Galactic Observer

John J. McCarthy Observatory

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A giant centipede swallowing the Earth? Find out more on page 16.

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

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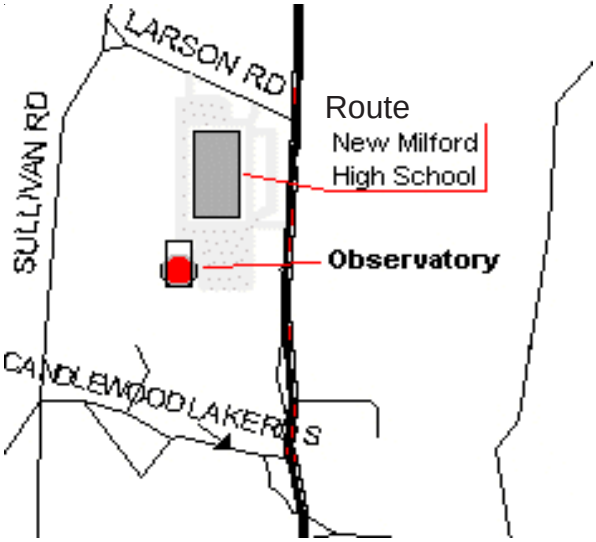

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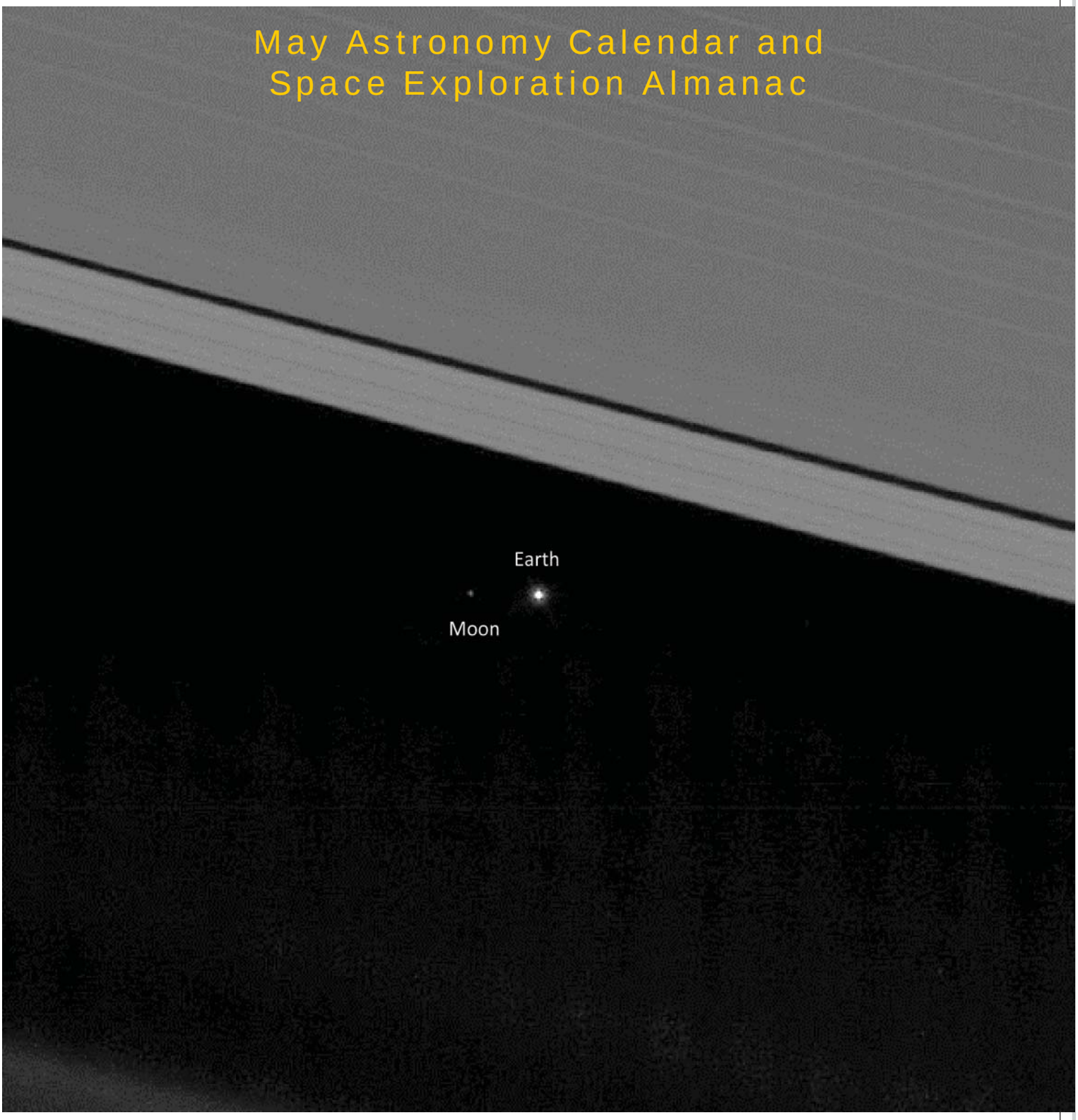
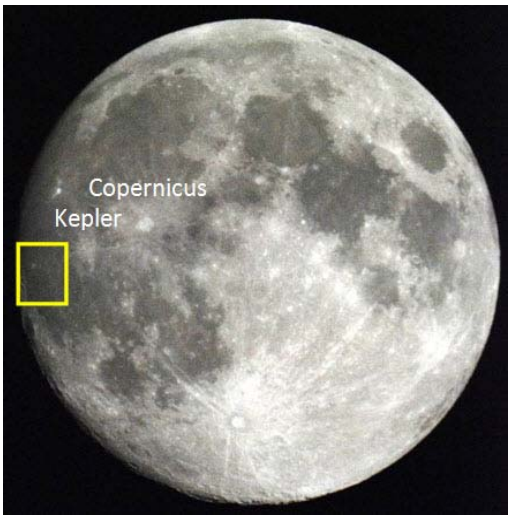


NASA's Cassini spacecraft captures the planet Earth (and Moon) from a distance of 870 million miles (1.4 billion km) in an image taken on April 12, 2017. Saturn's A Ring is at the top of this cropped image with the Keeler gap visible near the outer edge. In the original image, the F ring was also visible at the bottom of the image.
Image Credit: NASA/JPL-Caltech/Space Science Institute

"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).



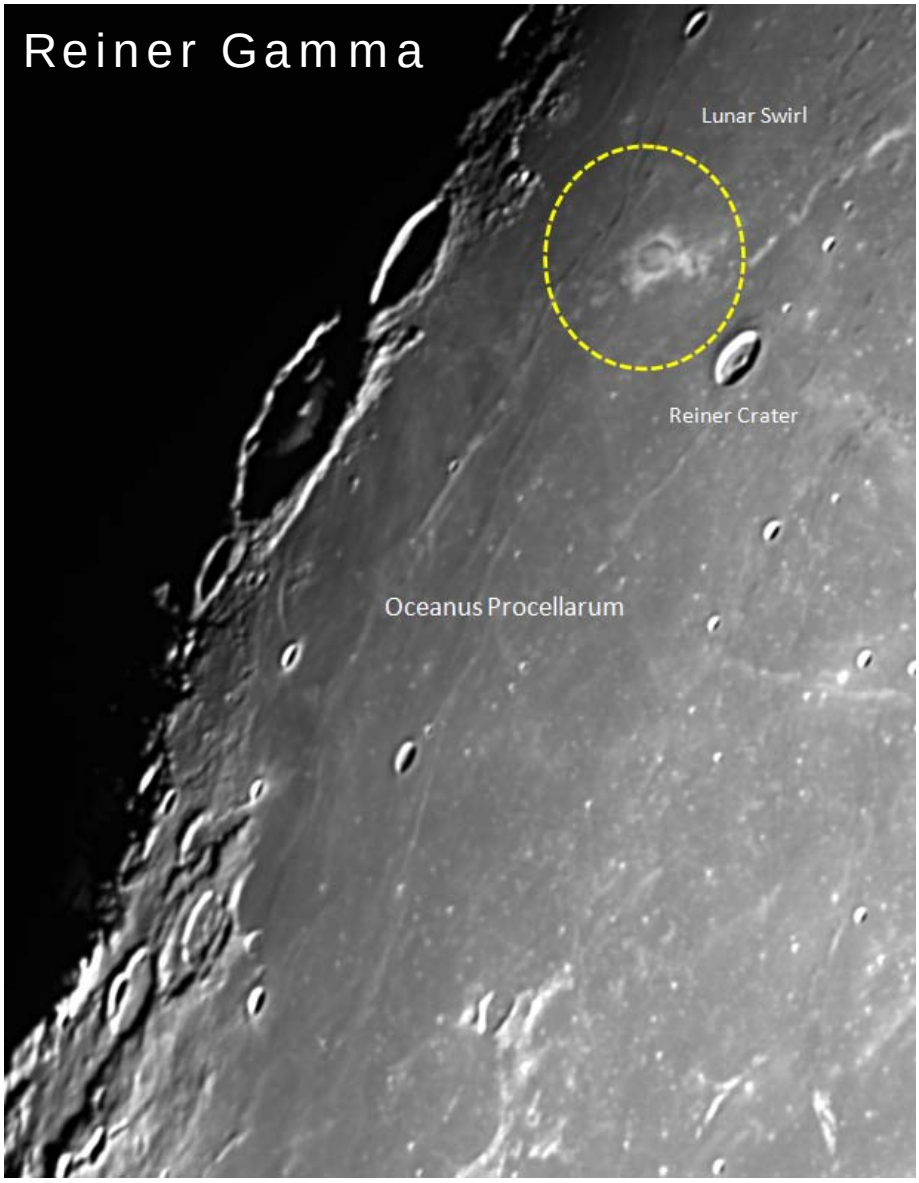
Lunar "oceans" are expansive, low-lying plains formed by ancient lava flows

Among the many mysteries of our Moon is the origin of the relatively bright patterns on its surface, called "lunar swirls." The most prominent and easily observed swirl is Reiner Gamma. When the Moon is nearly full, the swirl can be found near the western limb, west of the craters Copernicus and Kepler. The bright tadpole-shaped swirl stands out against the dark lunar mare of Oceanus Procellarum (Ocean of Storms).

Swirls appear unique to the Moon and can appear in groups or as a solitary feature. The International Astronomical Union lists the diameter of Reiner Gamma at 45.6 miles (73.44 km), although from orbit filaments can be seen that extend for hundreds of miles across the surface. Swirls have some common characteristics, for example, they appear to be associated with remnants of an ancient magnetic field and the area within the swirl appears to be less weathered by the solar wind than surrounding areas.

The swirls are thought to have been formed by the deflection of the solar wind by a localized magnetic field, but how the field formed is not fully understood. Data collected by the Lunar Reconnaissance Orbiter has confirmed that the exposure to the solar wind (which darkens the regolith) is less in area within the swirls than their surroundings and modeling has shown that a strong electric field can be generated when the solar wind's charged particles attempt to flow through the magnetic field.

Rock samples returned by the Apollo astronauts revealed that the Moon was still generating a magnetic field (from a rotating outer liquid core) as recently as 3 billion years ago. However, the original magnetic field would have weakened as the core cooled, so that these localized magnetic fields are unlikely to be remnants of the original, global field.



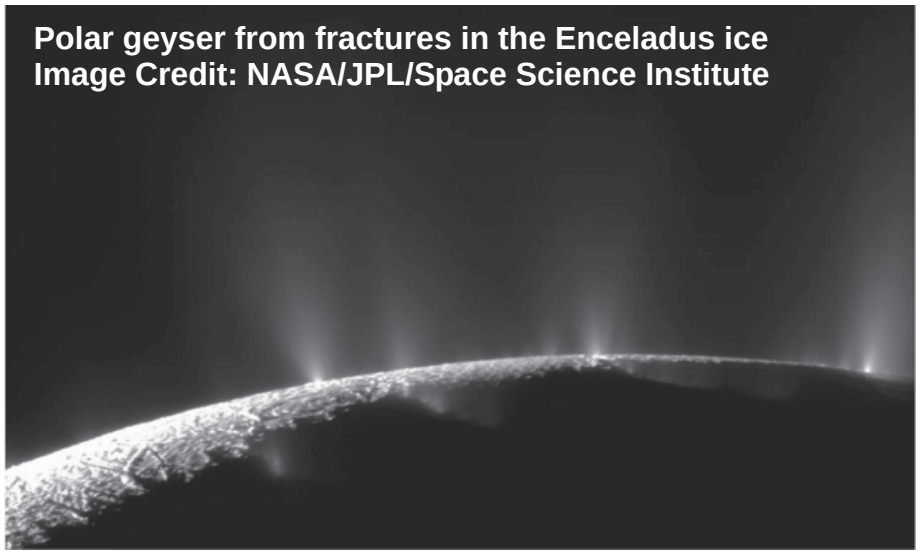
Several theories have been offered on the origin, including one that attempted to correlate the swirls with basin impacts on the opposite side of the Moon. While there is some correlation, there doesn't appear to be an impact basin associated with Reiner Gamma. Researchers are also exploring field production by a cometary impact or through an interaction with a passing comet. It may be that we will have to return to the Moon for a more definitive answer to this mystery.

Ocean Worlds

Recently published research papers on Saturn's moon Enceladus and Jupiter's moon Europa are strengthening the case that, beneath their icy shells, the two ocean worlds may have the right ingredients to support life.

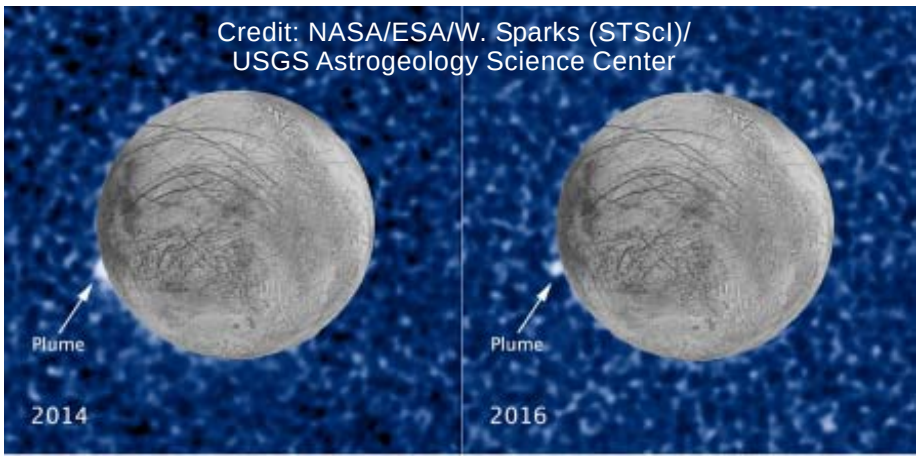
Enceladus is a small moon, only 314 miles (504 km) in diameter (Saturn's largest moon Titan is almost 10 times larger). Bright (reflecting almost all sunlight) and featureless, the moon garnered little attention until icy plumes were discovered in a backlit image captured by Cassini's camera as the spacecraft flew by in 2005. The plumes, erupting from fissures near the moon's south pole, are primarily water ice/vapor. Escaping the fissures (over 100 individual fissures have been catalogued) at approximately 800 miles per hour (1,287 km/hr), the icy particles continually renew the moon's surface and feed Saturn's gossamer E-ring.

On October 28, 2015, the Cassini spacecraft passed through the plumes, coming within 30 miles (48 km) of the icy surface. It was during this closest pass that, using an instrument designed to analyze Titan's atmosphere, hydrogen was detected within the plumes (98% of the vapor in the plumes is water with 1% hydrogen gas and the rest a mixture of other molecules). Researchers believe that the source of the hydrogen is hydrothermal activity on the moon's seafloor (produced from the interaction of water heated by the tidally squeezed mantle with the rock at the bottom of a global ocean). Microbes, on Earth, obtain energy using the hydrogen and the carbon dioxide dissolved in water from a chemical reaction known as methanogenesis.



Closer to the Sun, researchers have been using the Hubble Space Telescope to image Europa as the moon passes in front of Jupiter after a possible plume was spotted erupting from the moon in a 2014 image. Unlike the plumes of Enceladus, the plumes on Europa, if real, are intermittent (in ten separate observing campaigns, the plumes were seen on only three occasions). They do appear to erupt from an unusually warm area of the moon's icy surface that had been identified by NASA's Galileo spacecraft during its eleven flybys of the moon in the 1990s.

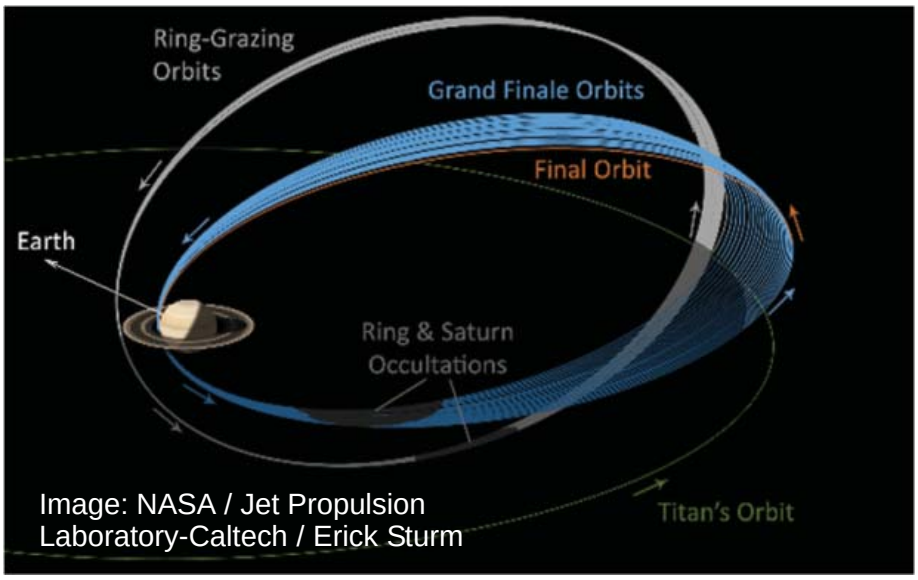
The Europa plume(s) have been measured to rise as high as 100 miles (160 km) above the moon's icy surface. As with Enceladus, the plume(s) are believed to be water erupting from a subsurface ocean. With the Europa Clipper spacecraft still in the early design stage, the opportunity to directly sample Europa's plume(s) will allow mission managers to optimize the spacecraft's instruments to detect the ingredients for a life-sustaining environment.



Composite image of Europa and the plumes in ultraviolet light during two Jovian transits

Grand Finale

On April 22nd (EDT), the Cassini spacecraft flew by Saturn's largest moon Titan. The encounter was used to reconfigure the spacecraft's trajectory for the final phase of its mission. Five days later, early in the morning on April 26th, Cassini threaded the gap between Saturn and its rings. The gap transits will be repeated weekly for a total of 22 orbits. The final orbit will take place on September 15th, when the spacecraft will enter the planet's atmosphere, concluding a mission that began almost 20 years ago on October 15, 1997 from a launch pad at the Kennedy Space Center.



The Cassini spacecraft's 22 Grand Finale orbits with the final orbit on September 15th in orange

The final 22 orbits will take the spacecraft from the very inner edge of the rings to the outer reaches of Saturn's atmosphere, exploring a region deemed too risky to visit earlier in the mission. The spacecraft's instruments will map the planet's magnetic field, sample icy ring particles and acquire detailed images of the both the rings and the gas giant's cloud tops.

The end of the mission comes as the spacecraft is running out of the fuel used for adjusting its course. Over the last 13 years in orbit around Saturn, Cassini has provided intriguing evidence of potentially habitable environments on at least two of Saturn moons (Titan and Enceladus). So as not to contaminate these worlds with a defunct spacecraft, mission managers elected to destroy the spacecraft while still maneuverable.

Betting on the Future

NASA's Innovative Advanced Concepts (NIAC) program fosters creative ideas on future space exploration. The agency recently announced its 2017 Phase I and Phase II selections. (Phase I awards provide nine months of funding for concept maturation. Phase II awards provide participants an additional two years of funding to further develop concept viability and to demonstrate its benefits).

The 2017 NIAC proposals selected for Phase I or Phase II funding are identified in a news release *https://www.nasa.gov/press-release/nasa-invests-in-22-visionary-exploration-concepts*. Phase I proposals include the study of "A Synthetic Biology Architecture to Detoxify and Enrich Mars Soil for Agriculture" by Adam Arkin at the University of California, Berkeley. He proposes to evaluate the effectiveness of certain strains of organisms (extremophiles) to detoxify the perchlorate and enrich the Martian soil with ammonia for future agriculture.

A Mechanical Beach Animal on Scheveningen beach, The Netherlands (2009). Courtesy of Theo Jansen. Photo by Loek van der Klis

Another proposal, "Evacuated Airship for Mars Missions," by John-Paul Clarke at the Georgia Institute of Technology revisits an idea first proposed by an Italian Jesuit Francesco Lana Terzi in his treatise "Prodromo dell'Arte Maestra" (1670). In it, Terzi's described the design of a lighter-than-air ship. He proposed creating a vacuum within large copper spheres incorporated into the design of his sailing vessel to displace the air and provide lift, allowing his ship to float through the atmosphere. Clarke proposes to overcome certain design challenges, such as vacuum-induced buckling, by using a multi-layer lattice for the airship's structural strength and vacuum containment. Clarke envisions that such a vehicle could be used for aerial surveys, supply transport, communication relay, and redeployment of ground-based assets such as rovers.

A Phase II proposal "Automaton Rover for Extreme Environments," by Jonathan Sauder at NASA's Jet Propulsion Laboratory, continues the investigation into mechanical robots (with limited high-temperature electronics) for applications in extreme environments such as exploring the surfaces of Mercury or Venus (the longest operating lander on Venus succumbed to the 860° F temperature and crushing atmosphere pressure after only two hours). The "automaton" would be a robust mechanical device capable of operating for long durations and performing complex actions.

For information on self-propelling, mechanical machines visit the creations (strandbeests or beach animals) of Dutch artist Theo Jansen at *https://www.exploratorium.edu/strandbeest*. The artist recently visited NASA's Jet Propulsion Laboratory where he presented his thoughts on "Creating New Forms of Mechanical Life…"

Stormy Weather

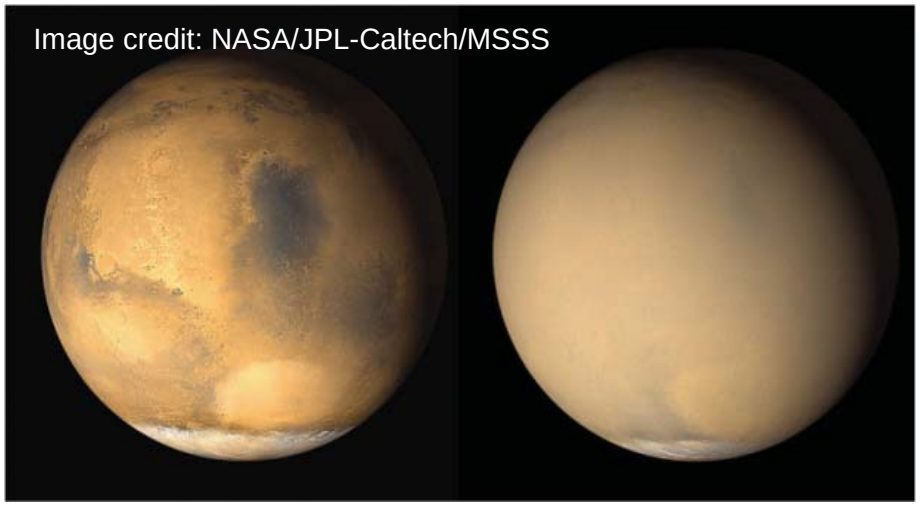
With Martian summer comes the threat of global dust storms. As the Sun heats the ground, the warmed air rises, carrying with it the fine dust that coats the surface. Mixing with the upper and much colder atmosphere produces the instability needed to generate a small dust devil or larger storm. Regional events can sometimes combine into planet-covering storms (on average such a global storm occurs once every three Martian or five and one-half Earth years).

During late February and into early March, two continent-size dust storms developed within two weeks of one another. One of the storms remained relatively stationary just to the west of Meridiani Planum where the Mars Exploration Rover Opportunity is working at Endeavour crater. Since Opportunity relies upon energy from its solar panels to power its systems, any loss in the opacity (clarity) of the atmosphere is a concern to project managers.

Martian weather is monitored daily by NASA's Mars Reconnaissance Orbiter. The spacecraft's Mars Color Imager (MARCI) camera can image the entire planet over 12 orbits (approximately every day). MARCI images are used to construct weather maps and to produce animated sequences that are available at *http://www.msss.com/msss_images/latest_weather.html*.

While the storms have abated, dust remains in the atmosphere. Elevated levels have affected Opportunity's operations, requiring more down time for recharging the rover's batteries (and less time for exploration). The Mars Science Laboratory Curiosity rover is unaffected, since the rover is powered by a radioisotope thermoelectric generator, and not by solar panels.

In 2001, NASA's Mars Global Surveyor orbiter recorded the dramatic changes in the Martian atmosphere over a one month period as a regional dust storm over Hellas basin (bright oval near the south polar cap in the left image) blossomed into a global storm. The dust in a global storm can be carried to altitudes of 37 miles (60 km). A July 2007 month-long dust storm halted all surface operations by the rovers Spirit and Opportunity. Ninety-nine percent of the direct sunlight was blocked by the dust at the Opportunity site as the rover's batteries drained.



Mars on June 2001 (left) and July 2001 (right) as seen from the Mars Global Surveyor

Atlas

The Cassini project is heading for a September 15th conclusion and grand finale encounter with Saturn's atmosphere. The spacecraft, which arrived at Saturn in 2004, had been traveling in a polar, outer ring-grazing orbit. On April 22nd (EDT), the spacecraft used a flyby of Saturn's largest moon Titan to modify its orbit to one that dives between the planet and the rings. The first pass through this gap was executed on April 26th (at 5 am EDT). Twenty-two orbits later, if the spacecraft survives multiple transits of the gap (using its high gain antenna as a dust and particulate shield), Cassini will plunge into Saturn's atmosphere.

Cassini's camera recently captured a close-up view of the ring-hugging moon Atlas. The flying saucer shaped moon is about 25 by 15 miles (40 by 20 km) in size and orbits Saturn at a distance of 85,544 miles (137,670 km) at the outer edge of the A Ring. The moon completes an orbit around Saturn once every 14.4 hours.

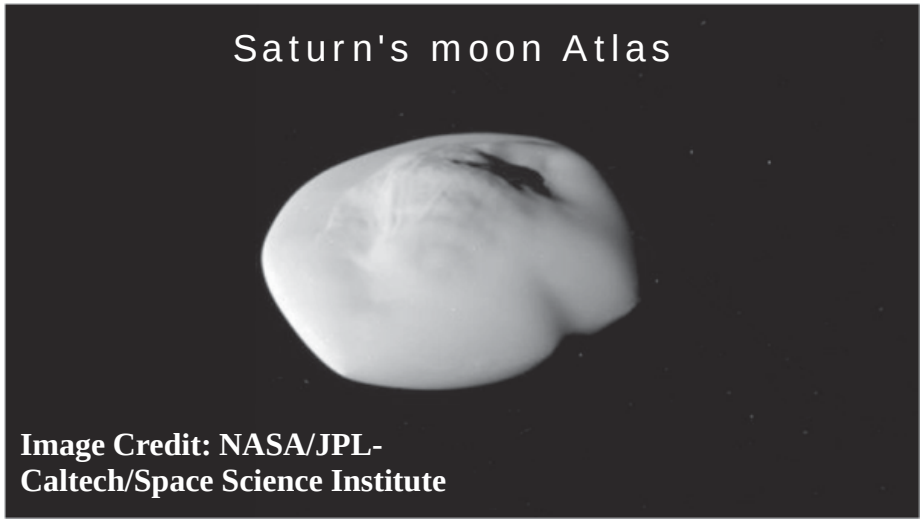


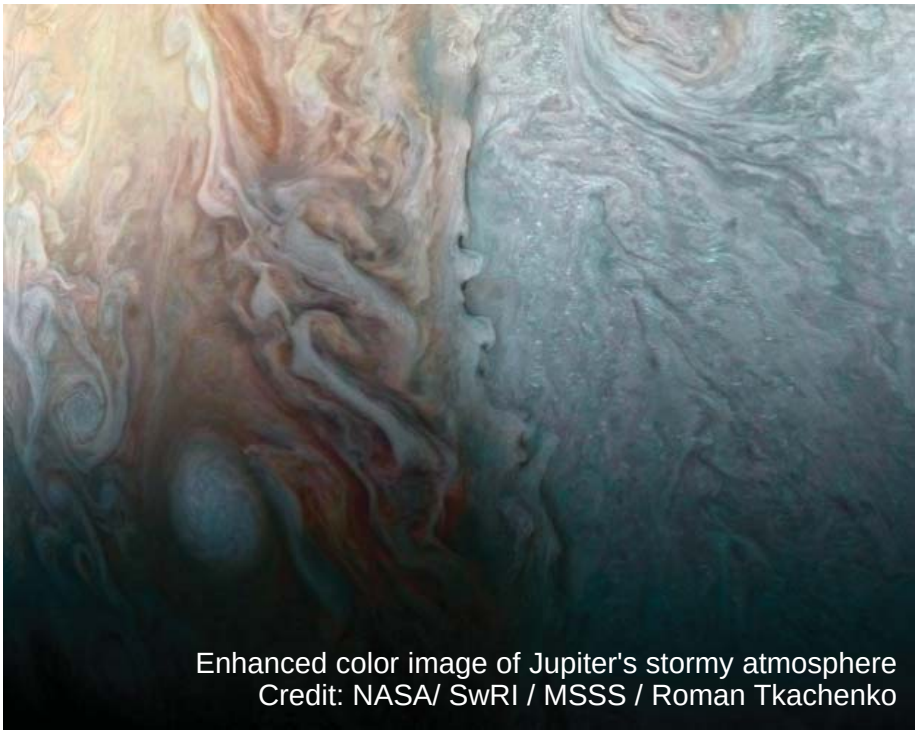
Image Credit: NASA/JPL-Caltech/Space Science Institute

This raw, unprocessed image of Atlas was taken on April 12, 2017. The Cassini spacecraft passed within 7,000 miles (11,000 kilometers) of the moon. The image is the closest ever taken of the moon.

Portraits of Jove

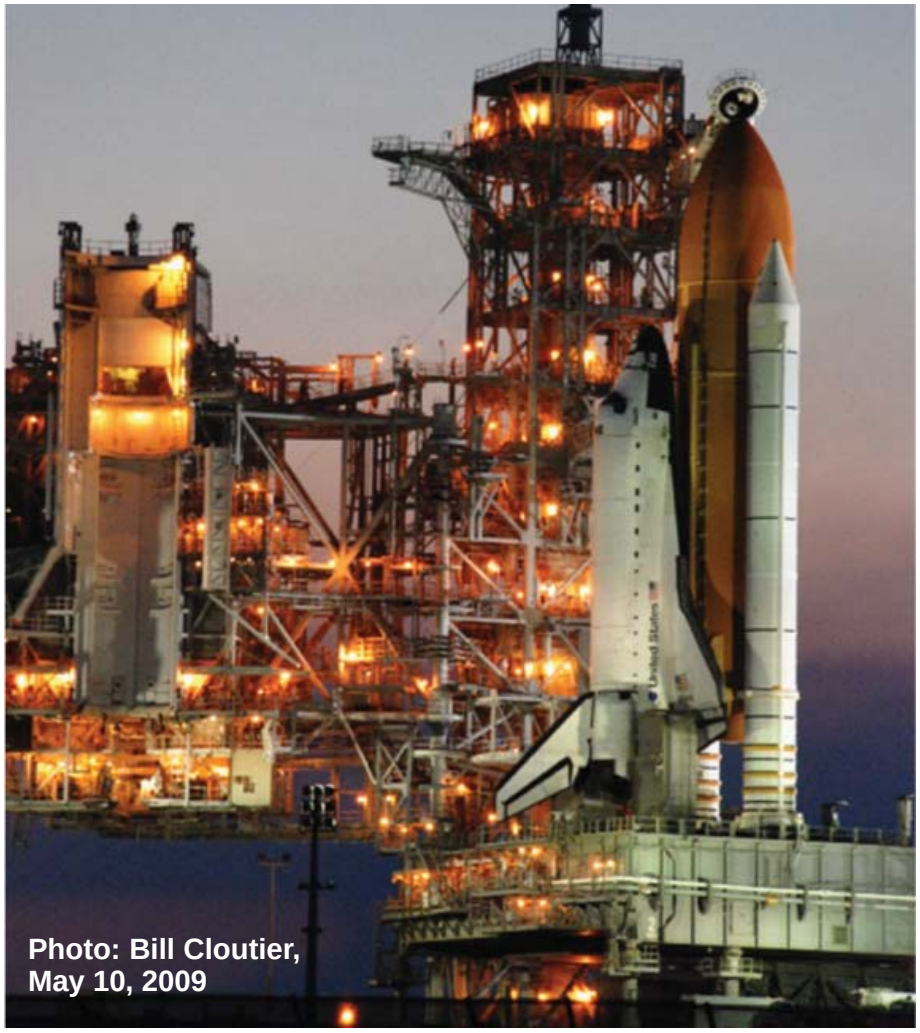
The Juno spacecraft completed its fifth close encounter with the planet Jupiter (Perijove 5), on March 27th. The image (below) of a stormy boundary in the south temperate belt on Jupiter was captured by the spacecraft's JunoCam instrument and processed (color enhanced) by a citizen scientist (Roman Tkachenko). The spacecraft was approximately 7,900 miles (12,700 kilometers) above the cloud tops 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.edu/junocam*.


Artist's concept of the Juno spacecraft orbiting Jupiter.
Credits: NASA/JPL-Caltech


Enhanced color image of Jupiter's stormy atmosphere
Credit: NASA/ SwRI / MSSS / Roman Tkachenko

Hubble Space Telescope Update

The space telescope was last serviced in May of 2009. During that final on-orbit servicing mission, conducted over five spacewalks at 340 miles above the Earth's surface, the space shuttle Atlantis astronauts installed two new instruments, repaired two others to restore operation, and replaced the telescope's batteries, gyroscopes and other critical instrumentation.Eight years later, the telescope continues to perform well with only minor anomalies with the gyroscopes. Certain instruments such as the Cosmic Origins Spectrograph's Far Ultraviolet etector do have a finite life (its photocathode is depleted during normal use), however nominal operations are expected until the early 2020s. The latest Space Telescope Users' Committee Report identifies the fine guidance sensors as the likely limiting factor for continued telescope operations. With the James Webb Space Telescope scheduled to launch in 2018, astronomers are hoping for several years of joint operation with the two telescopes.



Space Shuttle Atlantis on Pad 39A awaiting the launch of the final Hubble Space Telescope servicing mission.

Public Astronomy

Eighty-two years ago, on May 14, 1935, the Griffith Observatory opened to the public and 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 Griffith 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 Mount Wilson observatory, Griffith offered the city $100,000 for a public observatory to be built on Mount Hollywood in Griffith 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.

The California Science Center's ET-94 at NASA Michoud Assembly Facility near New Orleans, Louisiana.

Endeavour flew its 25th 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. Sometime in 2018, the 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 5th and 6th. 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 gibbous Moon may interfere with 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 large, 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 Michael van 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. Several of the areas described by Riccioli on Grimaldi's maps (shown above) are indicated on the next page.

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 of Tranquility* 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 20th, 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 carry Apollo 11 to the moon. More than 20,000 private firms and hundreds of thousands of

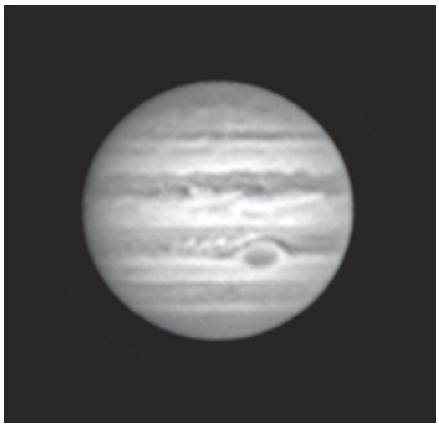
workers participated in this program, for a fraction of the cost of the Vietnam War. Not only did the United States reach the Moon, it built a national infrastructure of technology, manufacturing and education that has not been rivaled. In 1969, the United States was truly on top of the world.

Vehicle Assembly Building
Photo: Bill Cloutier

May Nights

For those who do their stargazing 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.

Jupiter and its Moons



Jupiter reached Opposition and its closest approach to Earth in early April. During the month of May, Jupiter is still well placed in evening sky after sunset. Jupiter will be at its highest approximately three hours and 20 minutes after sunset on May 1st (11:11 pm) and more than two hours earlier by month's end. As the Earth moves ahead of Jupiter on its inside orbit, Jupiter will diminish slightly in brightness and apparent size. As one of the brightest star-like objects in the night sky, Jupiter can be found in the constellation 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. On nights of good visibility the following events should be visible through a moderately-sized telescope.

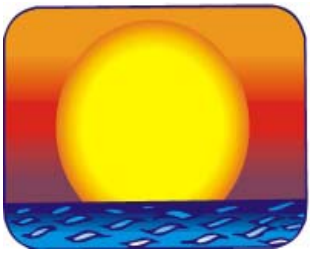
Jovian Moon Transits

Date	Moon	Transit Begins	Transit Ends
4th	Io	8:05 pm	10:16 pm
11th	Europa	7:39 pm	10:05 pm
11th	Io	9:59 pm	12:10 am (9th)
18th	Europa	10:16 pm	12:42 am (19th)
18th	Io	11:53 pm	2:04 am (19th)
27th	Io	8:16 pm	10:26 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
1st	10:41 pm	16th	8:05 pm
4th	8:11 pm	18th	9:43 pm
6th	9:49 pm	20th	11:21 pm
8th	11:27 pm	23rd	8:51 pm
11th	8:57 pm	25th	10:30 pm
13th	10:35 pm	30th	9:38 pm



Sunrise and Sunset (from New Milford, CT)

Sun	Sunrise	Sunset
May 1st (EDT)	05:50	19:52
November 15th (EST)	05:34	20:06
November 30th	05:22	20:21

Astronomical and Historical Events

1st Aten Asteroid 326290 *Akhenaten* closest approach to Earth (0.298 AU)
1st Kuiper Belt Object 42355 *Typhon* at Opposition (20.077 AU)
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 First Quarter Moon
2nd Distant flyby of Saturn's moons *Daphnis* and *Prometheus* by the Cassini spacecraft
2nd History: discovery of the first binary star (Xi Ursae Majoris) by William Herschel (1780)
3rd Atira Asteroid 164294 (2004 XZ130) closest approach to Earth (0.671 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 Mars Autumnal Equinox (southern hemisphere)
5th Amor Asteroid 2009 HG near-Earth flyby (0.065 AU)
5th Amor Asteroid 388838 (2008 EZ5) near-Earth flyby (0.082 AU)
5th Apollo Asteroid 11311 *Peleus* closest approach to Earth (2.058 AU)
5th History: launch of Freedom 7 and astronaut Alan Shepard aboard a Mercury-Redstone rocket, first American in space (1961)
6th Centaur Object 144908 (2004 YH32) at Opposition (11.782 AU)
6th Kuiper Belt Object 2010 FX86 at Opposition (45.227 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)
7th Distant flyby of Saturn's largest moon *Titan* by the Cassini spacecraft
7th Apollo Asteroid 2015 VD1 near-Earth flyby (0.046 AU)
8th Aten Asteroid 2016 CU246 near-Earth flyby (0.052 AU)
9th Distant flyby of Saturn's moons *Daphnis*, *Pan*, *Pandora* and *Titan* by the Cassini spacecraft
9th Apollo Asteroid 1864 *Daedalus* closest approach to Earth (0.435 AU)
9th Atira Asteroid 434326 (2004 JG6) closest approach to Earth (0.882 AU)
9th Apollo Asteroid 2329 *Orthos* closest approach to Earth (0.936 AU)
9th Kuiper Belt Object 90568 (2004 GV9) at Opposition (38.509 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 Full Moon (Full Flower Moon)
10th Apollo Asteroid 85585 *Mjolnir* closest approach to Earth (1.224 AU)
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 History: launch of the space shuttle Atlantis (STS-125), final Hubble Space Telescope servicing mission (2009)
12th Moon at apogee (furthest distance from Earth)
12th Apollo Asteroid 2016 LJ49 near-Earth flyby (0.062 AU)
12th Atira Asteroid 2012 VE46 closest approach to Earth (0.536 AU)
12th Apollo Asteroid 4769 *Castalia* closest approach to Earth (0.751 AU)

Astronomical and Historical Events (continued)

12th History: first planetarium (Adler Planetarium in Chicago) opens in United States (1930)
13th **Second Saturday Stars - Open House at McCarthy Observatory**
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 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)
14th History: the 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 microorganisms (1864)
15th Distant flyby of Saturn's moon *Ephimetheus*, *Pan*, *Aegaeon* and *Atlas* by the Cassini spacecraft
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 Apollo Asteroid 2012 EC near-Earth flyby (0.050 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 atmosphere of Venus and before impacting the surface (1969)
17th Mercury at Its Greatest Western Elongation – apparent separation from the Sun in the morning sky (26°)
17th Apollo Asteroid 4341 *Poseidon* closest approach to Earth (0.930 AU)
17th Kuiper Belt Object 65407 (2002 RP120) at Opposition (28.250 AU)
17th Kuiper Belt Object 2015 KH162 at Opposition (58.435 AU)
17th History: Soviet spacecraft Venera 6 returns 51 minutes of data while descending by parachute through the atmosphere 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 Last Quarter Moon
18th Apollo Asteroid 4581 *Asciepius* closest approach to Earth (0.365 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 History: launch of the first Army Hermes A-1 rocket from White Sands, NM (1950)
20th History: launch of the Pioneer Venus 1 spacecraft (1978)
21st History: launch of the Japanese Venus Climate Orbiter Akatsuki or Planet-C spacecraft and the Ikaros solar sail (2010)
22nd Distant flyby of Saturn's moons *Atlas*, *Janus* & *Aegaeon* by the Cassini spacecraft
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 2015 VX105 near-Earth flyby (0.069 AU)
23rd Aten Asteroid 5381 *Sekmet* closest approach to Earth (0.802 AU)
24th Distant flyby of Saturn's largest moon *Titan* by the Cassini spacecraft
24th Plutino 38628 *Huya* at Opposition (27.595 AU)
24th Plutino 2006 HJ123 at Opposition (33.410 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)
25th New Moon
25th Moon at perigee (closest distance from Earth)
25th History: the 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)

Astronomical and Historical Events (continued)

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 Aten Asteroid 2016 GK135 near-Earth flyby (0.074 AU)
27th Apollo Asteroid 6063 *Jason* near-Earth flyby (0.099 AU)
28th Distant flyby of Saturn's moons *Pandora*, *Mimas*, *Aegaeon* & *Prometheus* by the Cassini spacecraft
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)
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 Apollo Asteroid 2017 CS near-Earth flyby (0.020 AU)
29th Apollo Asteroid 481532 (2007 LE) near-Earth flyby (0.082 AU)
29th Kuiper Belt Object 2007 JH43 at Opposition (39.549 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 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 Scheduled launch of a cargo-carrying Dragon spacecraft atop a SpaceX Falcon 9 rocket to the International Space Station from Kennedy Space Center, Florida
31st Atira Asteroid 2013 JX28 closest approach to Earth (1.145 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 unlike Apollos, Atens spend most of their time inside Earth orbit.
- Atira: a group of near-Earth asteroids whose orbits are entirely within Earth's orbit
- Centaur: icy planetesimals with characteristics of both asteroids and comets
- Kuiper Belt: region of the solar system beyond the orbit of Neptune (30 AUs to 50 AUs) with a vast population of small bodies orbiting the Sun
- Opposition: celestial bodies on opposite sides of the sky, typically as viewed from Earth
- Plutino: an asteroid-sized body that orbits the Sun in a 2:3 resonance with Neptune
- Trojan: asteroids orbiting in the 4th and 5th Lagrange points (leading and trailing) of major planets in the Solar System

References on Distances

- the apparent width of the Moon (and Sun) is approximately one-half a degree (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

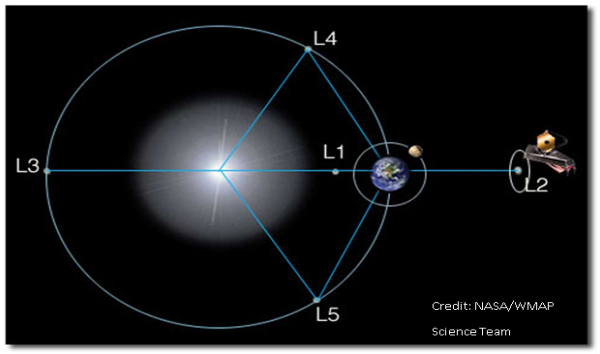
For the latest on what's happening on the Sun and the current forecast for flares and aurora, check out *www.spaceweather.com.*

International Space Station and Iridium Satellites

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

Lagrange Points

Five locations discovered by mathematician Joseph Lagrange where the gravitational forces of the Sun and Earth (or other large body) and the orbital motion of the spacecraft are balanced, allowing the spacecraft to hover or orbit around the point with minimal expenditure of energy. The L2 point (and future location of the James Webb telescope) is located 1.5 million kilometers beyond the Earth (as viewed from the Sun).



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Second Saturday Stars poster: Marc Polansky

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On the Cover

As on Earth, sand dunes are a ubiquitous feature of the Martian landscape. But certain anomalies peculiar to the red planet have given these geological structures a far wider palate of color, texture and design.

With an atmospheric density 1 percent of Earth's and wind velocities that rarely exceed 60 MPH, Mars would seem an unwelcome environment for generating swirling dust storms that could scatter their detritus in dunes. But every few Martian years (about 5.64 earth years), when the right conditions occur and the dust clouds form, the same atmospheric forces act to strengthen and perpetuate the winds—at times up to planet-circling velocities. [*You can read more on Martian storms on page 7 below*]

It is hard for scientists on earth to conduct tests and reach firm conclusions through surrogate mechanical rovers millions of miles away and with minimal tools. Perhaps the gritty electrostatic qualities of fine dust particles on the planet's surface cause them to form into erosion-resistant structures etched by swirling winds and geological forms molded by the surrounding landscape. The answers, when they come, will be critical to the design and planning of any missions to visit or colonize the red planet.

The transverse dune on the front page was observed by the High Resolution Imaging Science Experiment (HiRISE) instrument aboard the Mars Reconnaissance Orbiter (MRO) on April 27, 2009. It reveals a 35 kilometer-wide south-facing impact crater. The flow of the dune appears to have yielded ground to the large mound at the center of the image.

Source: NASA/JPL/University of Arizona

[*for more information on Mars dunes, go to https://astrogeology.usgs.gov/geology/mars-dunes.*]

HiRISE (High Resolution Imaging Science Experiment) has photographed hundreds of targeted swaths of Mars' surface in unprecedented detail.

https://mars.nasa.gov/mro/mission/instruments/hirise/

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

May 13th
8:00 - 10:00 pm

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

Map

May 2017

Celestial Calendar

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
	1  Gerard Kuiper discovers Neptune's Moon Nereid 1949 Discovery of Mars meteorite *Dar al Gani* 1998 	**2**  Cassini, Enceladus Flyby Cassini: Distant Flyby of Polydeuces, Atlas & Dione  Asteroid 1992 JD Near-Earth Flyby (0.024 AU)	**3**  Edmund Halley observes total eclipse phenomenon "Baily's Beads" (1715)	**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)	**5**  Eta Aquarids meteor shower peak Alan Shepard first American in space 1961   National Space Day	**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**  Moon at apogee (farthest from Earth) 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)	**13** 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)   2nd Saturday Stars Open House McCarthy Observatory Hubble Birthday Party
14  Launch of first Bumper rocket, from White Sands New Mexico (1948)	**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)	**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)	**20**  Launch of Japanese Venus Climate Orbiter Akatsuki or Planet-C spacecraft and the Ikaros solar sail (2010)
21  Launch of Pioneer Venus 1 spacecraft (1978)	**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** Moon at perigee (closest distance to Earth) Launch of Skylab 1 crew (1973 Comet Halley chronicled by Chinese astronomers (240 BC) Phoenix spacecraft lands on Martian soil 2008 JFK Moon goal speech (1961) 	**26** Launch of first "Navaho Missile", ICBM precursor (1948)	**27** 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)
28 Lawrence Maxwell Krauss born, Canadian-American theoretical physicist and author The Physics of Star Trek and A Universe from Nothing (1954)	**29** European Space Agency Born 1975	**30** Launch of Luna 22 (USSR), orbiter mission to study the Moon's magnetic field, geology and gravitation (1974) Measurements during solar eclipse confirm Einstein's relativity theory - 1919 	**31** Mariner 9, 1st artificial satellite of Mars (1971) Launch of Surveyor 1 Moon lander; transmitted over 11,000 images from Oceanus Procellarum (1966)			

Phases of the Moon

May 2 May 10

May 18 May 25