but rare on Earth's surface).

Ring Worlds

A partially exposed, 65-million-year-old fish from the Tanis deposit in North Dakota. (Robert DePalma / University of Kansas)

As described in the April issue of the "Proceedings of the National Academy of Sciences of the United States of America," a team of paleontologists from the Univer - sity of Kansas and University of Manchester found a tangled mass of animal, plant and fish fossils at the Hell Creek Formation in present day southwestern North Dakota. The impact-melt glassy spherules preserved in sediment (including in the gills of the fossilized fish), the radiometric dating of the elements in the sediment, the presence of shocked quartz, and a well-defined cap of iridium-rich overburden provided compelling evidence that the deposit is associated with the Chicxulub impact. The well-preserved fossilized remains suggest that the event happened quickly, burying the biological material in a layer of fine sediment. The authors suggest that

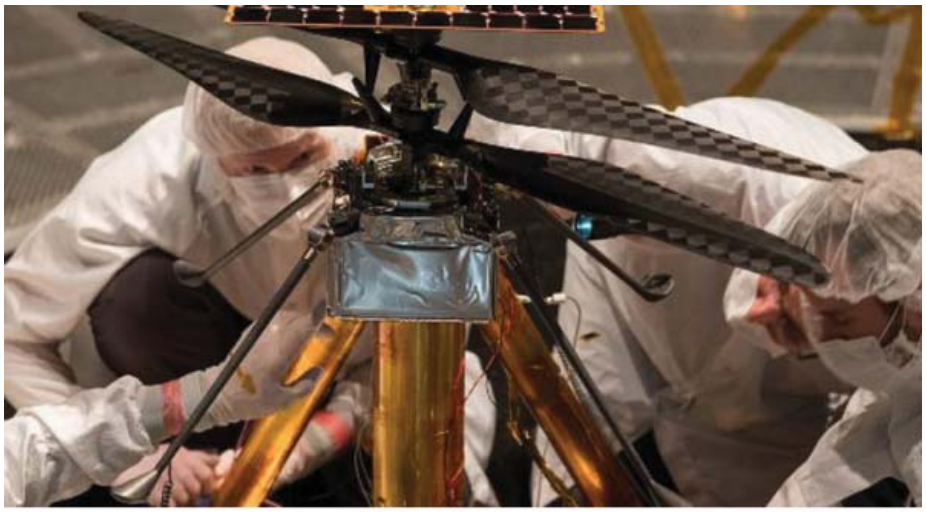
the silt deposit resulted from a seismically-induced seiche wave (generated as a result of an estimated magnitude 10 to 11.5 impact-generated earthquake) that could have arrived within minutes of the impact, followed by a rain of the glassy spherules. If the Hell Creek find is established to be associated with the Chicxulub impact, it provides a snapshot of a mass extinction event that changed evolutionary history and the extent of its destruction (1,900 miles or 3,050 km from the impact site).

A Martian Whirlybird

When the Mars 2020 rover is launched in July 2020, it won't be traveling to Mars alone. Hitching a ride to Mars with the rover will be a small helicopter. The "Mars Helicopter" is a technology demonstrator, designed to evaluate the proficiencies of flight in the thin Martian atmosphere and lower gravity environment (38% of Earth's), as well as the craft's ability to function and survive in temperatures as low as -130° F (-90° C) during the Martian night.

The helicopter will be flying in an atmosphere that is approximately one percent of the density of Earth's at sea level, comparable to flying on Earth at an altitude of 100,000 feet (30,480 meters). To compensate, the Mars Helicopter weighs only 4 pounds (1.8 kg) and is constructed of carbon fiber, aluminum and other lightweight materials.

Twin, counter-rotating blades, powered by rechargeable lithium-ion batteries, provide the lift. The blades will spin at 3,000 rpm, 10 times faster than a helicopter on Earth. With the counter-rotating blades, no tail rotor is required, saving weight and space (the helicopter will be attached to the underside of the rover dduring the trip to Mars).A bank of solar cells, mounted on top of the rotor mast, will rechar ge the batteries and power the heaters to keep the craft warm at night.



NASA Mars Helicopter being readied for testing in the vacuum chamber at NASA's Jet Propulsion Laboratory in Pasadena, California. Credits: NASA/JPL-Caltech

Shortly after the rover lands on Mars in February 2021, the helicopter will be deployed and begin test flights. The batteries will limit flight times to 90 seconds. The most ambitious flight would carry the helicopter 500 feet (153 meters) from the rover before returning, at a maximum altitude of 16.5 feet (5 meters). If successful, NASA could deploy helicopters on future missions as scouts and to access areas too hazardous for vehicles or astronauts.

A Valiant Attempt Comes Up Short

SpaceIL's Beresheet lunar lander, which rode into Earth orbit aboard a SpaceX Falcon 9 rocket on February 22, crashed into the lunar surface on April 11. The 5-foot-tall (1.5 meters) Israeli spacecraft had entered orbit around the Moon on April 4, after a month of maneuvers to slowly raise its orbit from one around the Earth to a lunar intercept (only the seventh country to achieve lunar orbit).

The view looking towards the Sea of Tranquility was the last photograph transmitted by the Beresheet spacecraft. Credit: SpaceIL

During the descent to the Mare Serenitatis (Sea of Serenity), controllers detected an error in the inertial measurement unit (used to determine orientation). Commands uplinked to the spacecraft to fix the problem inadvertently shut down the lander's hydrazine-fueled engine. An attempt at recovery was too late as the free-falling spacecraft ran out of altitude. Benjamin Netanyahu, Israeli prime minister, said that Israel will try again in two years' time.

Apollo 10

Apollo 10 was the second mission to orbit the Moon (Apollo 8 being the first) and the first lunar mission to include the Lunar Module (LM). The Saturn V rocket, carrying the command module (CM) named Charlie Brown and LM named Snoopy, was launched from Cape Kennedy on May 18, 1969.

Astronauts Thomas Stafford and Eugene Cernan flew the LM to within 47,000 feet (14,326 meters) of the lunar surface. The LM made two passes over the designated Apollo 11 landing site before jettisoning the LM's descent stage (in preparation for the rendezvous with the CM). At that time, the ascent stage began to wildly gyrate and for three harrowing minutes, the spacecraft went into a near-fatal roll before Stafford could gain manual control. The cause was eventually traced to a switch being in the wrong position.

The Apollo 10 Saturn V and the mobile launch platform atop the crawler-transporter. Credit: NASA.

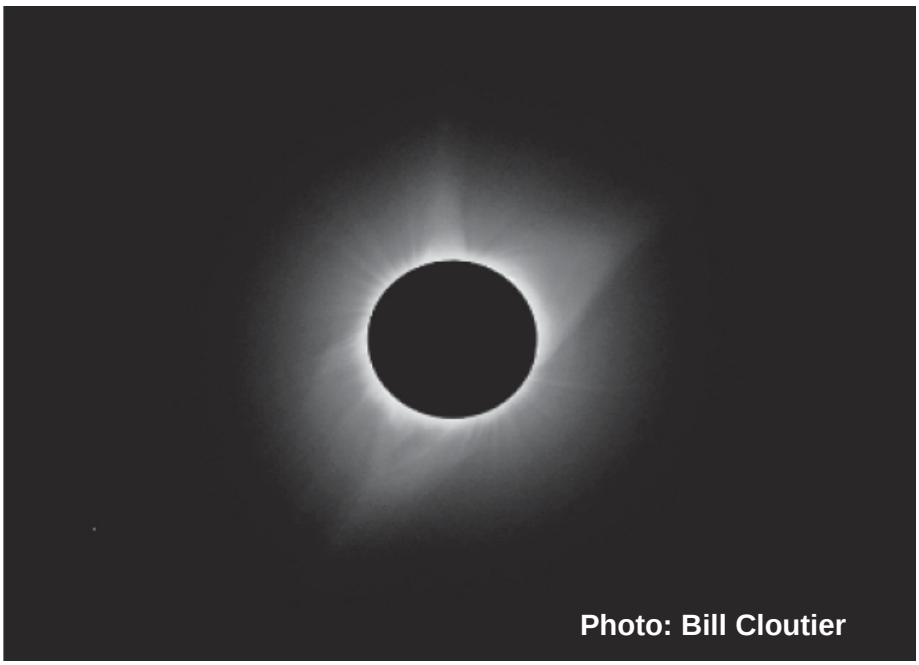


Photo: Bill Cloutier

The Einstein Solar Eclipse

One hundred years ago, Einstein's General Theory of Relativity was put to the test. The theory was published in 1915 and Einstein identified three tests that could be used to validate the theory including the deflection of light by a gravitational field. A solar eclipse offered the opportunity to measure the deflection of light (if any) from stars in visual close proximity to the Sun in the sky during totality.

With the end of World War I in November of 1918, Britain's Astronomer Royal, Sir Frank W. Dyson, proposed an expedition to view the eclipse and collect datathat would either support or refute the theory. The path of totality began in South America and crossed the Atlantic Ocean before traveling across the African continent.

English Astronomer Sir Arthur Eddington organized the expedition, sending one team to Sobral, Brazil, while he led the second team to Principe, a remote island off the west coast of Africa. Both teams would experience setbacks and challenges with the weather and equipment.

Einstein predicted that massive objects such as stars would warp spacetime, deflecting light in vicinity of the object. In preparation, Eddington measured the positions of stars in the Hyades cluster… during the night in January and February of 1919 as the Sun would move through the cluster during the day of the eclipse. If Einstein's theory was correct, the positions of the stars closest to Sun's limb would be slightly offset from the nighttime positions, as their light path was curved by the Sun's mass.

Despite inclement weather Eddington was able to make the measurements from Principe. His results did support Einstein's predicted deviation, and while Einstein would become a celebrity, not all in the astronomy community were quick to accept the results, with the poor quality of the images and citing calculation bias. Eddington's work was eventually vindicated when astronomers were able to duplicate his results during the 1922, 1953 and 1973 eclipses.

The General Theory of Relativity also explained the perihelion precession of Mercury's orbit and the gravitational redshift of light - t he other two tests proposed by Einstein.






The groundbreaking for an observatory on the property of the New Milford High School. By month's end, the telescope pier had been poured along with the building foundation, and an all-volunteer workforce had framed the outer walls of the building.

Philately

The US Postal Service will be issuing a new pair of postage stamps to mark the anniversary of the Apollo 11 landing fifty years ago on July 20, 1969. The first stamp will feature a photo of Buzz Aldrin on the Moon. Neil Armstrong, the photographer, can be seen in the reflection from Aldrin's gold coated visor. The other stamp features an image of the Moon captured by amateur astronomer Gregory Revera ofHuntsville, Alabama, with the location of Tranquility Base denoted.

Stamps have been used to celebrate the first Moon landing, beginning with the release of a 10-cent "First Man on the Moon" airmail stamp in September 1969. Designed by local artist Paul Calle, the master die for the stamp was flown to the Moon on board Apollo 11. Paul Calle and his son Chris were then commissioned to design a stamp commemorating the 20th anniversary. The $2.40 stamp, issued in July 1989, showed the astronauts planting the American flag on the Moon. Paul and Chris again teamed to design two stamps - 29 cent and $9.95 tribute, for the 25th anniversary. Released in July 1994, the postage stamps showed the astronauts saluting the flag on the Moon. For the 30th anniversary, a 33-cent stamp with the image of a boot print in the lunar soil, was issued in 1999.

Public Astronomy

Eighty-four years ago, on May 14, 1935, the Grif fith Observatory opened to the publicand its ownership transferred to the City of Los Angeles. Located on the southern slope of Mount Hollywood in Griffith Park, the public facility is operated by the city's Department of Recreation and Parks, and has welcomed over 76 million visitors since opening.

A public observatory was the brainchild of Grif fith J. Griffith, a Welsh immigrant who made his fortune in Mexican silver mines and California real estate. In 1896, he purchased and donated 3,015 acres to the city for a public park after visiting grand open spaces in Europe. In 1912, after a visit to the MountWilson observatory, Griffith offered the city $100,000 for a public observatory to be built on Mount Hollywood in Grif fith Park. Griffith was quoted as saying "Man' s sense of values ought to be revised. If all mankind could look through that telescope, it would change the world!"

Unfortunately, Griffith would not live to see his vision realized. Mired in political debate, work on the observatory didn't begin until 1933. However , guided by leading astronomers and scientists of the day , including astronomer George Ellery Hale, physicists Edward Kurth and Rudolph

Langer, Adler Planetarium Director Philip Fox and Russell Porter, leader of the amateur telescope making movement, the observatory was constructed and dedicated two years later. The planetarium was only the third of its kind in the United States; the technology was not even invented until four years after Griffith's death.

The Griffith Observatory is visible from many parts of Los Angeles, being located at an elevation of 1,134 feet above sea level. It is one of the most popular attractions in Southern California.

Space Shuttle History

The space shuttle Endeavour first arrived at the Kennedy Space Center on May 7, 1991 as a replacement for the lost Challenger. It was built out of spare parts from the construction of the Atlantis orbiter. Endeavour was first launched (STS-49) a year later on May 7, 1992. The orbiter's name was selected through a national competition among students and was named after the ship commanded by British explorer James Cook in his exploration of the South Pacific in 1768-71. Cook, among other accomplishments, observed the transit of the Sun by Venus from Tahiti in June 1769.

Endeavour flew its 25 th and final mission (STS-134) in May 2011 (the next to last shuttle flight). Commander Mark Kelly was the last astronaut to disembark from the shuttle at the conclusion of the mission. In September 2012, the shuttle was flown to Los Angeles on top of a Boeing 747 for permanent display at the California Science Center. Endeavour is currently in temporary storage at the museum and will be displayed in a launch configuration (vertical) once construction of a new exhibition center is complete.

In May 2015, the Science Center announced that they had acquired the only flight-qualified external tank in existence. The tank had been built in 2000 for the Columbia shuttle but never flew (it was replaced by a lighter version before it was assigned to a flight). The External Tank (ET-94) is 28 feet in diameter, 154 feet long and weighs approximately 65,000 pounds.

The external tank left NASA's Michoud Assembly Facility in Louisiana for California on April 12, 2016. Traveling by barge, the tank passed through the Panama Canal and arrived in Marina del Rey in late May . The tank was moved through the streets of Los Angeles to the Science Center following the route previously taken by Endeavour.

The Science Center has also acquired a pair of flight-worthy solid rocket boosters for the display. The 149-foot-tall (45 meter) solid rocket boosters were donated by Orbital ATK and NASA. T he refurbished tank will be lifted into a vertical configuration to form the structural support for the Endeavour orbiter and the twin solid rockets for display in Samuel Oschin Air and Space Center, a 200,000 square foot exhibition center being added to the Science Center's main building.

May Showers

The *Eta Aquarids* meteor shower peaks in the early mornings of the 5 th and 6 th. The dust producing the shooting stars is from *Comet Halley*. As with all meteor showers, the Aquarids are named for the constellation (Aquarius) from which they appear to radiate. Typically, you can expect to see up to 20 meteors per hour. A waxing crescent Moon will set early in the evening, with dark skies for viewing the shower this year.

Forgotten Names for an Ancient World

Lunar maps include the names of the prominent features: craters, mountain ranges and the lar ge, expansive lunar seas. Few, if any, include the names of the brighter lunar highlands: the original crust before it was transformed by a cosmic bombardment lasting several hundred million years.

Lunar cartography or mapping was both limited and crude until Galileo first trained his telescope upon the Moon. With the ability provided by the telescope to resolve individual features came the need for a uniform or standard naming convention. The first such detailed map was created by Dutch astronomer Michel Langren in 1645. Features on Langren's map were named for prominent leaders of the Catholic Church, scholars, philosophers and saints. Two years later, Johannes Hevelius, a wealthy Polish brewer, published the first treatise devoted to the Moon. His publication "Selenographia" included maps of every lunar phase developed over several years of observing. Unlike Langren, Hevelius used the names of terrestrial features for his lunar maps, specifically from ancient Greece and Rome. His naming convention was widely used by European astronomers for over a

century. However, Hevelius' lunar nomenclature was gradually replaced by a naming convention developed by Jesuit astronomer Giovanni Riccioli.

Riccioli included lunar maps in a dissertation defending the Catholic Church's view of the universe (Earth-centered) against the views being expressed by Galileo, Kepler and Copernicus (Sun-centered). Riccioli's lunar drawings were created by fellow Jesuit Francesco Grimaldi. Riccioli assigned names to the lunar seas associated with weather or other conditions (Sea of Rain, Clouds, Cold, Serenity , and Crises). Other features were given names of scientists and philosophers from ancient Greece, Rome or from medieval Europe. The craters around the Sea of Nectar did include names of Catholic saints, although most were associated with astronomy.

Many of Riccioli's original names remain in use today after being officially recognized by the International Astronomical Union in 1935. What have been lost are the names of the areas between the seas or the Moon's bright crust. Riccioli originally assigned names to these areas in a manner similar (although sometimes opposite) to what he used for the lunar seas (Land of Heat, Hail, Frost, Dryness and Sterility).

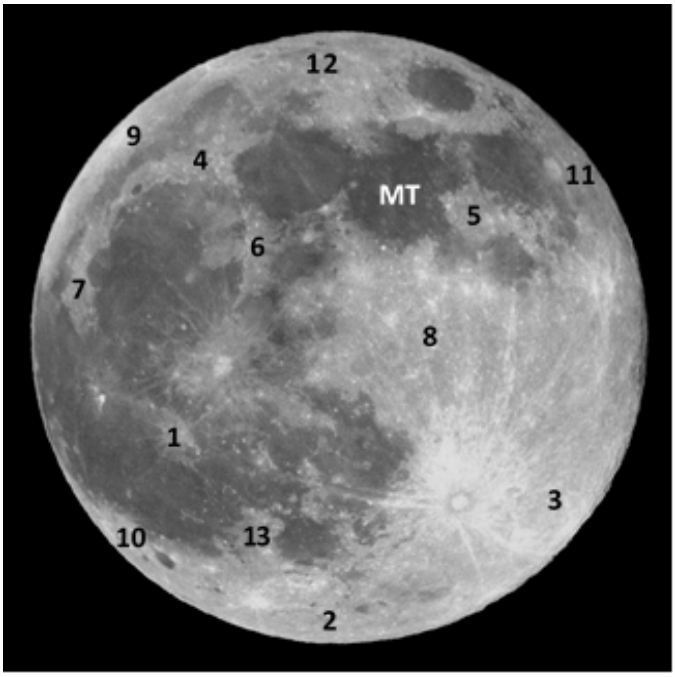
Today, references to the lunar crust or "land" are generally non-descript and sterile in comparison (south polar region, eastern limb, Descartes highlands) to Riccioli' s imaginative and sometimes poetic labels.

So, the next time you see the Moon in the sky , take a few minutes and reacquaint yourself with a part of history. Once you have located Mare Tranquillitatis (MT) or the Sea ofTranquility on the moon's eastern (right) limb, look for Terra Sanitatis or the Land of Healthiness, the adjoining brighter area to the south.

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

Key to Major Land Features

1. Insula Ventorum (Island of Winds)
2. Terra Colaris (Land of Heat)
3. Terra Fertilitatis (Land of Fertility)
4. Terra Grandinis (Land of Hail)
5. Terra Manna (Land of Manna)
6. Terra Niuiu (Land of Snows)
7. Terra Pruinae (Land of Frost)
8. Terra Sanitatis (Land of Healthiness)
9. Terra Siccitatis (Land of Dryness)
10. Terra Sterilitatis (Land of Sterility)
11. Terra Vigoris (Land of Cheerfulness)
12. Terra Vitae (Land of Liveliness)
13. Peninsula Fulminu (Peninsula of Thunder)



May History

On May 25, 1961, President Kennedy, in an address before a joint session of Congress, set forth a challenge to the American people: "I believe this nation should commit itself, before this decade is out, to landing a man on the Moon and returning him safely to the earth." With what started out as an attempt to reverse the political setbacks in Laos, the Congo, the Bay of Pigs in Cuba, and as a response to the first flight into space by cosmonaut Yuri Gagarin, Kennedy's speech set the gears of a technological revolution into motion. The post-Sputnik world of the 1960's would see two great nations compete to control the "high ground," the new frontier in the Cold War.

Lost in the political posturing and often overlooked is that, in less than 10 years, on May 20, 1969, the 456-foot-tall doors on the Vehicle Assembly Building at the Kennedy Space Center opened to reveal AS506, the official designation of the Saturn V rocket that would carryApollo 11 to the moon. More than 20,000 private firms and hundreds of thousands of workers participated in this program, for a fraction of the cost of the Vietnam War. Not only did the United

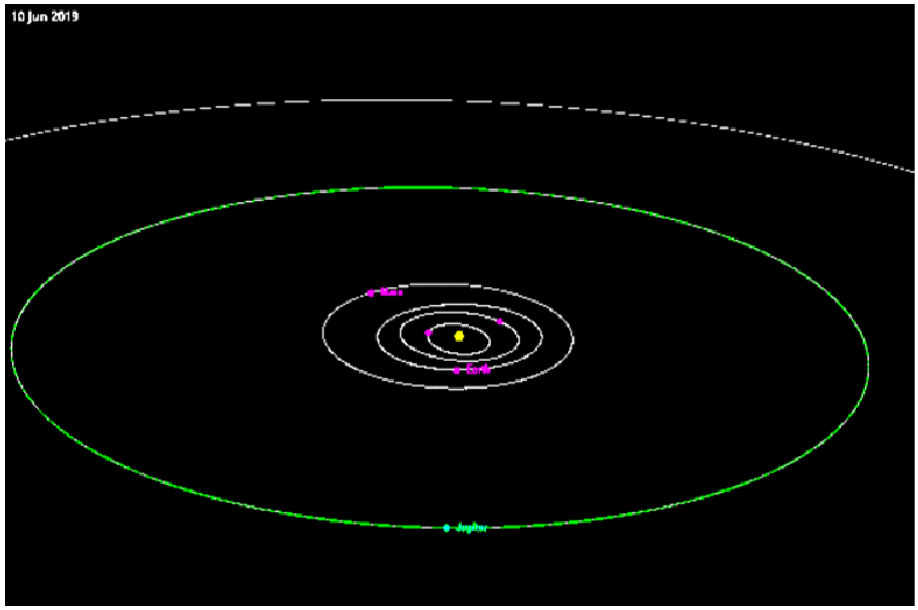
States reach the Moon, it built a national infrastructure of technology, manufacturing and education that has not been rivaled. In 1969, the United States was truly on top of the world.

Jupiter

Jupiter returns to the evening sky in May as it approaches Opposition in June. At the beginning of the month, the gas giant rises in the southeast around 11 pm EDT. By month's end, Jupiter is above the horizon just before 9 pm (forty minutes after sunset).

Jupiter reaches Opposition on June 10th at which time it will be visible all night and at its highest in the sky around midnight local time. With an orbital period of 1 1.86 years, Jupiter aligns with the Earth and Sun every 399 days. This year, the gas giant will be found in the constellation Ophiuchus and shinning at a bright -2.6 magnitude.

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. The photo on the right shows the shadow of Ganymede projected on the cloud tops of the Jovian disk. On nights of good visibility, the following events should be visible through a moderately-sized telescope. (between sunset and midnight).



Opposition occurs for a superior planet (one with an orbit further from the Sun than the Earth's) when the planet is opposite the Sun in the sky (rising at sunset and setting at sunrise). The Opposition of Jupiter occured on June 10th. Graphics: Dominic Ford

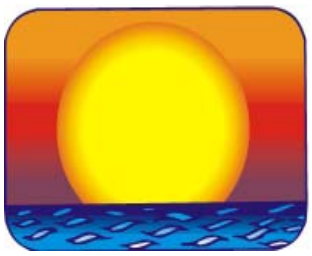
Jovian Moon Transits

Date	Moon	Transit Begins	Transit Ends
3rd	Io	11:57 pm	2:08 am (4th)
5th	Europa	7:23 pm	9:48 pm
12th	Io	8:19 pm	10:31 pm
13th	Europa	9:56 pm	12:22 am (14th)
19th	Io	10:13 pm	12:25 am (20th)
28th	Io	6:35 pm	8:47 pm

Red Spot 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	Transit Time	Date	Transit Time
April 30th	10:37 pm	17th	9:36 pm
May 3rd	8:36 pm	19th	11:14 pm
5th	9:44 pm	22nd	8:43 pm
7th	11:22 pm	24th	10:21 pm
10th	8:51 pm	26th	11:59 pm
12th	10:29 pm	29th	9:28 pm



Sunrise and Sunset (from New Milford, CT)

Sun	Sunrise	Sunset
May 1 (EDT)	05:51	19:51 pm
May 15	05:35	20:06 pm
May 31	05:23	20:20 pm

May Nights

For those who do their star - gazing early in the evening, a myriad of spectacular objects appear out of the twilight, winking into view as the Earth turns away from the Sun. Leo dominates the southwestern sky with its reverse question mark arrangement of stars, punctuated by the star Regulus, forming the front of the lion, and a triangular arrangement of stars forming the back or tail of the creature. To the west of Leo is an open star cluster called the Beehive (M44) in the constellation Cancer. On a dark night it can be seen with the naked eye. East of Leo, towards the constellation Boötes is the globular cluster M3. Boötes is easily identified by its bright star Arcturus. Follow the arc in the handle of the Big Dipper to find Arcturus, at the base of the kite-shaped constellation. M3 is located further away than the center of our galaxy, the Milky Way, and is one of the many outstanding globular clusters that will grace the late spring and summer skies.

Astronomical and Historical Events

1st Atira Asteroid 2013 JX28 closest approach to Earth (0.541 AU)
May 01 - 60th Anniversary (1959), Goddard Space Flight Center Established
1st History: discovery of Saturn's moon *Daphnis* by the Cassini spacecraft (2005)
1st History: discovery of the Mars meteorite *Dar al Gani 476* (1998)
1st History: discovery of Neptune's moon *Nereid* by Gerard Kuiper (1949)
2nd Amor Asteroid 3122 *Florence* closest approach to Earth (1.379 AU)
2nd Amor Asteroid 1036 *Ganymed* closest approach to Earth (2.243 AU)
2nd History: discovery of the first binary star (Xi Ursae Majoris) by William Herschel (1780)
3rd Amor Asteroid 4957 *Brucemurray* closest approach to Earth (1.066 AU)
4th New Moon
4th Centaur Object 471143 *Dziewanna* at Opposition (35.085 AU)
4th History: launch of Lunar Orbiter 4 for photographic evaluation of Apollo and Surveyor landing sites (1967)
4th History: launch of the AQUA satellite to study precipitation, evaporation, and the cycling of Earth's water (2002)
4th History: launch of the Magellan/Venus radar mapping spacecraft and attached Inertial Upper Stage from the space shuttle Atlantis (STS-30) (1989)
5th *Eta Aquarids* meteor shower peak (best viewing: early morning on the 5th and 6th)
5th Amor Asteroid 2016 GF216 near-Earth flyby (0.092 AU)
5th Amor Asteroid 1980 *Tezcatlipoca* closest approach to Earth (1.244 AU)
5th History: launch of NASA's InSight spacecraft (Mars lander) from the Vandenberg Air Force Base, California (2018)
5th History: launch of Freedom 7 and astronaut Alan Shepard aboard a Mercury-Redstone rocket, first American in space (1961)
6th Amor Asteroid 2009 MN8 near-Earth flyby (0.076 AU)
6th Apollo Asteroid 1865 *Cerberus* closest approach to Earth (0.369 AU)
6th History: groundbreaking for the John J. McCarthy Observatory, a world-class observatory in New Milford, CT., with a mission to promote science literacy (2000)
8th Amor Asteroid 2014 KQ84 near-Earth flyby (0.080 AU)
9th Amor Asteroid 2008 HS3 near-Earth flyby (0.037 AU)
9th Apollo Asteroid 2017 RC near-Earth flyby (0.037 AU)
9th Centaur Object 144908 (2004 YH32) at Opposition (11.457 AU)
9th Kuiper Belt Object 2010 FX86 at Opposition (45.104 AU)
9th History: launch of MUSES-C (Hayabusa), Japanese sample return mission to asteroid *Itokawa* (2003)
9th History: first Earth-based laser aimed at the Moon: crater Albategnius (1962)
9th History: launch of first production model of the Project Mercury capsule from Wallops Island, Virginia to test the escape system (1960)
10th History: President Truman signs Public Law 507, creating the National Science Foundation (1950)
10th History: Estherville Meteorite Shower: a 455 pound meteorite fell to earth in Emmet County just north of Estherville, Iowa, where it buried itself 15 feet in the ground - largest meteorite known to have fallen in North America (1879)
11th First Quarter Moon
11th **Second Saturday Stars - Open House at McCarthy Observatory**
11th Apollo Asteroid 468005 (2012 XD112) near-Earth flyby (0.098 AU)
11th History: launch of the space shuttle Atlantis (STS-125), final Hubble Space Telescope servicing mission (2009)
12th Aten Asteroid 2009 FU23 near-Earth flyby (0.071 AU)
12th Aten Asteroid 2100 *Ra-Shalom* closest approach to Earth (0.474 AU)
12th Kuiper Belt Object 90568 (2004 GV9) at Opposition (38.611 AU)
12th History: first planetarium (Adler Planetarium in Chicago) opens in United States (1930)
13th Moon at perigee (closest distance from Earth)
13th History: launch of first Project Bumper rocket from White Sands, NM; the two stage rocket was a combination of a German V-2 and American WAC Corporal rocket (1948)
14th Centaur Object 65489 *Ceto* at Opposition (38.592 AU)
14th History: Griffith Observatory, one of the first institutions in the U.S. dedicated to public science, opens in Los Angeles (1935)
14th History: launch of the Herschel infrared telescope and the Planck microwave observatory (2009)
14th History: launch of Skylab, the United States' first space station (1973)
14th History: the American Interplanetary Society (later renamed the American Rocket Society) launches its first liquid fueled (liquid oxygen and gasoline) rocket from Staten Island, N.Y. (1933)

Astronomical and Historical Events (continued)

14th History: German Society for Space Travel (Verein für Raumschiffahrt or VfR) launches the Repulsor-1, a liquid fueled (liquid oxygen and gasoline) rocket (1931)
14th History: Orgueil Meteorite Shower: large carbonaceous chondrite that disintegrated and fell in fragments near the French town of Orgueil; presence of organics renewed the debate on spontaneous generation as the origin of life; fragments analyzed by the French chemist Louise Pasteur for indigenous microoganisms (1864)
15th Atira Asteroid 434326 (2004 JG6) closest approach to Earth (0.991 AU)
15th History: discovery of Pluto's moons *Nix* and *Hydra* by Hal Weaver, et al's (2005)
15th History: sixth docking of a space shuttle (Atlantis) with Russian space station Mir (1997)
15th History: launch of Faith 7 and astronaut Gordon Cooper aboard a Mercury-Atlas rocket, final Mercury mission (1963)
15th History: Soviet Union launches Sputnik IV containing a self-sustaining biological cabin and dummy astronaut (1960)
16th Kuiper Belt Object 65407 (2002 RP120) at Opposition (30.810 AU)
16th History: launch of the space shuttle Endeavor on its final mission (2011)
16th History: Soviet spacecraft Venera 5 returns 53 minutes of data while descending by parachute through the atmo sphere of Venus and before impacting the surface (1969)
17th Amor Asteroid 153591 (2001 SN263) (2 Moons) closest approach to Earth (1.268 AU)
17th Kuiper Belt Object 2015 BP519 at Opposition (52.674 AU)
17th History: Soviet spacecraft Venera 6 returns 51 minutes of data while descending by parachute through the atmo sphere of Venus and before impacting the surface (1969)
17th History: discovery of Jupiter's cloud belts by Italian Jesuit, astronomer, and physicist Niccolo Zucchi (1630)
18th Full Moon (Full Flower Moon)
18th Apollo Asteroid 2012 KT12 near-Earth flyby (0.008 AU)
18th History: launch of Apollo 10 with astronauts John Young, Tom Stafford and Gene Cernan; the lunar module Snoopy was flown within 50,000 feet of the lunar surface while the command module Charlie Brown orbited the Moon (1969)
19th Kuiper Belt Object 2015 KH162 at Opposition (58.988 AU)
19th History: launch of the first Army Hermes A-1 rocket from White Sands, NM (1950)
20th Apollo Asteroid 68950 (2002 QF15) near-Earth flyby (0.088 AU)
20th Apollo Asteroid 2017 QP16 near-Earth flyby (0.099 AU)
20th History: launch of the Pioneer Venus 1 spacecraft (1978)
21st Apollo Asteroid 217628 *Lugh* closest approach to Earth (1.388 AU)
21st History: launch of the Japanese Venus Climate Orbiter Akatsuki or Planet-C spacecraft and the Ikaros solar sail (2010)
22nd History: launch of the GRACE Follow-On spacecraft from the Vandenberg Air Force Base, California. The tandem satellites tracking Earth's water movement and changes in sea level.
22nd History: launch (and recovery) of monkeys Patricia and Mike on an Aerobee rocket, reaching a record altitude of 30 miles (1952)
23rd Apollo Asteroid 4179 *Toutatis* closest approach to Earth (2.978 AU)
24th History: launch of Aurora 7 and astronaut Scott Carpenter aboard a Mercury-Atlas rocket; second American to orbit Earth (1962)
24th History: launch of Midas 2; first Experimental Infrared Surveillance Satellite (1960)
24th History: Russian civil engineer Ivan Yarkovsky born. Proposed idea that heat radiated from rotating bodies, such as asteroids, would generate a small force which over time could change the orbit (1844)
25th Aten Asteroid 66391 (1999 KW4) near-Earth flyby (0.035 AU)
25th Aten Asteroid 2015 KQ18 near-Earth flyby (0.027 AU)
25th History: Phoenix spacecraft lands in the Martian arctic (2008)
25th History: launch of Skylab I crew; astronauts Pete Conrad, Paul Weitz and Joseph Kerwin (1973)
25th History: President John F. Kennedy's Moon goal speech to Congress (1961)
25th History: science fiction writer and futurist Arthur C. Clark proposes communication satellites in geosynchronous orbit (1945)
25th History: first recorded perihelion passage of comet Halley by Chinese astronomers (240 BC)
26th Last Quarter Moon
26th Moon at apogee (furthest distance from Earth)
26th Amor Asteroid 16064 *Davidharvey* closest approach to Earth (2.163 AU)
26th History: launch of the first "Navaho Missile," a pilotless aircraft consisting of a missile and a booster; program goal was to determine the feasibility of an intercontinental missile (1948)
27th Dwarf Planet *Ceres* closest approach to Earth (1.751 AU)
28th Plutino 469987 (2006 HJ123) at Opposition (32.782 AU)
28th History: launch of Mars 3 (USSR) lander and rover; lander became the first spacecraft to attain soft landing on Mars, although transmissions ceased after 15 seconds (1971)

Astronomical and Historical Events (continued)

28th History: launch of an Army Jupiter missile carrying two primates (Able and Baker) to an altitude of 300 miles; monkeys survived the flight (1959)
28th History: Frank Drake born, radio astronomer devised the "Drake Equation" as an attempt to estimate the number of worlds in our galaxy that might harbor intelligent life (1930)
29th History: Solar Eclipse observations (specifically, positions of stars in the vicinity of the Sun) used to confirm Einstein's General Theory of Relativity (1919)
29th Aten Asteroid 2003 LH near-Earth flyby (0.040 AU)
29th History: launch of Luna 22 (USSR), lunar orbiter mission that included imaging as well as studying the Moon's magnetic field, the composition of lunar surface rocks, and the gravitational field (1974)
29th History: measurements during solar eclipse agree with predictions based on Einstein's General Relativity theory (1919)
30th Apollo Asteroid 2011 HP near-Earth flyby (0.031 AU)
30th Amor Asteroid 52387 Huitzilopochtli closest approach to Earth (0.500 AU)
30th Kuiper Belt Object 2010 JO179 at Opposition (58.249 AU)
30th History: launch of Mariner 9, Mars orbiter and first artificial satellite of Mars; mapped Martian surface and imaged moons *Phobos* and *Deimos* (1971)
30th History: launch of Surveyor 1, Moon lander; transmitted over 11,000 images from Oceanus Procellarum (1966)
31st Plutino 38628 *Huya* at Opposition (27.684 AU)
31st History: European Space Agency's birthday (1975)

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

Solar Activity

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

NASA's Global Climate Change Resource

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

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 lar ge 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).

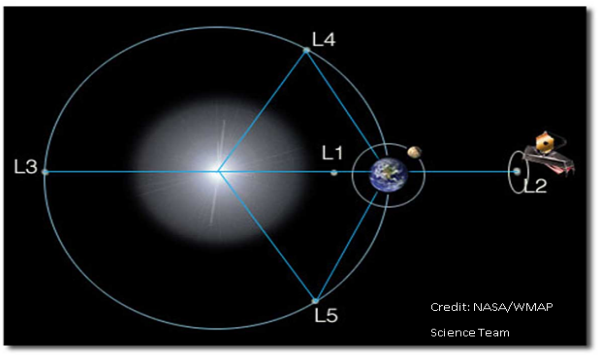


Image Credits

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

Front Page Graphic

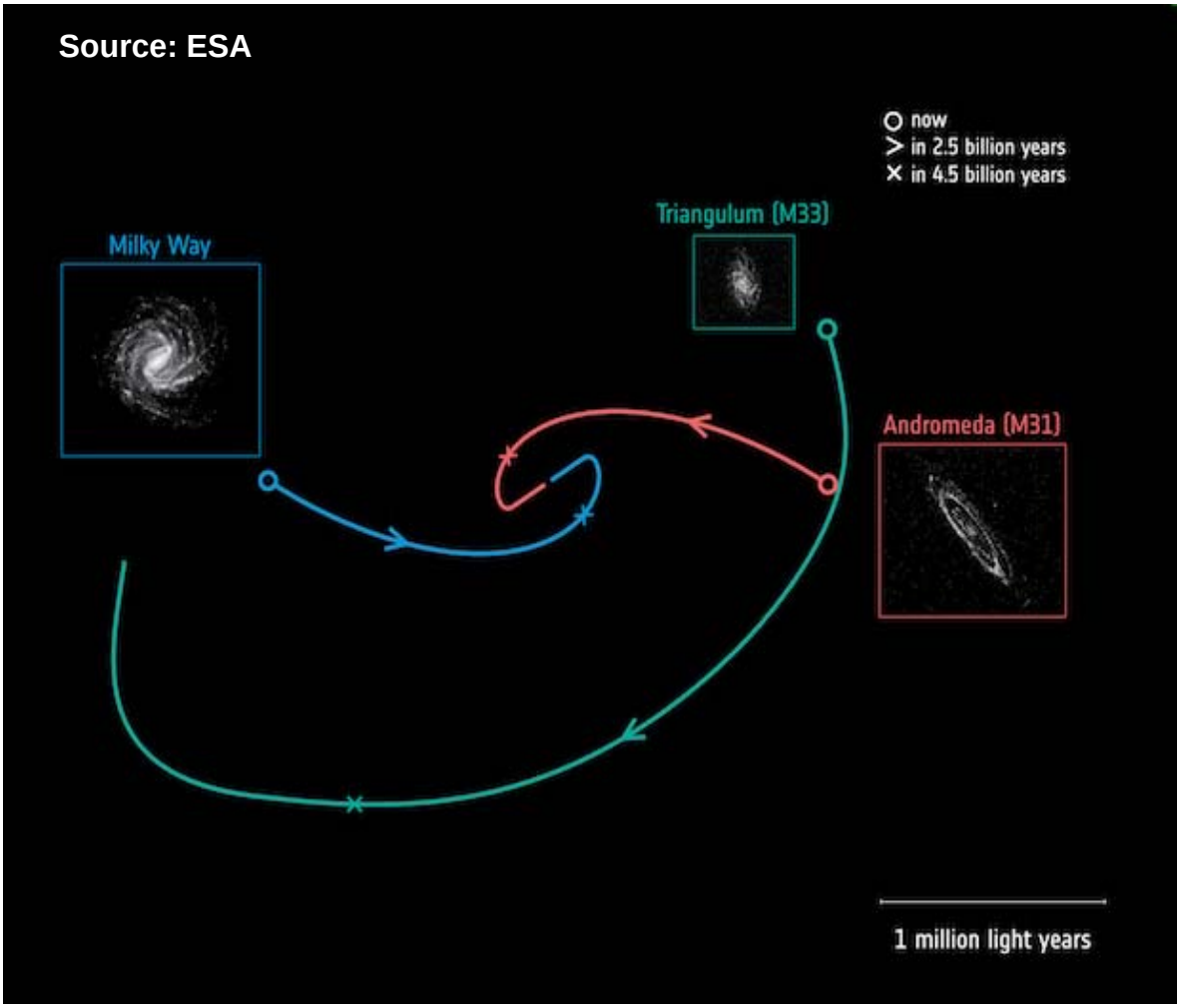
NGC 2623 is a galaxy in the constellation Cancer, and the end product of a collision and subsequent merger between two neighboring galaxies. This violent encounter caused clouds of gas within both galaxies to become compressed and stirred up, in turn triggering a sharp spike of star formation, evidenced in the tidal tails at each end.

As the universe expands, it is common for galaxies to be drawn closer together by gravity and merge. Depending on the relative number, breadth and structure of the colliding galaxies, the outcome can be catastrophic, with affected stars losing their orbital memory and drifting aimlessly in a process called violent relaxation. Often, the end result will be an ellipsoidal array of older, low-mass stars, with minimal star formation activity, surrounded by large numbers of globular clusters. Although collisions between individual stars are unlikely, giant molecular clouds (or stellar nurseries) may form near the galactic center, with the potential to create new stars, but at a lower rate than normal.

Our own Milky Way has endured galactic mergers in the past, and will again in the future. Gaia, a space observatory of the European Space Agency (ESA), was launched on December 18, 2013 and guided into an operational orbit in a location known as Lagrange point 2 (L2) - one of a number of destinations of interest for future spacecraft, 1.5 million km from Earth - and expected to operate until 2022. Gaia (*Mother Earth* in Greek mythology) is programmed to compile a 3D space catalog of about a billion stars, or roughly , one percent of the Milky Way, including planets, comets, asteroids and quasars. By charting the positions, distances, movements, and changes in brightness of stars, it is expected to reveal numerous celestial objects, observe hundreds of thousands of asteroids within our own Solar System, study about 500,000 distant quasars, and even provide stringent new tests of Albert Einstein's General Theory of Relativity.

By measuring the positions, distances and motions of stars, the program will reveal patterns inconsistent with the general flow of the galaxy. Evidence has already been revealed of rogue stars linked to a prior merger between the Gaia-Enceladus galaxy and the Milky Way during our galaxy's early formation stages 10 billion years ago. And looking into the future, analysis of the Andromeda galaxy indicates that the anticipated unfriendly merger with our home galaxy will start a bit later , and could start as a glancing blow. But by that time the Earth could already be be a smoking ember of a burned-out sun.

Sources: *https://en.wikipedia.org/wiki/Magellanic_Clouds; https://scitechdaily.com/; https://sci.esa.int/gaia/60892-galactic-ghosts-gaia-uncovers-major-event-in-the-formation-of-the-milky-way/;https://directory.eoportal.org/web/eoportal/satellite-missions/g/gaia; https://www.spaceanswers.com/ep-space/gaia-updates-astronomers-on-nearby-galactic-collision1/; https://en.wikipedia.org/wiki/Gaia_(spacecraft).*



The future orbital trajectories of three spiral galaxies: our Milky Way (blue), Andromeda, also known as M31 (red), and Triangulum, also known as M33 (green).

The circle indicates the current position of each galaxy , and their future trajectories have been calculated using data from the second release of ESA's Gaia missionThe Milky Way is shown as an artist's impression, while the images of Andromeda and Triangulum are based on Gaia data.

Arrows along the trajectories indicate the estimated direction of each galaxy's motion and their positions, 2.5 billion years into the future, while crosses mark their estimated position in about 4.5 billion years.

Approximately 4.5 billion years from now, the Milky Way and Andromeda will make their first close passage around one another at a distance of approximately 400.000 light-years. The galaxies will then continue to move closer to one another and eventually merge to form an elliptical galaxy.

The linear scale of 1 million light years refers to the galaxy trajectories; the galaxy images are not to scale.

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

May 2018

Celestial Calendar

Phases of the Moon

May 7 May 15

May 21 May 29

Tuesday

1

Gerard Kuiper discovers Neptune's Moon Nereid 1949

Discovery of Mars meteorite *Dar al Gani* 1998

Wednesday

2

Cassini, Enceladus Flyby Cassini: Distant Flyby of Polydeuces, Atlas & Dione

Asteroid 1992 JD Near-Earth Flyby (0.024 AU)

Thursday

3

Edmund Halley observes total eclipse phenomenon "Baily's Beads" (1715)

Friday

4

Launch of Magellan spacecraft to Venus by space shuttle Atlantis (1989)

Launch of the AQUA satellite to study precipitation, evaporation, and the cycling of Earth's water (2002)

Space Day

Saturday

Moon at apogee (farthest from Earth)

5

Eta Aquarids meteor shower peak

Alan Shepard first American in space 1961

6

Groundbreaking for the John J. McCarthy Observatory (2000)

7

Distant flyby of Saturn's largest moon Titan by the Cassini spacecraft

16th Anniversary (1997), Galileo, Ganymede 8 Flyby

8

First snapshot of Earth and its moon, captured by NASA's Mars Global Surveyor (MGS) spacecraft while orbiting Mars (2003)

9

Launch of MUSES-C (Hayabusa), Japanese sample mission to asteroid Itokawa (2003)

First Earth-based laser aimed at Moon crater Albategnius (1962)

10

Estherville, Iowa meteorite shower - 1897

Konstantin Eduardovitch Tsiolkovsky, Russian Rocketry Pioneer created his calculations about space flight theory - 1897

11

Space Shuttle Atlantis, last Hubble Space Telescope Servicing Mission (2009)

12

First planetarium in U.S. (Adler) opens in Chicago (1930)

NASA astronaut, Gregory Harold "Box" Johnson born, veteran of two space flights, STS-123 and STS-134 (1962)

2nd Saturday Stars Open House McCarthy Observatory

13

Launch of first Bumper rocket, from White Sands New Mexico (1948)

14

Griffith Observatory opens in Los Angeles (1935).

Launch of Skylab 1973

Early liquid fueled rockets:German Society for Space Travel (1931); American Interplanetary Society (1933)

15

6th docking of a space shuttle (Atlantis) with Russian space station Mir (1997)

Launch of Faith 7 - Final Mercury mission 1963

16

Soviet spacecraft Venera 5, 6 send data on Venus, then impact planet May 16-17,(1969)

Space Shuttle Endeavour final launch (2011)

Moon at perigee (closest to Earth)

17

Norman Lockyer born, co-discoverer of helium (1836)

Discovery of Jupiter's cloud belts by Italian Jesuit, astronomer, and physicist Niccolo Zucchi (1630)

18

Apollo 10 to Moon Young/Stafford/Cernan (1969)

19

Launch of first Army Hermes A-1 rocket from White Sands, NM (1950)

Scheduled launch of the GRACE Follow-On spacecraft Vandenberg Air Force Base, California

20

Launch of Pioneer Venus 1 spacecraft (1978)

21

Launch of Japanese Venus Climate Orbiter Akatsuki or Planet-C spacecraft and the Ikaros solar sail (2010)

22

Space X first successful commercial launch of spacecraft to the ISS, Cape Canaveral (2012)

First Hubble images of Saturn ring plane as the rings are edge-on to the Sun, viewed from Earth (1995)

23

Cassini spacecraft 91st flyby of Saturn's moon Titan (602 miles, or 970 kilometers).

Dr. H. Paul Shuch born, American scientist and engineer, hasled radio amateurs in the search for extraterrestrial intelligence (1946)

24

Launch of Midas 2, 1st experimental infrared surveillance satellite 1960

Scott Carpenter, second American in space (1962)

25

Launch of Skylab 1 crew (1973

Comet Halley chronicled by Chinese astronomers (240 BC)

Phoenix lander on Martian soil 2008

JFK Moon goal speech (1961)

26

Launch of first "Navaho Missile", ICBM precursor (1948)

27

Lawrence Maxwell Krauss born, Canadian-American theoretical physicist and author The Physics of Star Trek and A Universe from Nothing (1954)

28

Abel and Baker 1st primates in orbit (1959)

Frank Drake born, author of "the Drake Equation" on intelligent life (1930)

Launch of Mars 3 (USSR) lander and rover - 1st spacecraft to attain soft landing on Mars (1971)

29

Measurements during solar eclipse confirm Einstein's relativity theory - 1919

30

Launch of Luna 22 (USSR), orbiter mission to study the Moon's magnetic field, geology

European Space Agency Born 1975

31

Mariner 9, 1st artificial satellite of Mars (1971)

Launch of Surveyor 1 Moon lander; transmitted over 11,000 images from Oceanus Procellarum (1966)