Galactic Observer

John J. McCarthy Observatory

Volume 10, No. 3 March 2017

From ghoulies and ghosties / And long-leggedy beasties / And things that go bump in the night, / Good Lord, deliver us!

Turn to page 19 to find out what's going wrong here.

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.

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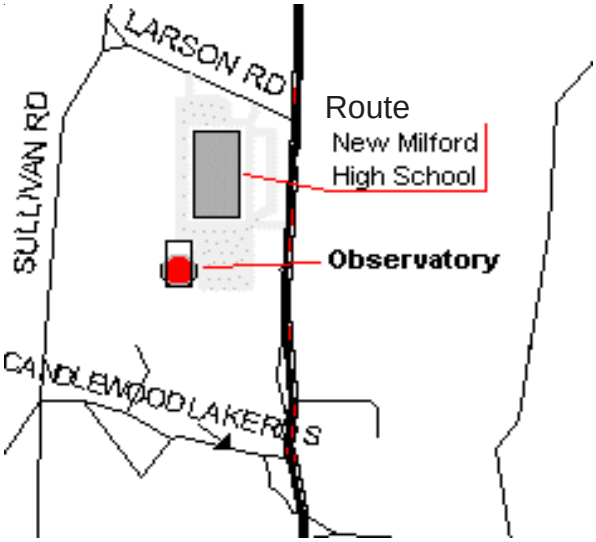
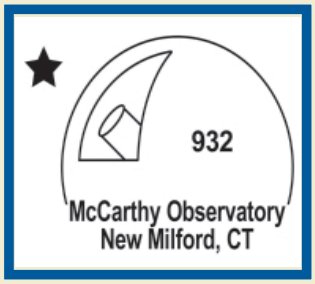


In This Issue



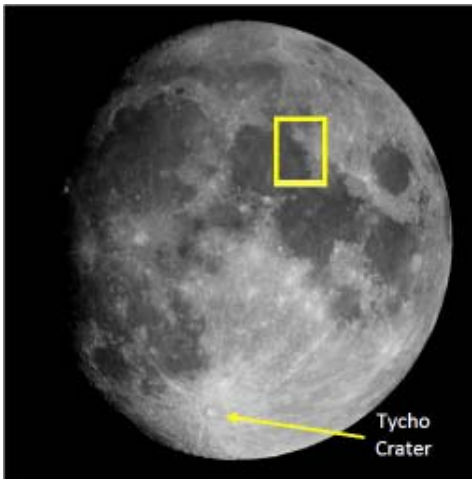
March Astronomy Calendar and Space Exploration Almanac

A majority of the nearside lunar maria (basaltic plains) are visible in the darkened portion of a waxing crescent Moon (8% illuminated) in late January. While the dazzling crescent is illuminated by the Sun, the darkened portion is brightened by light reflecting off the Earth. This phenomena (Earthlight or Earthshine) was first correctly explained by Leonardo Da Vinci over 500 years ago. Photo: Bill Cloutier.

"Out the Window on Your Left"

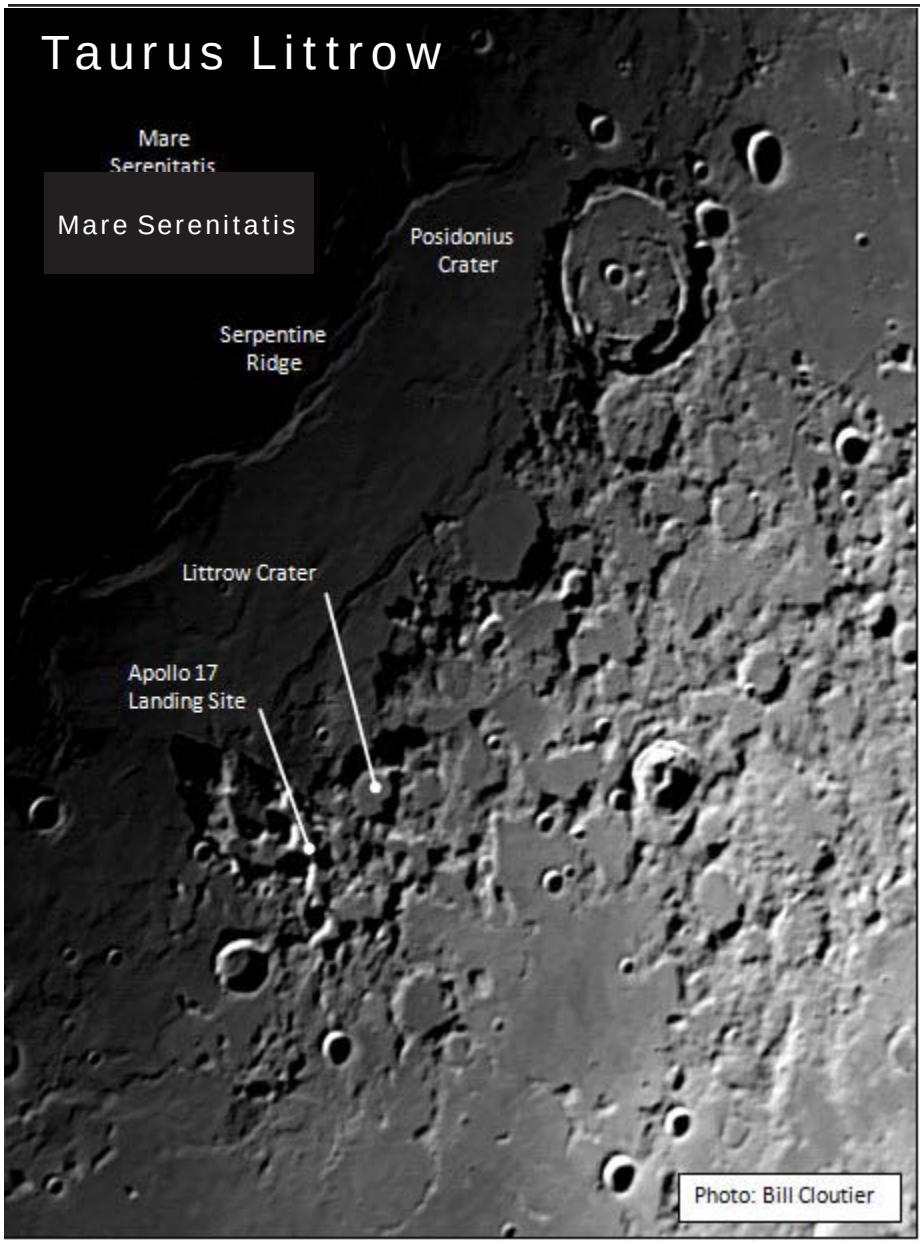
It's been almost 45 years since we left the last footprint on the dusty lunar surface. Sadly, as a nation founded on exploration and the conquest of new frontiers, we appear to have lost our will to lead as a space-faring nation. But, what if the average citizen had the means to visit our only natural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

Former Apollo astronaut Eugene Cernan passed away on January 16th at the age of 82. He was the last person to leave a footprint on the lunar surface as the commander of the Apollo 17 mission. Cernan reflected on the mission and the Apollo program in his final words before climbing the ladder and entering the Lunar Module - "And, as we leave the Moon at Taurus-Littrow, we leave as we came and, God willing, as we shall return, with peace and hope for all mankind. "Godspeed the crew of Apollo 17."



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

The Apollo 17 landing site was nestled in a cluster of mountains that had created a valley opening onto Mare Serenitatis (Sea of Serenity). The valley is located just south of Littrow Crater and on the perimeter of the Taurus Mountain range. The adjacent mare was created by a series of lava flows that had erupted onto the surface several hundred million years after the impact basin was formed by a collision with an asteroid or comet more than 3.8 billion years ago.



The large impact crater to the north of the valley is Posidonius. The 59 mile (95 km) diameter crater is classified as a Class III fractured-floor crater with an annular moat. Located on the edge of large mare deposits, it is believed that magma pooled beneath the floor of the crater. As the pressure of the magma intrusions increased, the crater floor was lifted, creating the fractures.

The conspicuous crater at the bottom of the image (above) is Tycho (53 miles or 85 km in diameter). Its bright rays of pulverized material extend across the nearside of the Moon, including one ray that appears to traverse the Apollo 17 landing site. Rays are characteristic of relatively young craters as the streaks fade within a billion years or so as the lunar regolith is gar-

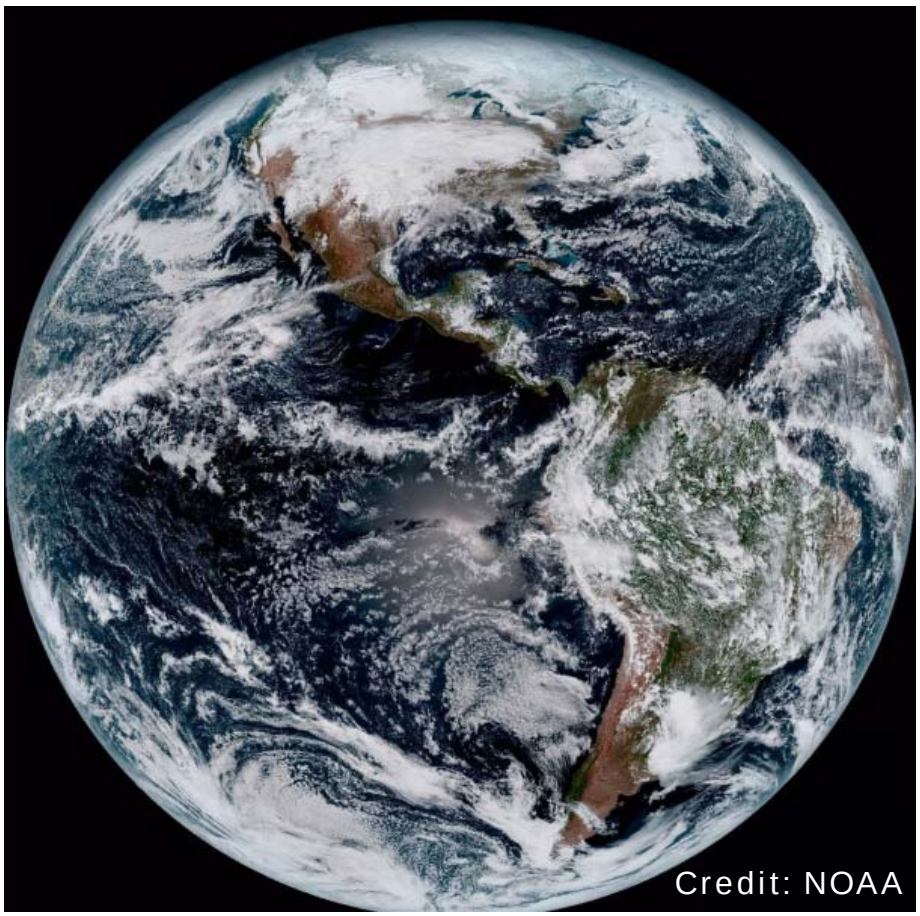
dened by additional impacts, and solar radiation darkens the bright ejecta. Impact glass found at the Apollo 17 site was determined to be 108 million years old, much youger than the other rocks at the site. If, as suspected, the impact glass is from the Tycho impact, it would also date the crater, believed to be one of the youngest, larger impact features on the Moon.

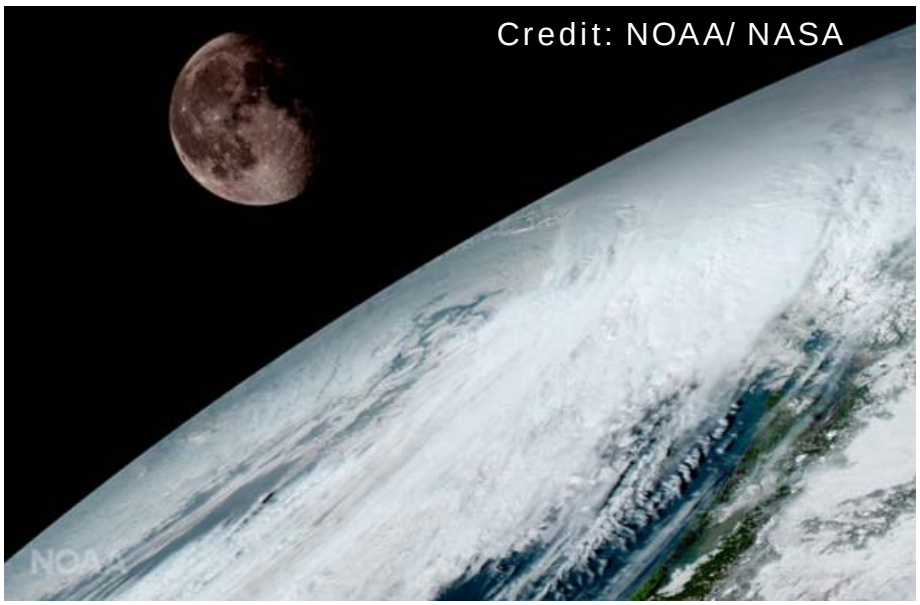
New Eye in the Sky

The color composite image (at right) of the north and south American continents was captured by the National Oceanic and Atmospheric Administration's (NOAA) new Geostationary Operational Environmental Satellite (GOES-16). The satellite was launched from Cape Canaveral, Florida on November 19th and is the first of four new satellites in the GOES series that NOAA will rely upon for improved hurricane, tornado and other severe weather tracking. The satellite is also equipped to support search and rescue missions with a special transponder designed to detect distress signals.

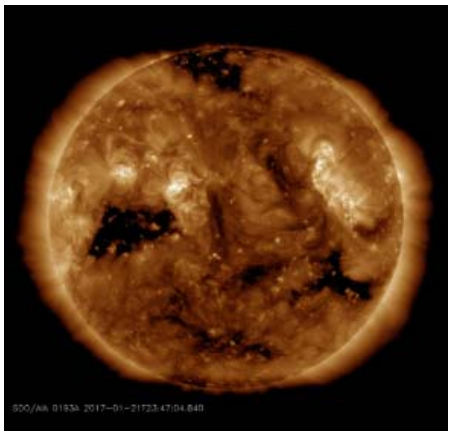
GOES-16 was placed in a geostationary orbit, approximately 22,300 miles above the Earth's surface. The next satellite in the series (to be designated as GOES-17 once it is moved into its operational orbit) is expected to launch in the Spring of 2018 (the satellite is currently undergoing environmental testing at Lockheed Martin).

On January 15th, GOES-16 captured an image of the Moon near the Earth's limb (the satellite uses the Moon for calibration). Its Advanced Baseline Imager (ABI) instrument can provide forecasters a full color image of the entire Earth every 15 minutes and the continental U.S. every five minutes. Areas of concern (including severe weather such as hurricanes or wild fires) can be targeted with imaging refreshed as often as every 30 seconds. The ABI has two visible, four near-infrared and 10 infrared channels that can be used to discern atmospheric particulates including ice, smoke and volcanic ash.


Credit: NOAA


Credit: NOAA/ NASA

GOES-16 is also equipped with an Extreme Ultraviolet and X-Ray Irradiance Sensor (EXIS) to monitor solar flares. The flares, eruptions of plasma from the Sun's atmosphere (shown on next page), can damage satellites, disrupt communications and the power grid, as well as posing a health hazard to astronauts aboard the ISS.



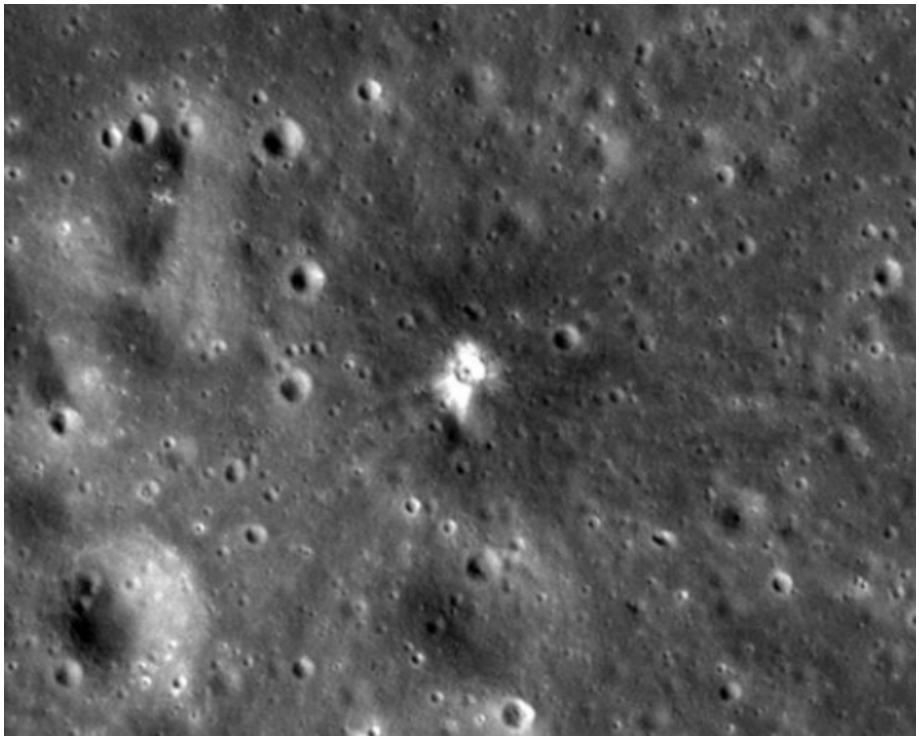
The Sun in extreme ultraviolet light on January 21st when a small flare was recorded by GOES-16. Credit: Solar Dynamics Observatory, NASA

A Fresh Look

The lunar surface was once thought to be a cosmic time capsule, virtually unchanged over billions of years. Today, based upon detailed images captured by NASA's Lunar Reconnaissance Orbiter's camera (LROC), it is apparent that the Moon's surface (regolith) has been and is being "gardened" (pulverized and churned) by a relentless bombardment of small impacts. If the current findings are indicative of the Moon's history, the upper surface may be completely transformed much more rapidly than previously imagined.

A team of scientists from Arizona State University and Cornell University studied 14,000 pairs of images (before-and-after) from LROC's narrow angle camera. Two hundred and twenty-two new impact craters were identified in the more recent image (that were not present in the earlier image of the same field of view). The impact craters ranged in size from several feet (meters) to 140 feet (43 meters) in diameter.

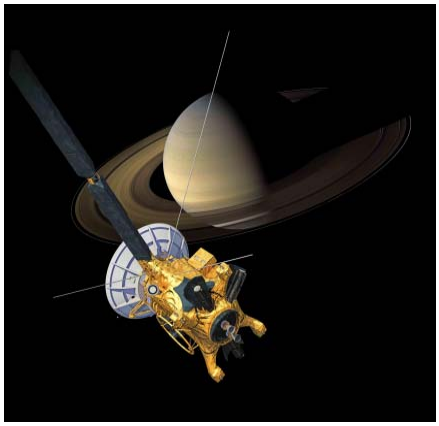
The impact rate, size and speed of the impactors, and the secondary effects of the impact (high-velocity ejecta and impact melt) are all important considerations, not only in determining the relative age of the surface, but in assessing the hazards to future astronauts, equipment and structures when we return to the Moon for long duration stays and/or establish permanent colonies.



A 62-foot-wide (18.8 meters) crater produced by an impact on March 17, 2013. Credit: NASA/Goddard Space Flight Center/Arizona State University

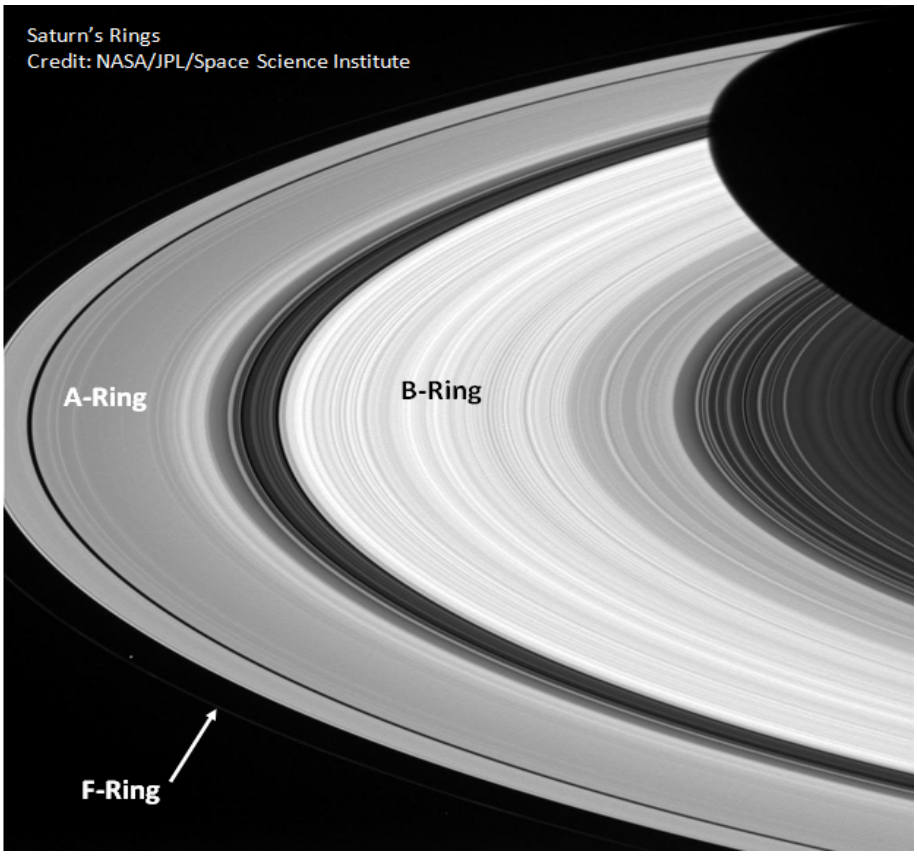
F-Ring Revealed

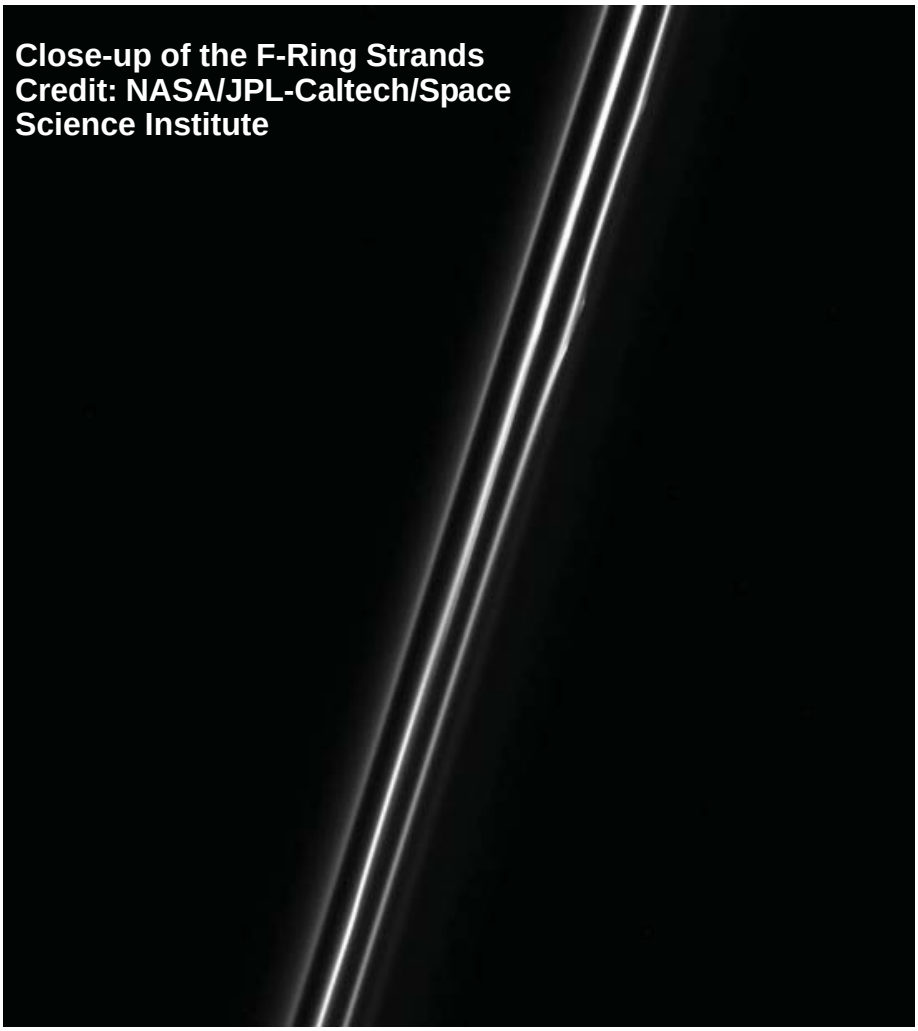
The Cassini project is heading for a September 15th conclusion and grand finale encounter with Saturn's atmosphere. The spacecraft is currently traveling in a polar, outer ring-grazing orbit. Cassini's camera recently captured a close-up view of Saturn's F-Ring, the planet's outermost distinct ring, located 1,800 miles (3,000 km) beyond the outer edge of the A-Ring. The ring is contained by the shepherd moon Prometheus.



While overwhelmed by Saturn's bright and expansive A-Ring, the F-Ring is resolved into multiple strands when viewed up close. Three bright strands and a wispy forth strand can be seen in the Cassini image. The image of the dusty strands comprising the F-Ring was captured at a distance of approximately 122,000 miles (197,000 km) from Saturn.

The F-Ring is only a few hundred miles across and very active, with changes noticeable over a few hours. Computer simulations suggest that the F-Ring was created as a result of multiple collisions of small moons that formed and then disintegrated near the outer edge of the rings as Saturn's ring system evolved.





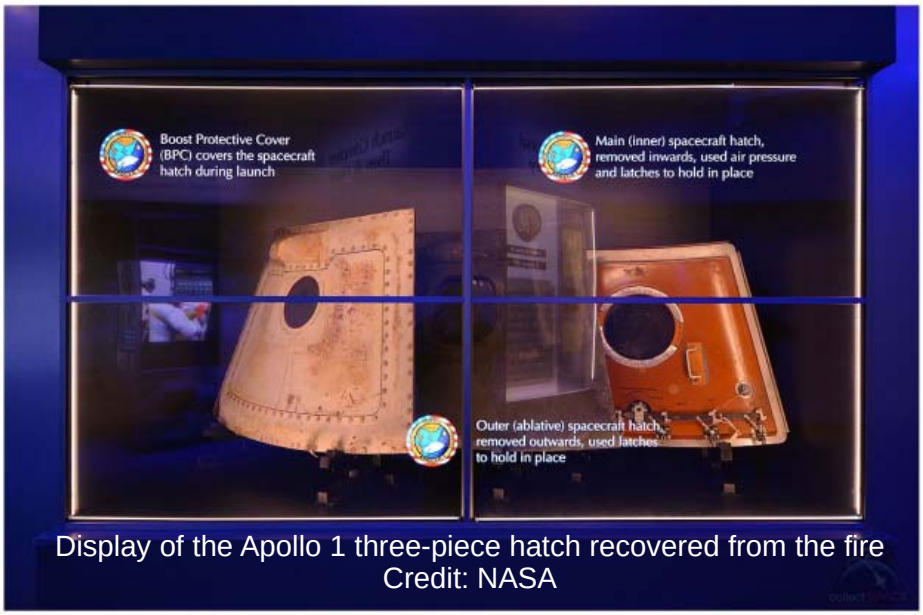
Ad Astra Per Aspera (A Rough Road Leads to the Stars)

NASA's Day of Remembrance is held each January to honor those men and women who lost their lives pursuing the exploration of space. The crew of Apollo 1 and those of the space shuttles Challenger and Columbia are among those recognized for their sacrifice. A permanent memorial, with artifacts from the two lost shuttles, was established at the Kennedy Space Center 18 months ago, but the Apollo 1 capsule remained hidden away in a warehouse at NASA's Langley Research Center in Hampton, Virginia.

Long overdue, a new exhibit at Kennedy Space Center Visitor Complex finally recognizes the contributions of Apollo 1 astronauts, Gus Grissom, Ed White and Roger Chaffee. The investigation that followed the fire culminated in a redesigned and much safer command module. Without the design upgrade, including the elimination of highly flammable materials within the capsule, it was likely that a crew would have been eventually lost in deep space.

While NASA would not put the entire fire-ravaged capsule on display, they selected a most powerful artifact as the centerpiece of the memorial – the capsule's three-piece hatch. It was the original hatch design that prevented the astronauts from escaping as they were being asphyxiated. Following the accident, the hatch was redesigned and simplified, and modified to open outward rather than inward. The changes made it possible to open the hatch in 5 seconds rather than the 90 second required by Apollo 1 astronauts. The six tech-

nicians who fought through the flames, black and toxic smoke, and sustaining burns to their hands in a futile attempt to rescue the crew are also honored in the memorial.

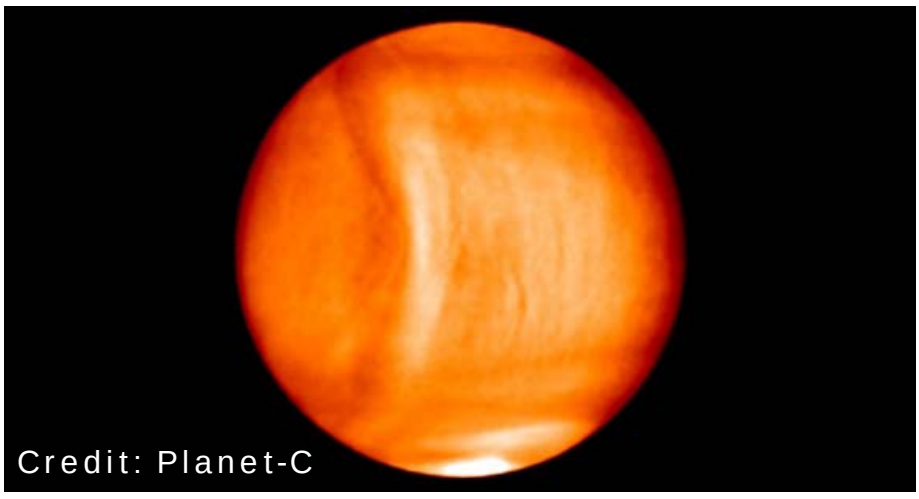


Display of the Apollo 1 three-piece hatch recovered from the fire
Credit: NASA

Venusian Wave

Japan Aerospace Exploration Agency's Akatsuki spacecraft has been monitoring the planet Venus since the spacecraft arrived in December 2015. Only days after entering orbit around the cloud-shrouded world, Akatsuki's cameras recorded what appeared to be a stationary, bow-shaped wave. The atmospheric wave extended for 6,200 miles (10,000 km), from north to south. It remained in a relatively fixed position for four days above Aphrodite Terra, a continent size plateau, before disappearing. The location of the wave suggests that it was created by the thick lower atmosphere passing over the mountainous terrain, with the air being displaced upward (similar to air riding over mountain ranges on Earth).

Winds on Venus blow faster than the planet rotates (a day on Venus is longer than its year) and are more variable than on Earth (the Venus Express spacecraft recorded a 33% increase in cloud-top wind speeds over a six year period). Winds at the planet's cloud tops exceed 220 miles per hour (355 kph), more than 435 mph (700 kph) in the middle layers, and only a few miles per hour near the surface. The formation and persistence of a large pressure wave suggests that the atmosphere on Venus may be more complex than previously thought.


Credit: Planet-C

Red Alert!

Gliese 710 is a faint red dwarf, approximately 63 light years away in the constellation Ophiuchus. Researchers had discovered, using data from the Hipparcos Astrometry Satellite (1989-1993) that, in approximately one million years, the red dwarf would pass within one light year (6 trillion miles) of our Sun. At that distance, Gliese 710 would likely disrupt the orbits of those icy worlds that inhabit the Oort Clouds, scattering some and sending others to rain down upon the inner solar system.


Gliese 710 (Credit: Digitized Sky Survey, SkyView)

The Gaia spacecraft (launched in 2013) is able to measure a star's position and motion 200 times more accurately than Hipparcos. Data from Gaia indicates the likelihood of an even closer encounter (almost five times closer) in 1.35 million years. At closest approach Gliese 710 will be three times brighter than the star Sirius and brighter than all the planets except Venus. At this distance, its impact on our solar system may be even more disruptive.

State of the State

In December, the State Council Information Office of the People's Republic of China issued a white paper on China's recent accomplishments in space exploration and future ambitions. Some of the highlights of the last five years include:

• over 100 spacecraft launched with a 97.67 percent success rate, including Earth observation satellites, communication and broadcasting systems, navigation and positioning satellites, and new technology test satellites;

• maiden flight of its newest rocket booster, the heavy-lift Long March 5, and the development of a more powerful liquid-fueled engine;

• spacecraft rendezvous demonstrations (automatic and manual);

• launch of the Tiangong-2 space laboratory (and the manned spacecraft that docked at the laboratory);

• China's first soft landing on the surface of another celestial body when the Chang'e-3 lander set down on the lunar surface near Sinus Iridum in December 2013;

• development of a new launch site (Wenchang) and renovation of its Jiuquan, Taiyuan and Xichang launch sites;

• construction of deep space tracking and communication stations;

• promoting scientific research with the launch of the Dark Matter Particle Explorer, Shijian-10 and Quantum Science Experiment Satellite; and

• improved monitoring of space debris and active mitigation methods.

In the next five years, China plans on expanding its launch capabilities with new medium and heavy-lift boosters to support its ambitious plans for near-Earth, lunar and deep space missions. China has also shown interest in developing new technologies to lower the cost of space access that might include developing a reusable space plane. Future space exploration activities include:

View of the Earth-Moon (far side) from the Chang'e 5 Test Mission Spacecraft. Photo Credit: CASC/CCTV

• a lunar sample return mission in 2017;

• the first soft landing on the far side of the Moon in 2018 using a communications relay at the Earth-Moon L2 (Lagrange) point;

• launch of a Mars probe in 2020 that may include both an orbiter and a rover;

• development of a Moon rocket (with a maiden flight of the heavy-lift booster circa 2030);

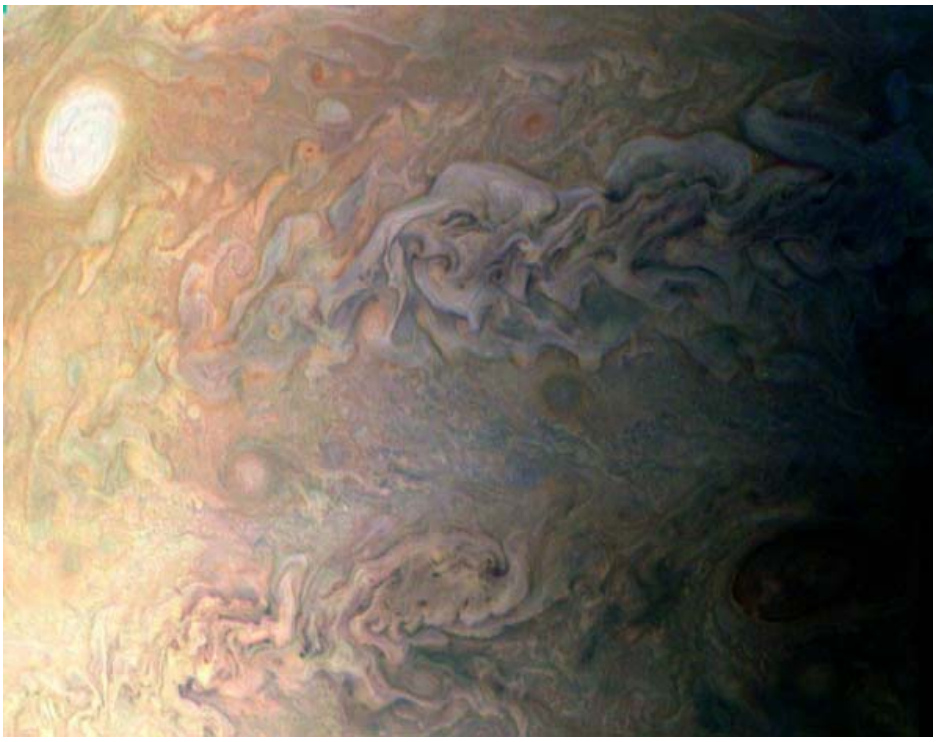
• possible Martian sample return mission;

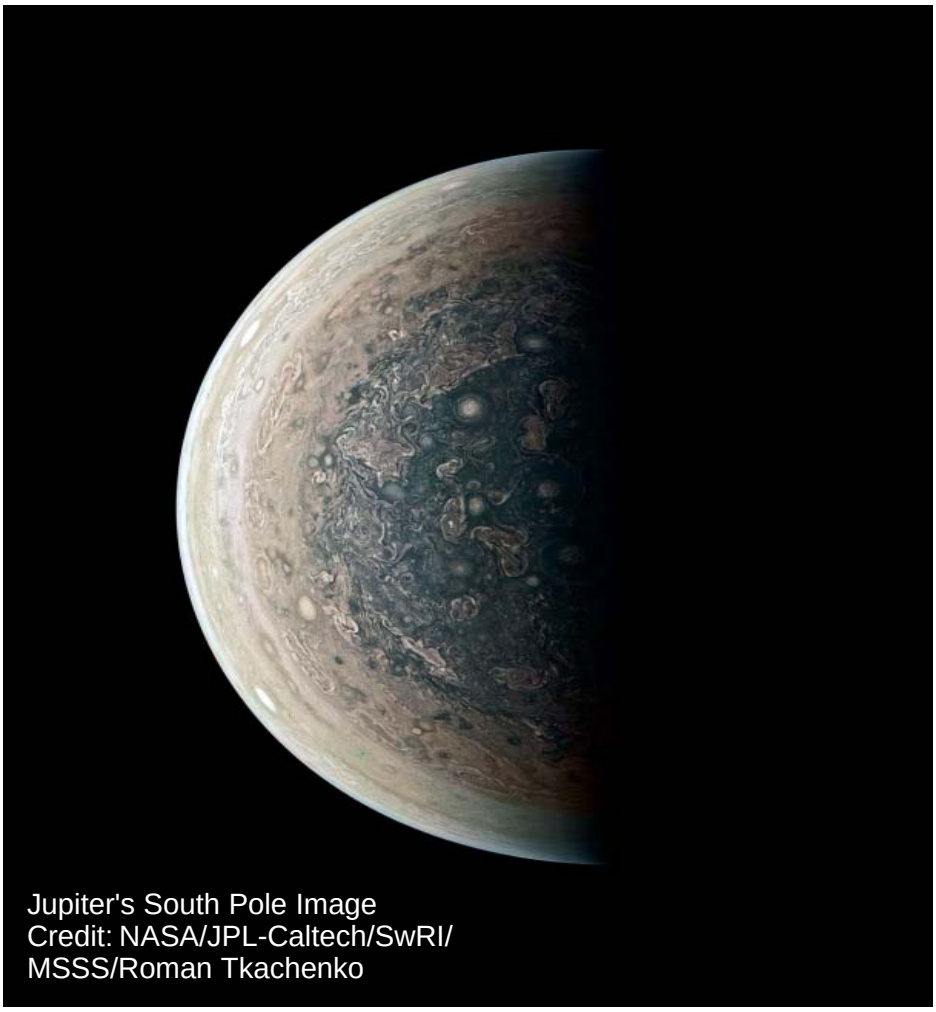
• planetary fly-bys, including exploration of the Jovian system, and

• re-provision and expansion of the Earth-orbiting Tiangong-2 space laboratory.

The white paper was silent on human exploration of the Moon and Mars that have been discussed in other forums and on its military expansion in near-Earth space despite recent activity in areas such as anti-satellite technology.

If Vincent van Gogh Had Painted Jupiter





Jupiter's South Pole Image
Credit: NASA/JPL-Caltech/SwRI/
MSSS/Roman Tkachenko

Juno was launched in August 2011 and arrived at Jupiter on July 4, 2016. It is the most distant solar-powered spacecraft, operating at approximately 517 million miles (832 million km) from the Sun. To power the spacecraft's instruments at such a great distance, Juno is equipped with three 30-foot long (9 meter) solar panels to capture the Sun's feeble light.

The Juno spacecraft completed its third close encounter with the planet Jupiter (Perijove 3) on December 11th. The image (below) has been enhanced to bring out details of the clouds to the southeast of one of the eight storms (while oval) that currently form a "string of pearls" in the southern hemisphere. The counter-clockwise rotating storms are further south than the Great Red Spot and usually 8 or 9 storms are visible at any time. Although they generally don't interact, three of the storms did merge over a three year period between 1998 and 2000 to form a storm rivaling the Great Red Spot in size.

The image was captured by the spacecraft's JunoCam instrument and processed by a citizen scientist (Eric Jorgensen). The spacecraft was 15,300 miles (24,600 km) from the planet when the image was taken. The camera, which can capture full color views of the planet's atmosphere during close approaches, was designed for public outreach (the public can suggest points of interest for targeting by the camera on each pass) and images from the camera are available to the public for review and processing at *www.missionjuno.swri.edujunocam*.

The Juno mission completed Perijove 4 on Thursday, February 2nd traveling at a speed of 129,000 mph (207,600 kph) relative to the gas giant. The image of Jupiter's south pole (processed by a citizen scientist Roman Tkachenko) was captured from a distance of 63,400 miles (102,100 km). Several white oval storms are visible along a band near the limb.

One Year in Space

NASA astronaut Scott Kelly and Russian cosmonaut Mikhail Kornienko returned to Earth last March (2016) after spending almost a year aboard the International Space Station (ISS).

Astronaut Kelly's participation in the long-duration flight had an added benefit since he is an identical twin. His brother, Mark Kelly, remained on Earth and volunteered to be a control subject, providing biological samples before, during and after Scott's return.

Preliminary results are just now being released, with additional analysis continuing. Areas of research included:

• Changes in physical performance

• Behavioral health and the psychological effects of long-duration spaceflight including confinement

• Visual impairment possibly due to pressure changes in the brain and spinal fluid in a weightless environment

• Changes to the immune system

• Atherosclerosis (hardening and narrowing of the arteries)

• Human factors (for example, retention of fine motor skills and training, decision making, alertness and reasoning)

• Changes in the major organs, muscle and brain over time

• Changes in the digestive system and organisms within the gastrointestinal tract

One of the unexpected findings was in the chromosomal change in Scott Kelly's white blood cells. Telomeres are repetitive nucleotide sequences at each end of a chromatid (one of the two identical strands along which a chromosome splits during cell division). They act to preserve the information-carrying sequences of the DNA. As an individual ages, the telomeres decrease in length. Researches had thought the added stress of the one-year mission would accelerate the shrinkage. Instead, Scott's telomeres increased in length during his year in space before shortening after he returned to Earth.

The twins DNA and RNA were also compared, pre- and post-flight. While unique differences are not unusual in the generic material of even identical twins, more than 200,000 RNA molecules were found to be expressed differently between the twins.

Scott Kelly returned two inches taller from living in a microgravity environment and with a pronounced difference in the ratio of the two dominant bacterial groups found in the digestive tract. Both attributes returned to pre-flight conditions shortly after Scott's return.

Scott Kelly and Mikhael Kornienka aboard the International Space Station (Source: NASA)

Twist of Fate

On March 3, 1969, a Saturn V rocket carried the crew of Apollo 9 into Earth orbit for the first manned flight test of the lunar module. The ten-day mission was the most complex conducted with two manned spacecraft, including the evaluation and testing of the first spacecraft designed to operate solely outside the Earth's atmosphere, a spacewalk, rendezvous and docking exercises, and the test firing of the lunar module's descent engine. The successes of Apollo 9 paved the way for the lunar landing missions that followed.

A year earlier, the crew of Apollo 9 (astronauts James McDivitt, David Scott and Russell Schweickart) had been assigned to Apollo 8, with the same mission objectives. However, by mid-year 1968, it was clear that the lunar lander, due to numerous manufacturing and technical concerns, would not be ready for a year-end flight. With a growing concern that the Soviets were ready to begin flying their new Soyuz spacecraft again (after a fatal accident on its first flight), NASA decided to send

A fish-eye camera view of the interior of the Apollo Lunar Module Mission Simulator at the Kennedy Space Center. In the foreground is mission commander James McDivitt; in background is Russell Schweickart, lunar module pilot. Source: NASA.

Apollo 8 on a flight around the Moon without the lunar lander. McDivitt considered the mission no more than a publicity stunt and turned it down, opting to switch with the Apollo 9 crew in anticipation that the lunar lander would then be available for that flight. McDivitt's decision would ultimately determine who would be the first to walk on the Moon, as the backup crew for Apollo 8 would become the prime crew for Apollo 11. With the crew switch, Pete Conrad went from the commander of Apollo 11 to the commander of Apollo 12 and from the first to the third person to walk on the Moon.

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

Credit: NASA photo showing Dr. Goddard with his a liquid oxygen-gasoline

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. 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.

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, between March 20th and the 27th).

March Nights

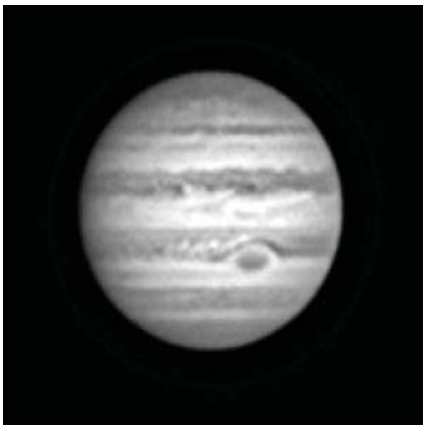
March, the month named for the planet Mars, denotes the end of the long winter nights. The Sun crosses the celestial equator at 6:29 am (EDT) on the 20th marking the Vernal Equinox and the beginning of the spring season in the northern hemisphere. If you have the opportunity to be in the Yucatan on this day, take a trip out to Chichen Itza to watch the Sun cast the shadow of a plumed serpent on the pyramid of Kukulcan.

Sunrise and Sunset

Sun	Sunrise	Sunset
March 1st (EST)	06:28	17:44
March 15th	07:05	19:01
March 31st	06:38	19:18

Jupiter and its Moons

With Jupiter reaching Opposition on April 7th, rising with the setting Sun and visible all night, March offers an opportunity to observe the gas giant without sacrificing a good night's sleep. Jupiter rises approximately 3 hours after the sunset on March 1st. By month's end Jupiter is visible in the eastern sky more than two hours earlier. As one of the brightest star-like objects in the night sky, Jupiter can be found in the constellation Virgo.



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 on the Jovian disk. On nights of good visibility the following events should be visible through a moderately-sized telescope.

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 7 pm to midnight local time:

Jupiter Moon Transits

Date	Moon	Transit Begins	Transit Ends
3rd	Io	8:29 pm	10:41 pm
8th	Europa	7:13 pm	9:42 pm
9th	Ganymede	9:38 pm	12:08 am (10th)
10th	Io	10:23 pm	12:35 am (11th)
15th	Europa	10:48 pm	1:17 am (16th)
19th	Io	7:44 pm	9:56 pm
26th	Io	9:38 pm	11:50 am (27th)

Transit of Jupiter's Red Spot

Date	Transit Time	Date	Transit Time
Feb 28th	8:39 pm	14th	11:09 pm
2nd	10:17 pm	17th	8:38 pm
4th	11:55 pm	19th	10:16 pm
5th	7:46 pm	21st	11:54 pm
7th	9:24 pm	24th	9:23 pm
9th	11:02 pm	26th	11:01 pm
12th	9:31 pm	29th	8:30 pm

Astronomical and Historical Events

1st Asteroid 16 Psyche closest approach to Earth (2.237 AU), target of new NASA Discovery mission scheduled for launch in October 2023
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 Aten Asteroid 2012 DR32 near-Earth flyby (0.007 AU)
2nd Apollo Asteroid 2011 OJ45 near-Earth flyby (0.079 AU)
2nd Asteroid 243 Ida closest approach to Earth (1.859 AU)
2nd Kuiper Belt Object 2013 FZ27 at Opposition (47.573 AU)
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 Moon at perigee (closest distance from Earth)
3rd Asteroid 29 Amphitrite at Opposition (8.9 Magnitude)
3rd Apollo Asteroid 2016 RZ17 near-Earth flyby (0.078 AU)
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 Schweikart in the first manned flight test of the lunar module (1969)

Astronomical and Historical Events (continued)

3rd History: launch of the Pioneer 4 spacecraft towards the Moon; first U.S. spacecraft to escape the Earth's gravity (1959)
4th Moon occults the star Aldebaran in Taurus (approximately 11:10 pm)
5th First Quarter Moon
5th Distant flyby of Saturn's largest moon Titan by the Cassini spacecraft
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 Apollo Asteroid 5786 Talos closest approach to Earth (0.804 AU)
6th Kuiper Belt Object 2013 FY27 at Opposition (79.044 AU)
6th 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 mid-February 2016 JPL's Planet Quest reports 1,941 confirmed exoplanets orbiting 1,209 stars
6th History: flyby of Comet Halley by Vega 1, a Soviet spacecraft (1986)
7th Distant flyby of Saturn's moons Mimas and Pan by the Cassini spacecraft
7th History: John Herschel born, first astronomer to survey the southern hemisphere (1792)
8th Aten Asteroid 2014 HB124 near-Earth flyby (0.092 AU)
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 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 Comet 2P/Encke Perihelion (0.336 AU) 10th Apollo Asteroid 2015 EF near-Earth flyby (0.048 AU)
10th Apollo Asteroid 138404 (2000 HA24) near-Earth flyby (0.067 AU)
10th Apollo Asteroid 2008 CA6 near-Earth flyby (0.084 AU)
10th Apollo Asteroid 428694 Saule closest approach to Earth (0.908 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 Second Saturday Stars - Open House at McCarthy Observatory
11th Apollo Asteroid 2012 EQ10 near-Earth flyby (0.045 AU)
11th Aten Asteroid 2016 EX202 near-Earth flyby (0.053 AU)
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 Full Moon (Full Worm Moon)
12th Daylight Saving - Set Clock Ahead 1 Hour (United States)
12th Comet 2P/Encke closest approach to Earth (0.655 AU)
13th History: flyby of Comet Halley by Giotto, a European Space Agency spacecraft (1986)

Astronomical and Historical Events (continued)

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)
14th Pi Day
14th Distant flyby of Saturn's moons Epimetheus and Pandora by the Cassini spacecraft
14th Aten Asteroid 2005 ES70 near-Earth flyby (0.056 AU)
14th Atira Asteroid 2015 DR215 closest approach to Earth (0.529 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 9162 Kwiila closest approach to Earth (0.533 AU)
15th History: Alan Bean born; astronaut, moonwalker and artist (1932)
16th Apollo Asteroid 1998 SL36 near-Earth flyby (0.021 AU)
16th Amor Asteroid 4055 Magellan closest approach to Earth (1.275 AU)
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)
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 Amor Asteroid 3199 Nefertiti closest approach to Earth (1.027 AU)
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: 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)
18th Moon at apogee (furthest distance from Earth)
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 History: Tenham meteorite fall; fragments of a large meteor rain down on a remote area of western Queensland, Australia (1879)

Astronomical and Historical Events (continued)

19th History: Moon flyby by the Hiten spacecraft; Japan's first lunar flyby, orbiter and surface impactor (1990)
20th Last Quarter Moon
20th Vernal Equinox (beginning of the Spring season in the northern hemisphere) at 6:29 am EDT (10:29 UT)
20th Distant flyby of Saturn's moons Titan, Janus and Pallene by the Cassini spacecraft
20th Apollo Asteroid 65803 Didymos closest approach to Earth (1.144 AU)
20th 48th Lunar and Planetary Science Conference, Woodlands, Texas
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)
22nd Distant flyby of Saturn's moon Pan by the Cassini spacecraft
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 Distant flyby of Saturn's largest moon Titan by the Cassini spacecraft
23rd Centaur Object 31824 Elatus at Opposition (15.242 AU)
23rd Dwarf Planet 136472 Makemake at Opposition (51.605 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)
25th Apollo Asteroid 162173 Ryugu closest approach to Earth (0.651 AU) (target of the Japanese sample return spacecraft Hayabusa 2 in 2018)
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 Apollo Asteroid 2015 TC25 near-Earth flyby (0.020 AU)
26th Atira Asteroid 2013 JX28 closest approach to Earth (1.031 AU)
26th History: American astronomer J.W. Draper takes first photograph of the Moon (1840)
27th Aten Asteroid 2010 EG21 near-Earth flyby (0.074 AU)
27th Aten Asteroid 367943 Duende closest approach to Earth (1.697 AU)
27th Apollo Asteroid 719 Albert closest approach to Earth (2.829 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)
28th Apollo Asteroid 215588 (2003 HF2) near-Earth flyby (0.043 AU)
28th Apollo Asteroid 2006 HW50 near-Earth flyby (0.064 AU)
28th Apollo Asteroid 2016 TB18 near-Earth flyby (0.099 AU)
28th History: flyby of Comet Halley by the ICE spacecraft (1986)
28th History: Heinrich Olbers discovers the asteroid 2 Pallas (1802)
29th Distant flyby of Saturn's moons Enceladus and Mimas by the Cassini spacecraft
29th History: First flyby of Mercury by the Mariner 10 spacecraft (1974)
29th History: Heinrich Olbers discovers the asteroid 4 Vesta (1807)
30th Moon at perigee (closest distance from Earth)
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

Solar Activity

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

International Space Station and Iridium SatellitesPnce Team

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).

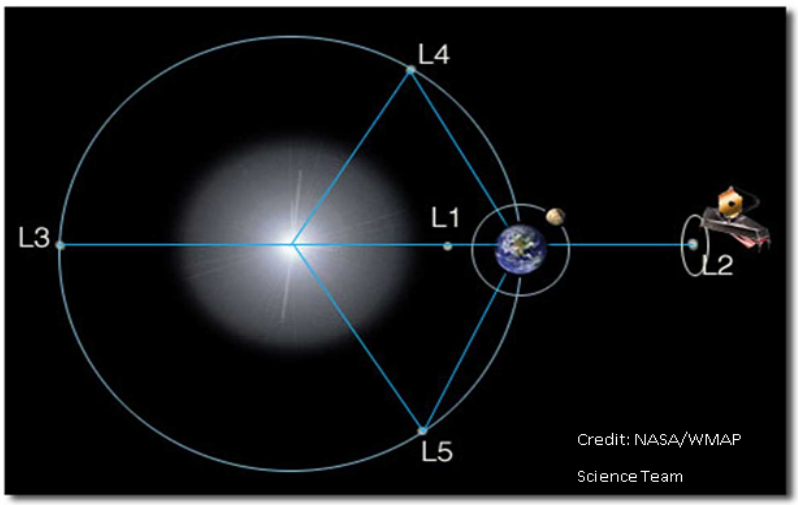


Image Credits

Front page design and graphic calendar: Allan Ostergren

Second Saturday Stars poster: Marc Polansky

Cartoon: Bucky Milam, Danbury Area Computer Society

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

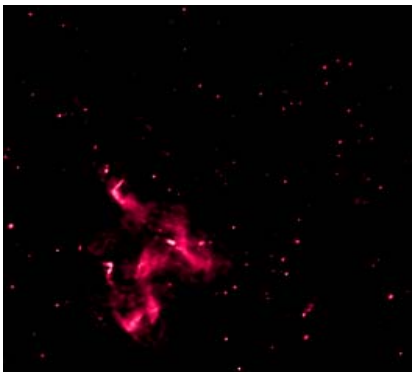
Cover Image

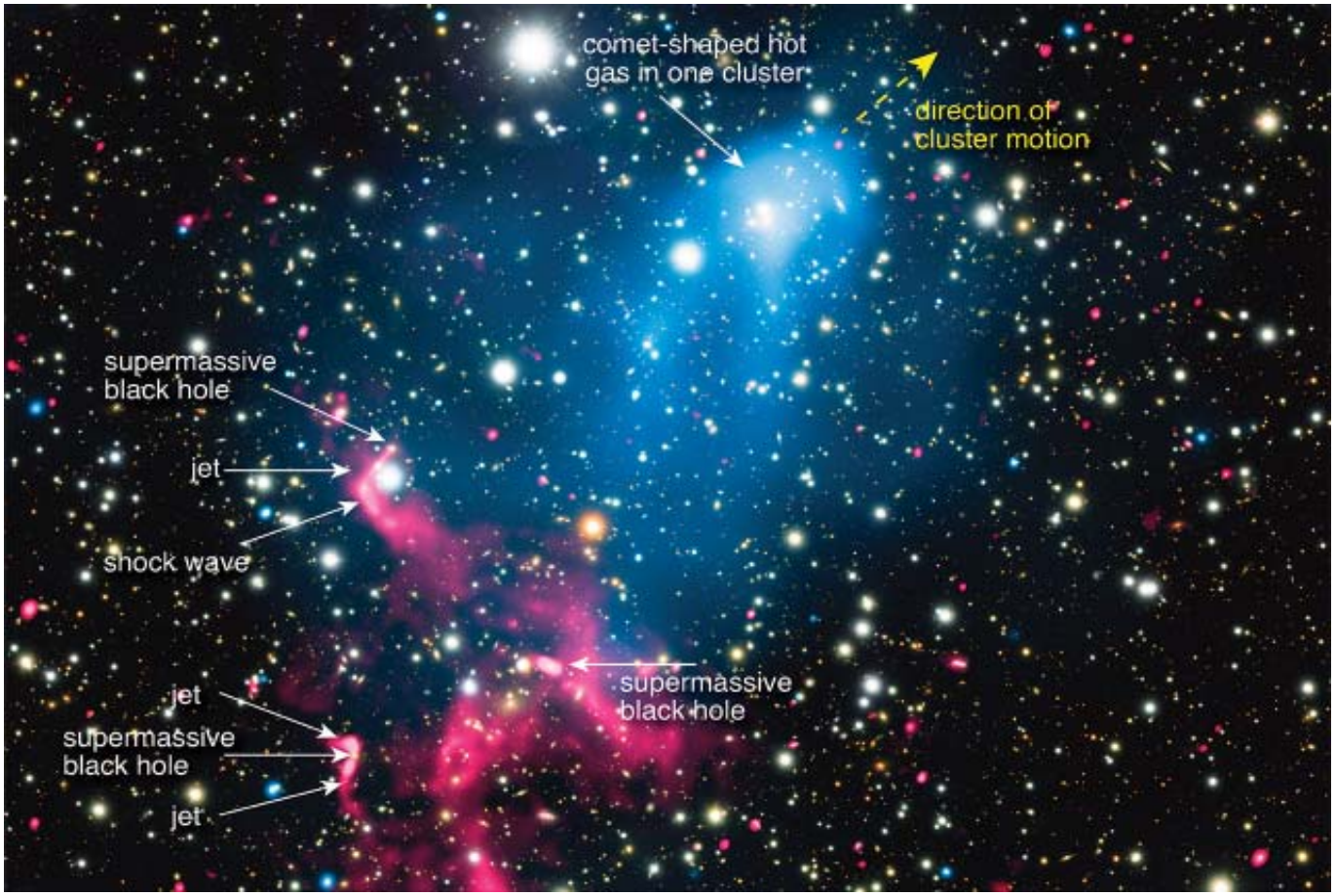
Galaxies and their stars are so widely diffused that their silent wanderings might seem inconsequential — and when galaxies collect into clusters of thousands, their paths should be so scattered that they could freely cohabit without consequence. But when they gather into humungous clusters of thousands, the tidal effects of their collective gravity and radiation can have catastrophic results.

The image below is of a pair of "colliding" galaxy clusters in the constellation Hydra: Abell 3411 and 3412, about two billion light years from Earth. The image at bottom is a composit of three views shown above: optical data from Subaru, the 8.2-metre flagship telescope of the National Astronomical Observatory of Japan, located at the Mauna Kea Observatory on Hawaii, X-ray images from the Chandra Observatory, and radio emissions from the Giant Metrewave Radio Telescope in India

The three images testify to wrenching throes the merging galaxies are enduring as hot gases are accelerated and stretched by the gravitational interaction of supermassive black holes.

For more information, go to *http://chandra.harvard.edu/photo/2017/a3411//*





Second Saturday Stars

FREE EVENT

Every Month at the

John J. McCarthy Observatory

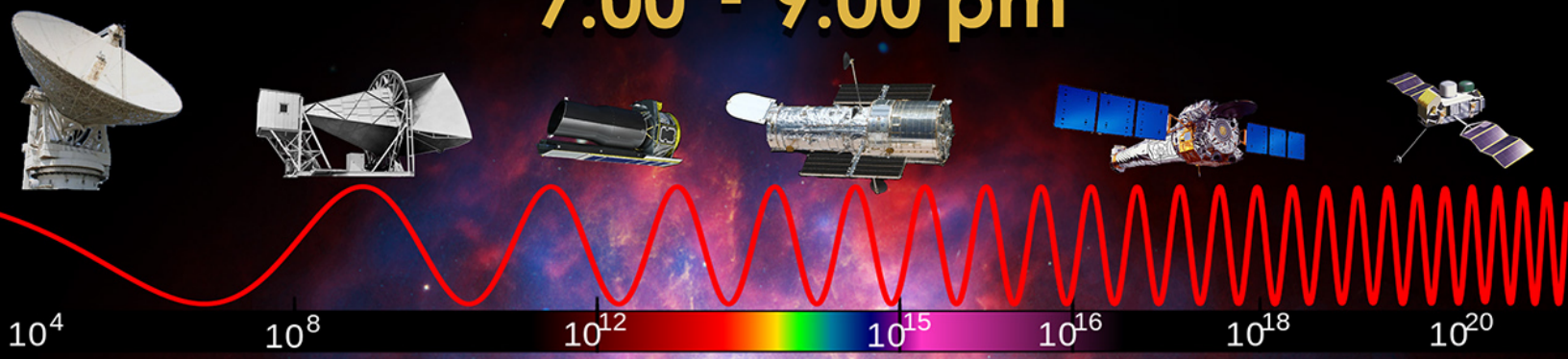
Behind the New Milford High School

860.946.0312

www.mccarthyobservatory.org

March 11th

7:00 - 9:00 pm



Super-Vision

Discovering the secrets of the universe at every wavelength

Refreshments
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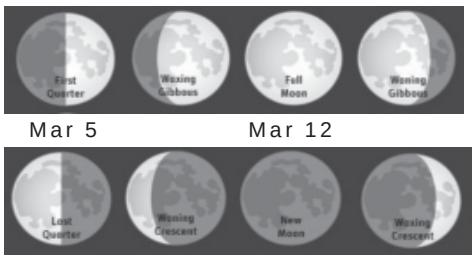
ASL Interpretation Available with Prior Notice
Rain or Shine

March 2017

Celestial Calendar

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
Phases of the Moon  Mar 5 Mar 12 Mar 20 Mar 27			**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 of Rosetta spacecraft to comet 67 P/ Churyumov-Gerasimenko (2004)	Moon at apogee (farthest from Earth) **3**   Launch of Apollo 9; first test of lunar module (1969) ESA's Mars Express spacecraft close flyby of Martian moon Phobos (2010) 	**4**  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) 	**10**  Flyby of Comet Halley by Japanese Sakigake spacecraft (1986) Mars Reconnaissance Orbiter arrives at Mars (2006) 	Urbain Leverrier born - Predicted existence of Neptune (1811) **11**   Launch of Pioneer 5 into solar orbit to study interplanetary magnetic fields (1965)  2nd Saturday Stars Open House McCarthy Observatory
12 Daylight Saving Time   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** Pi 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** Moon at apogee (farthest from Earth) Alexei Leonov First Spacewalk (1965) Soviet Vostok rocket explodes during launch, killing 48 (1980)
19 Moon flyby by Japan's Hiten orbiter and impactor (1990)	**20** Vernal Equinox 6:45 PM EDT	**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** Moon at perigee (closest distance to Earth) Launch of Soviet spacecraft Luna 10, first to orbit Moon (1966)	