Galactic Observer

John J. McCarthy Observatory

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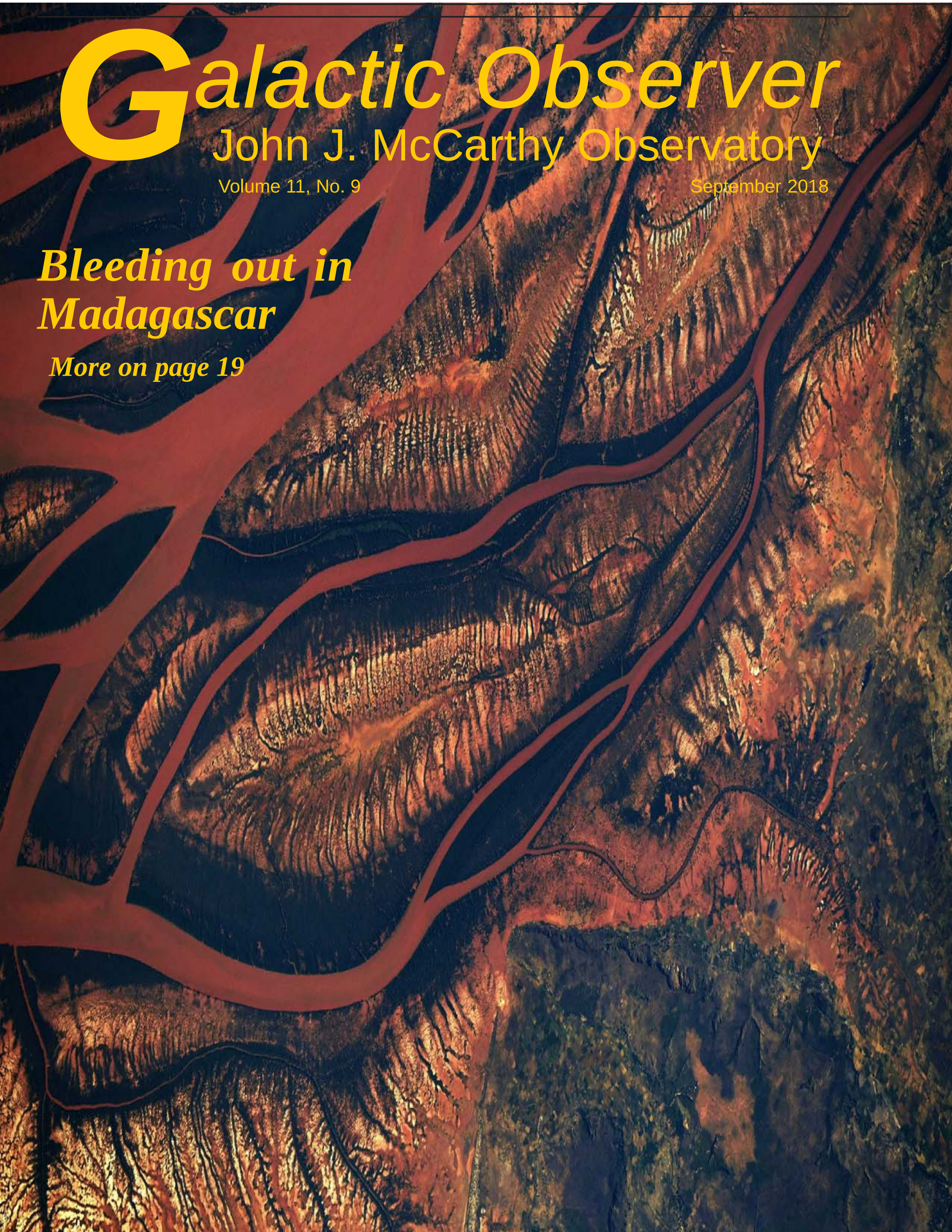

Bleeding out in Madagascar

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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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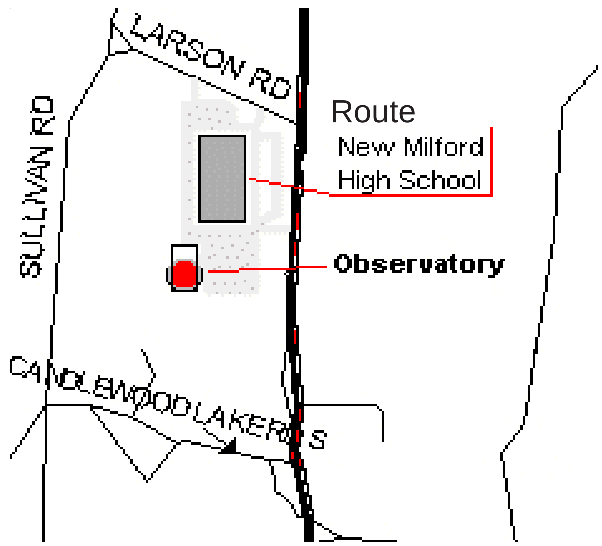

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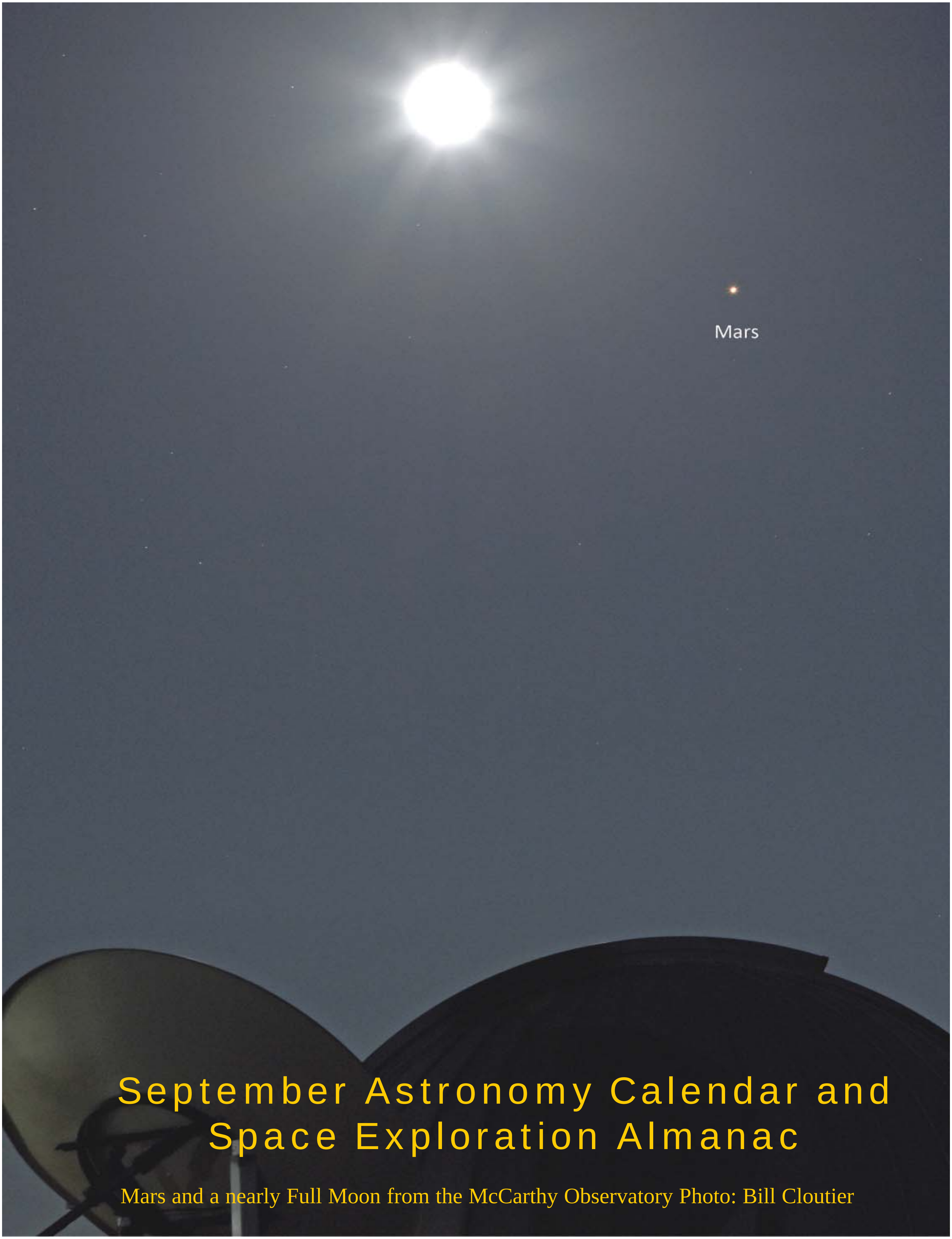
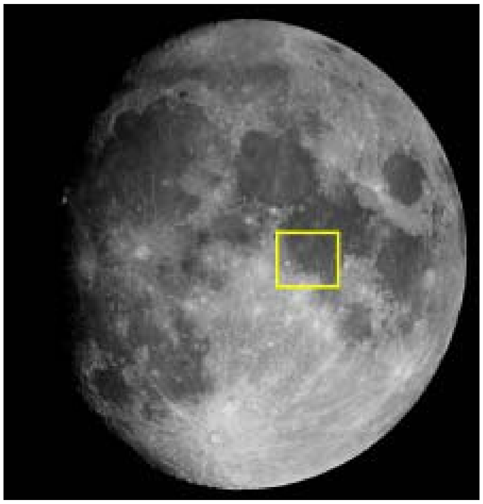


September Astronomy Calendar and Space Exploration Almanac

Mars and a nearly Full Moon from the McCarthy Observatory Photo: Bill Cloutier

"Out the Window on Your Left"

IT'S BEEN MORE than 45 years since we left the last foot print 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 "seas" are expansive, low-lying plains formed by ancient lava flows

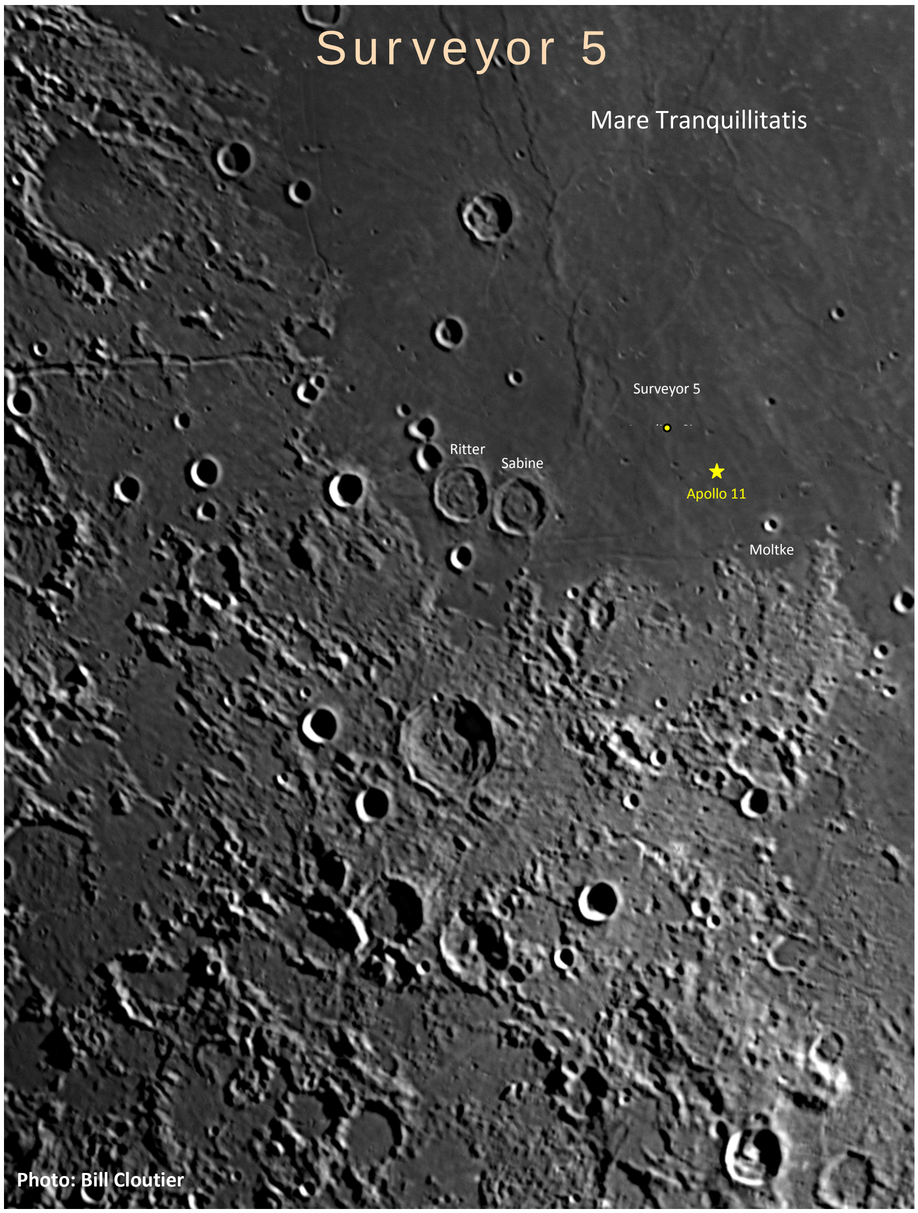
The Surveyor 5 spacecraft landed on the inside slope of a small impact crater (a rimless crater approximately 30 x 40 feet or 9 x 12 meters), on the lava plains of Mare Tranquillitatis (Sea of Tranquility) on September 11, 1967. It had been launched three days earlier from Cape Kennedy on an Atlas-Centaur rocket. The lander operated over the course of four lunar days (approximately 3 Earth months), with a final transmission on December 17th.

The Surveyor program consisted of 7 robotic spacecraft. They were designed to support the upcoming Apollo missions by validating soft-landing technologies and providing data on the surface and environmental conditions that the astronauts would encounter. Surveyor 5 was the third successful soft-landing of the series.

The basic Surveyor spacecraft assembly consisted of an aluminum-tube tripod that provided mounting surfaces for equipment, systems and instruments. Its three footpads extended 14 feet (4.3 meters) from the spacecraft's center. The spacecraft was about 10 feet (3 meters) tall, topped by a central mast. A solar array mounted on the mast provided power for the spacecraft's instruments and rechargeable batteries. At landing, the spacecraft had a mass of 670 pounds (303 kg).

Surveyor 5 landed less than 62 miles (100 km) from where Neil Armstrong and Buzz Aldrin would set down the lunar module *Eagle* two years later. It was the first Surveyor mission to return data on the regolith's chemistry and composition, finding that the surface resembled pulverized basalt on Earth. The samples returned by the Apollo 11 astronauts had similar properties and chemistry.

The robotic spacecraft returned a total of 19,118 pictures from the Moon's surface and 83 hours of data (chemical analysis of the regolith) during the first lunar day. On October 18th, the



spacecraft was also able to provide thermal data during a total eclipse of the Sun. Overall, all mission objectives were achieved.

To Touch the Sun

A Delta IV Heavy rocket lifted off from Cape Canaveral Air Force Station, Florida, in the early morning hours of August 12th, carrying with it humankind's first attempt to travel through the Sun's outer atmosphere (corona). NASA's Parker Solar Probe, named for Dr. Eugene Parker, a pioneer in heliophysics, will fly by Venus seven times over its seven year long mission, using the planet's gravity to modify the spacecraft's orbit for progressively closer solar encounters. The first Venus flyby is scheduled for October and the spacecraft within 15 million miles of the Sun's surface and through the outer corona in early November.

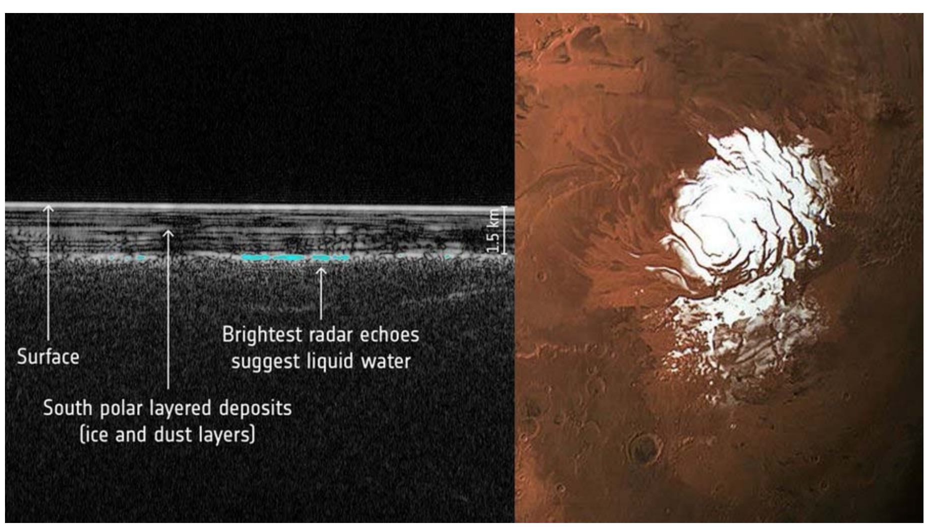
The mission includes 24 coronal transits. Future Venus flybys will send the probe as close as 3.8 million miles, at speeds reaching a record 430,000 miles per hour. Data from the probe is expected to contribute to our understanding of the Sun's atmosphere and space weather, including the supersonic solar wind that permeates the solar system, and coronal mass ejections and flares that can damage orbiting satellites, electrical transmission grids and equipment on Earth, as well as pose a danger to astronauts.

Credits: NASA/Bill Ingalls

Subglacial Lake on Mars

A paper published in the journal Science in late July presented evidence of a reservoir of liquid under the ice at Mars' south pole. The discovery is based upon data collected by the European Mars Express' radar instrument MARSIS (Mars Advanced Radar for Subsurface and Ionosphere Sounding). MARSIS detected a strong reflection about 1 mile (1.5 kilometers) below the surface of the ice cap in the Planum Australe region.

The underground reservoir extends for 12½ miles (20 km) and, if liquid, is likely a brine contain-



Radar Profile of Planum Australe (left) and the southern ice cap (right)
Credits: Mars Express MARSIS instrument and NASA/JPL/CORBY WASTE

ing a mixture of salts (for example, magnesium, calcium and sodium are present on Mars), due to the subfreezing temperatures (estimated to be at least as cold at 14° F (-10° C), but possibly as low as -76° F (-60° C)). While a challenging environment for life, single-cell organisms have been found under similar conditions in sub-glacial Antarctic lakes on Earth.

The Mars Express spacecraft conducted the survey of the southern ice cap between May 2012 and December 2015. Twenty-nine sets of radar surveys were collected that exhibit profiles similar to subglacial lakes found in the Antarctic and Greenland. If confirmed, this would be the first body of liquid water found on Mars.

Arrival

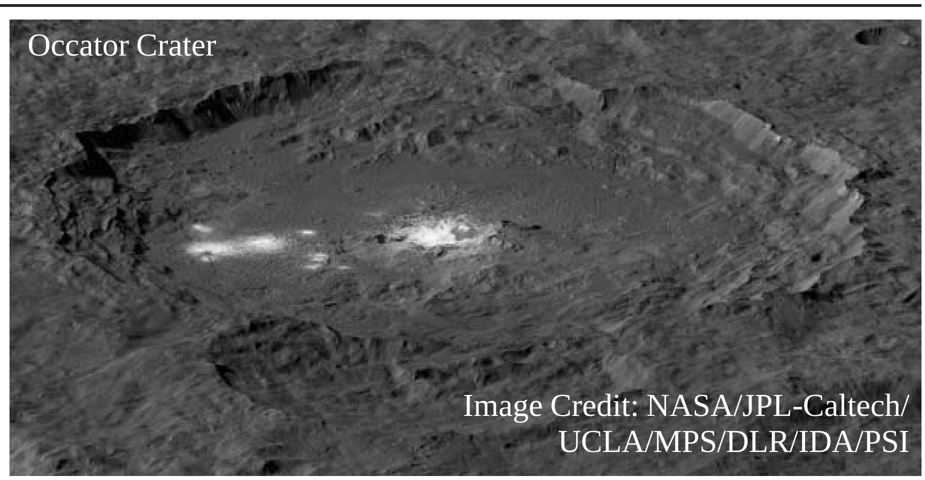
The Japanese spacecraft Hayabusa 2 arrived at its destination, the Ryugu asteroid, in late June after a journey of three and one-half years (it was launched from the Tanegashima Space Center on December 3, 2014). The robotic spacecraft will spend 18 months in orbit around the asteroid before returning to Earth in 2020. Ryugu, discovered in 1999, is about 3,000 feet (920 meters) across with a rotational period of 7.6 hours. The asteroid's orbit crosses Earth's orbit when it is closest to the Sun and extends out past the orbit of Mars at its furthest.

Hayabusa 2 is designed to collect, and return to Earth, small samples from Ryugu's surface during brief touchdowns. The spacecraft will also deploy four landers to the asteroid's surface to collect environmental data. The landers will be able to explore several different locations on this primitive body, "hopping" in the asteroid's infinitesimal gravity (about 1/100,000th of Earth's).

Credit: JAXA, University of Tokyo, Kochi University, Rikkyo University, Nagoya University, Chiba Institute of Technology, Meiji University, University of Aizu and AIST

Dawn Mission Finale

After almost 11 years, NASA's Dawn spacecraft is running out of the fuel required to maintain the spacecraft orientation and communication link with Earth as it orbits Ceres. With the mission clock winding down, NASA moved Dawn into its final orbit, only 22 miles (35 km) above the dwarf planet's icy surface. The low-altitude orbit is providing scientists with unprecedented views,

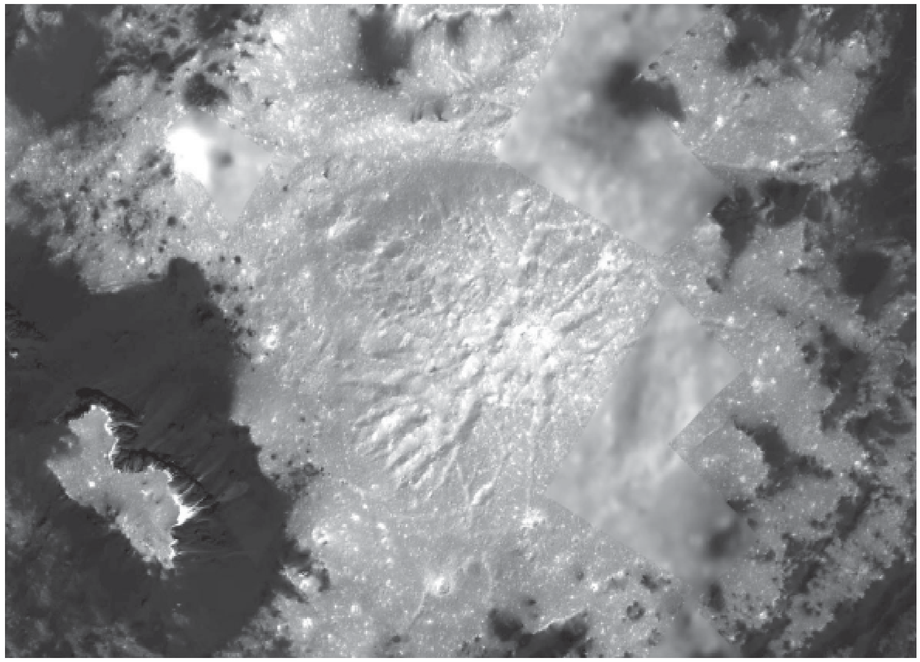


Occator Crater

Image Credit: NASA/JPL-Caltech/UCLA/MPS/DLR/IDA/PSI

including Cere’s bright spots (more than 300 have been identified).

The bright spots are primarily sodium carbonate and ammonium chloride salt deposits that have made their way to the surface from an underground reservoir. The close-up images returned by Dawn lend support to the hypothesis that the leaching of the briny material is an ongoing process and that the dwarf planet is geologically active.

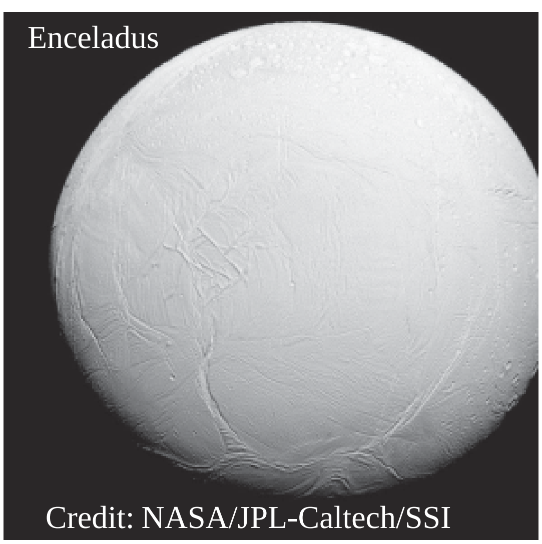


Mosaic of Cerealia Facula in Occator Crater, the brightest area on Ceres
Image Credit: NASA/JPL-Caltech/UCLA/MPS/DLR/IDA/PSI

A Cradle for Life?

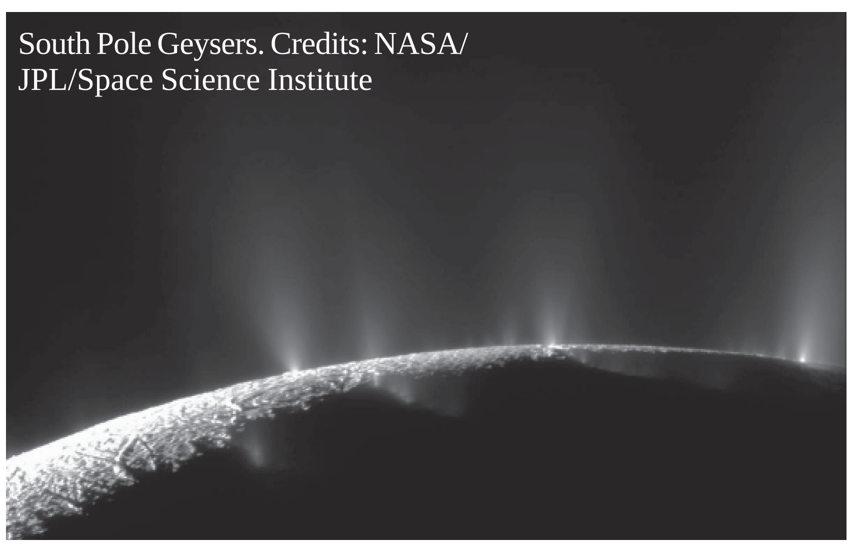
In a June issue of the journal Nature, the authors present the discovery of macromolecular (large complex) organic material in the ice grains embedded in the plumes erupting on Saturn’s moon Enceladus. Scientists had previously reported finding relatively-common, simple organic molecules in the plumes; however, with this new discovery, Enceladus’ oceans may be the ideal location to look for, and find, primitive life in the outer solar system.

The icy plumes were first detected during a close flyby of the moon by the Cassini spacecraft in 2005. Subsequent flybys, including one in October 2015 that passed within 30 miles (48 km) of the moon’s south pole and through its icy plumes (101 individual plumes have been identified), provided evidence of hydrothermal activity in the ocean. Using computer models, scientists believe that the hydrothermal vents on the ocean floor heat and mix the mineral-rich water from the porous core of the moon. Gas bubbles bring heated material from the ocean floor to the surface, where it is released through cracks in the icy shell that surrounds the moon (Saturn’s E-ring, a diffuse ring in which Enceladus orbits, is comprised of material from Enceladus’ geysers). Even with the end of the Cassini mission in September of 2017, the data collected over the 13 year mission continues to yield new discoveries.



Enceladus

Credit: NASA/JPL-Caltech/SSI



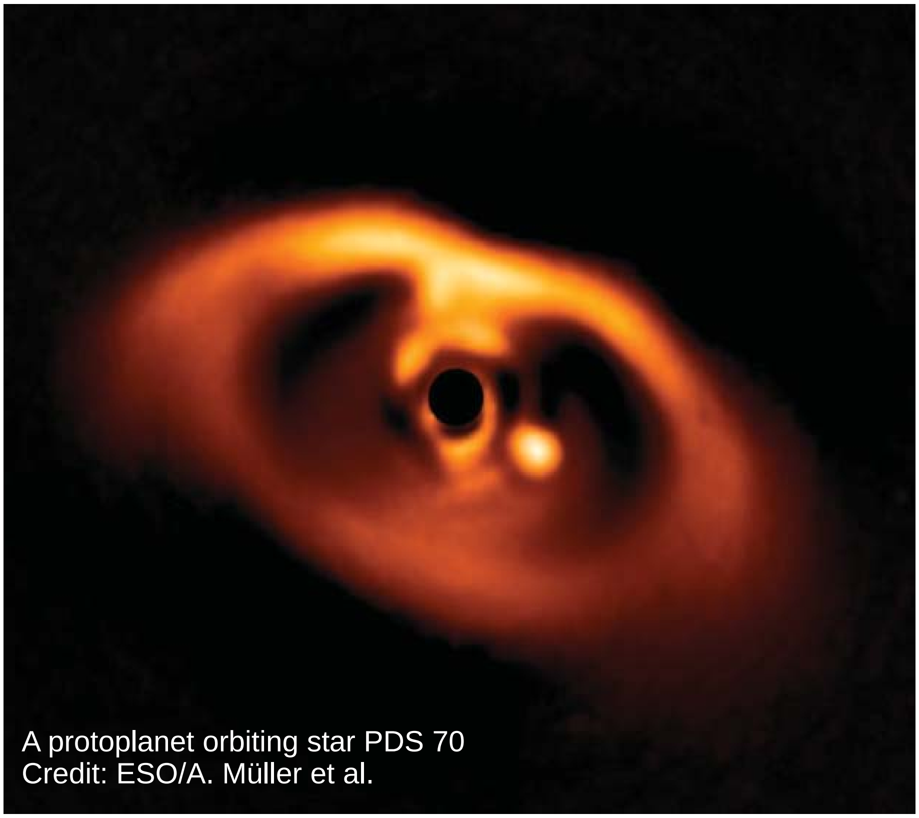
South Pole Geysers. Credits: NASA/JPL/Space Science Institute

Birth of a Planet

Astronomers have captured the formation of a new planet around the fledgling star PDS 70, 370 light years away. The planet was detected with the European Southern Observatory's (ESO) Very Large Telescope and SPHERE (Spectro-Polarimetric High-contrast Exoplanet REsearch), a planet-hunting instrument. With the light of the central star blocked (using a coronagraph to mask the light of PDS 70), the planet can be seen as a bright spot cutting through the disc of gas and dust encircling the star. (SPHERE uses a method known as high-contrast imaging and advanced data processing techniques to isolate the faint signal of the planet from the brighter surroundings.)

The planet is located approximately 1.9 billion miles (3 billion km) from its star, about the same distance that Uranus orbits our Sun. The gas giant is several times more massive than Jupiter, with a surface temperature estimated to be around 1,800° F (1,000° C). The team that discovered the newly formed planet, led by a group at the Max Planck Institute for Astronomy in Heidelberg, Germany, was also able to measure its brightness in different wavelengths and obtain a spectrum that suggests that the planet's atmosphere is cloudy.

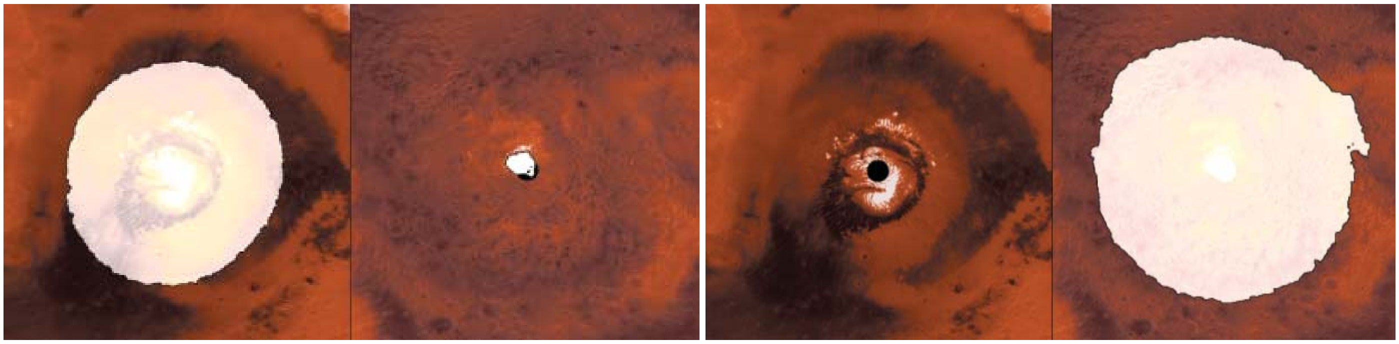
Instruments such as SPHERE, in combination with the new generation of extremely large telescopes coming on line, will greatly enhance our understanding of planetary formation.



A protoplanet orbiting star PDS 70
Credit: ESO/A. Müller et al.

Martian Ice Caps

Mars' rotational axis is tilted at 25°. The tilt, as with Earth, creates seasonal changes in the climate during the Martian year. Much like Earth, Mars' polar regions are covered in ice, but unlike Earth where the ice caps consist of water ice, the ice caps on Mars include both water ice (permanent) and carbon dioxide (CO_2) that freezes out of the atmosphere in the late autumn and early winter and sublimates back into the atmosphere in warmer weather.



The image, above, shows the northern ice cap at its greatest extent (left) during the height of the Martian winter. By comparison, the southern cap (right) has retreated to its minimum size. The image, below, shows the maximum expanse of the southern cap (right) during winter in the southern hemisphere.
Credit: NASA / JPL-Caltech

The orbit of Mars is much more eccentric than Earth's more circular orbit and, as such, its seasons vary in length. In the northern hemisphere, Spring and Summer on Mars are the longest seasons at 7 and 6 months, respectively. The shorter Fall and Winter seasons (5.3 and 4 months, respectively), are when the northern ice cap forms. It is also when Mars is nearest the Sun in its orbit (perihelion) and therefore warmer. The southern hemisphere, by comparison, has longer and colder winters. These differences not only affect the composition of the ice caps, but their overall size (the northern cap covers 53° at its maximum while the southern cap covers more than 70°).

While both poles have permanent water-ice layers and seasonal CO_2 layers, the south pole also has a permanent CO_2 deposit. Measurements from the Mars Reconnaissance Orbiter (MRO) indicate that the layer may be more than one-half mile (a kilometer) in depth. The manifestation of the deposit and questions as to its permanency remain.

New Moons by Jove

Twelve new moons have been discovered orbiting Jupiter. The moons were first spotted during a search for "Planet 9," a hypothetical planet in the outer region of the solar system (Kuiper Belt) that could explain the clustering of orbits of several trans-Neptunian objects. The twelve new moons bring the total of Jovian satellites to 79.

Two of the moons orbit in the same direction as Jupiter's rotation (prograde group). The two moons take less than a year to orbit Jupiter and are thought to be fragments of a larger body. Nine of the moons orbit in the opposition direction (retrograde group). At a greater distance from the gas giant, the nine moons take about two years to complete an orbit. This group is thought to be remnants of a possible collision.

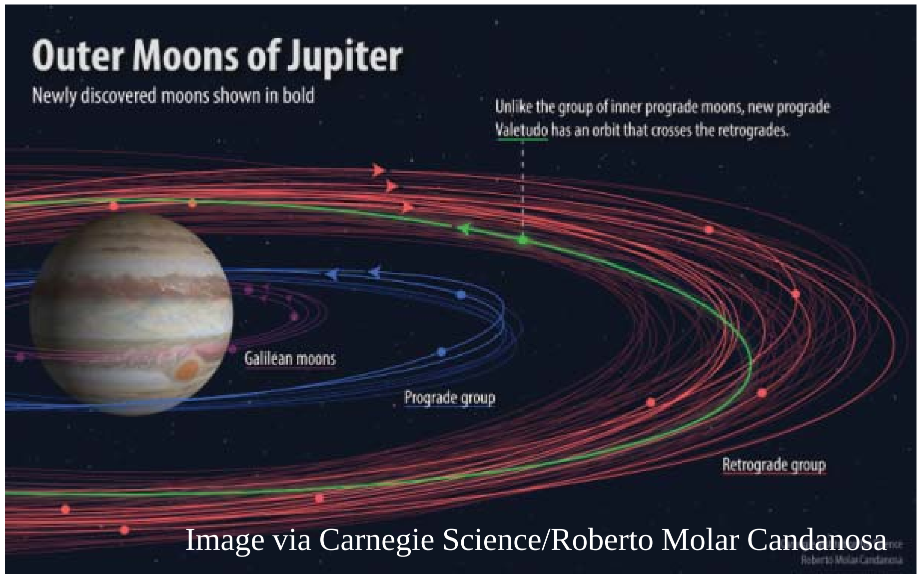
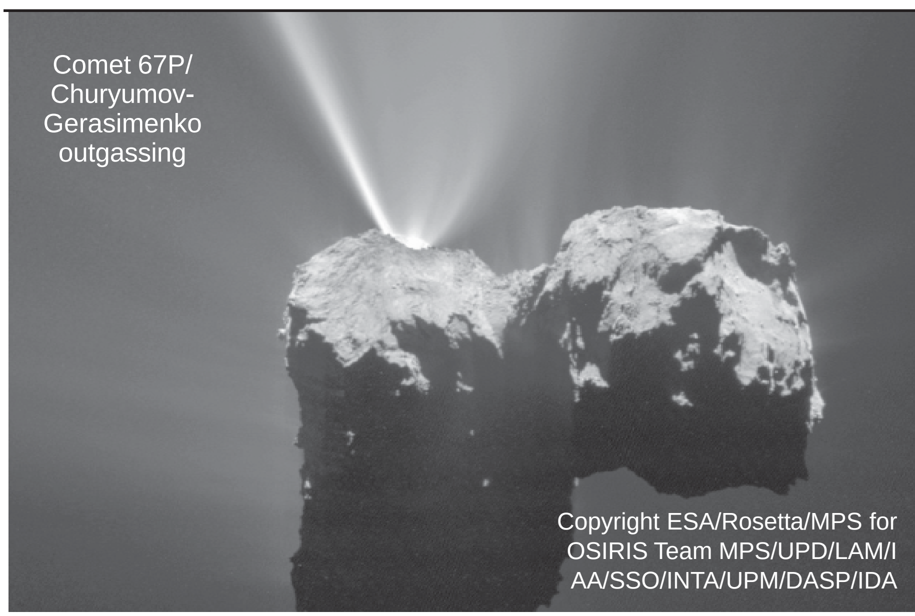


Image via Carnegie Science/Roberto Molar Candanosa

The twelfth moon is an oddity, orbiting in the same direction as the prograde group, but with a track that carries it into the retrograde group. It is the smallest of Jupiter moons, less than one-half mile (one km) across and takes about one and one-half years to complete an orbit. However, based upon its orbit, it's only a matter of time before the moon, unofficially called "Valetudo,"comes in contact with one of the members of the retrograde group.


Comet 67P/ Churyumov-Gerasimenko outgassing

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Rosetta Mission Image Archive

The European Space Agency's (ESA) mission to comet 67P/Churyumov-Gerasimenko concluded two years ago with a controlled impact of the spacecraft Rosetta upon the icy surface. Rosetta was the first spacecraft to orbit a comet (for 23 months), monitoring the comet during its closest approach to the Sun (inside the orbit of Mars) and on its way back out towards the orbit of Jupiter. In November 2004, it dispatched a lander (Philae) to the comet's surface.

The public can now relive the mission through the images returned by the spacecraft. ESA has made available over 100,000 high-resolution images from its OSIRIS camera. The images can be found in the Archive Image Browser *(https:/imagearchives.esac.esa.int/)*.

Titan Revealed

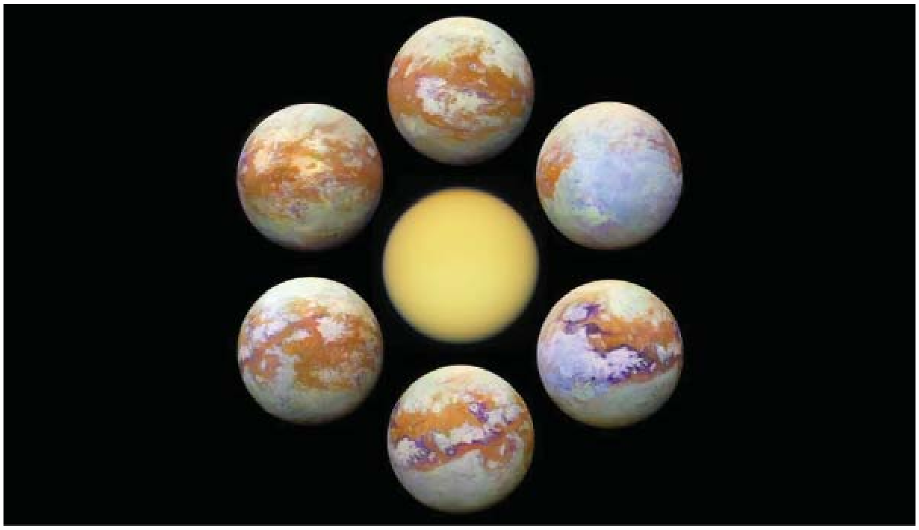
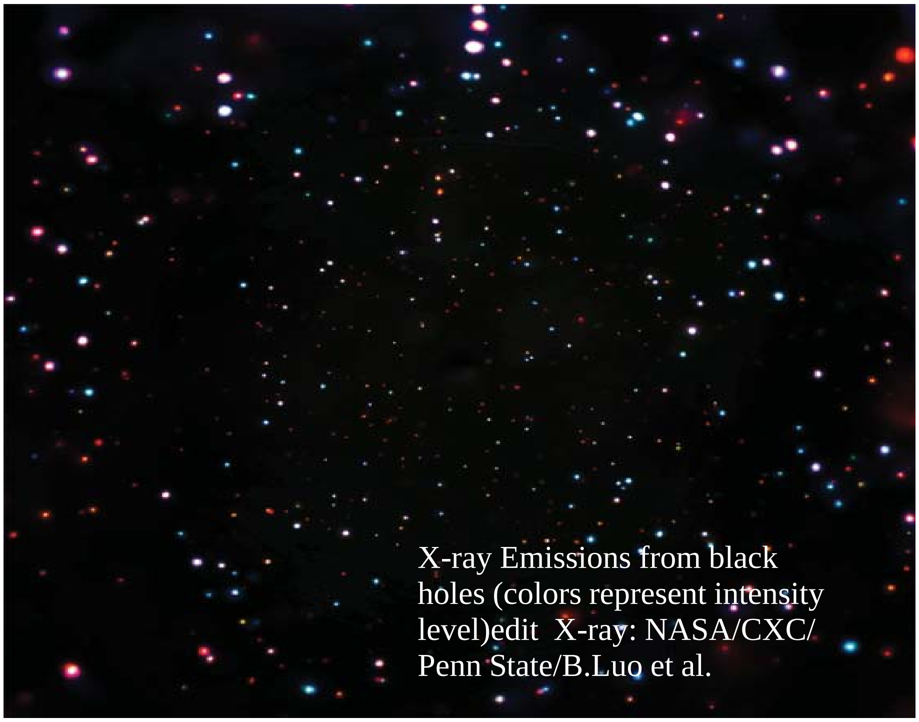


Image credit: NASA/JPL-Caltech/Stéphane Le Mouélic, University of Nantes, Virginia Pasek, University of Arizona

The Cassini-Huygens mission team has released new infrared images of Saturn's largest moon, Titan. The images were created from 13 years of data collected by Cassini's Visual and Infrared Mapping Spectrometer (VIMS), and a considerable effort by the team to normalize the images from many different flybys, viewing and lighting conditions, and image resolution.

Titan is Saturn's largest moon and the second largest in the solar system (Jupiter's moon Ganymede is just 2% larger), with a diameter of 3,200 miles (5,150 km). It was discovered on March 25, 1655 by Christiaan Huygens, a Dutch astronomer. At 759,000 miles (1.2 million km) from Saturn, it takes nearly 16 Earth-days to complete one orbit. Like Earth's moon, Titan is tidally locked, with one side permanently facing Saturn. Titan is also a dynamic world, with seasonal changes, transient dune fields, flowing rivers and lakes, however, at a surface temperature of -290° F (-179° C), ice is as hard as rock and the lakes and rivers are filled with liquid methane and ethane, instead of water.

The images (above) show the surface of the moon without the hindrance of the smoggy atmosphere. In visible light (center image), the surface is completely shrouded by aerosols in the upper atmosphere. The VIMS instrument was able to image the surface in the infrared wavelength, where there is much less scattering of light by the aerosols. A map of Titan with labeled features is available at *https://photojournal.jpl.nasa.gov/catalog/PIA20713*.

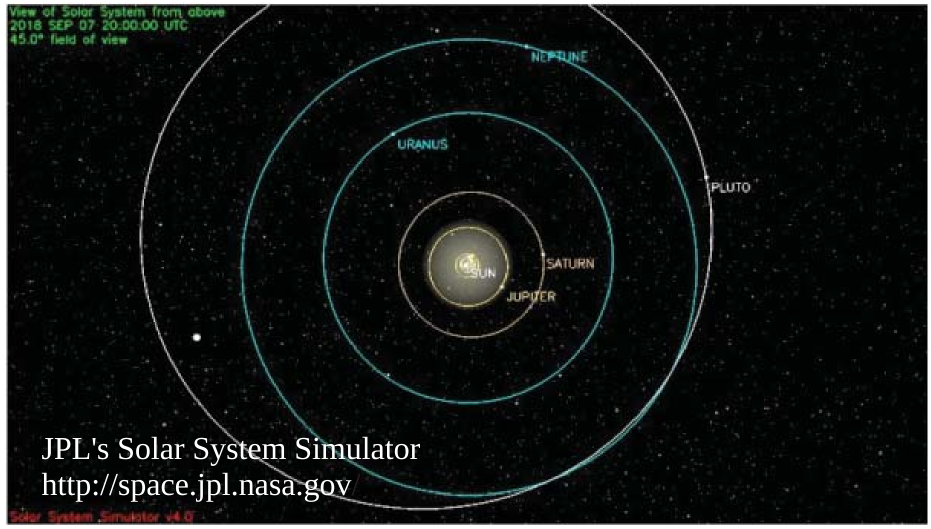


X-ray Emissions from black holes (colors represent intensity level)edit X-ray: NASA/CXC/Penn State/B.Luo et al.

An Abundance of Black Holes

The Hubble Space Telescope has provided unparalleled views of the universe with its long exposure images of celestial objects visible in ultraviolet to near-infrared light. NASA's Chandra X-ray Observatory has now provided astronomers a similar view in the higher energy X-ray portion of the electromagnetic spectrum. The colors in the image (below) represent different levels of X-ray energy: lowest energy - red, medium - green, and highest energy - blue.

Chandra imaged an area of the sky equivalent to two-thirds the size of a full Moon for almost two thousand hours. The concentration of black holes found during the observing campaign, over that relatively small area of the sky, translates into a billion black holes over the entire sky. The data provides a history of black hole formation and growth over billions of years and suggests growth spurts rather than a gradually accumulation of mass. It may also provide a boundary on the minimum mass (seed mass) for the development of supermassive black holes.



Neptune at Opposition

The Earth will come between Neptune and the Sun on September 7th (EDT), i.e., “Opposition.” On that day, Neptune will rise as the Sun sets and will be visible throughout the night (highest in the sky after midnight). At magnitude 7.7, a telescope will be required to see the planet’s disk.

Neptune is the outermost planet in the solar system (since the demotion of Pluto), orbiting the Sun at an average distance of 2.8 billion miles (4.5 billion km). The ice giant was discovered in 1846, and, with an orbital period of 165 years, has only recently completed one orbit of the Sun since its discovery. Primarily gaseous hydrogen and helium, Neptune is 17 times more massive than Earth. Its bluish hue comes from trace amounts of hydrocarbons (e.g., methane) in the atmosphere. Neptune rotates around its axis once every 16 hours and while furthest from the Sun (and its energy), the planet’s winds are the most powerful in the solar system, exceeding 1,000 mph in the upper altitudes.

Neptune has 14 moons, the last one being discovered by Mark Showalter of the SETI Institute in 2013, after noticing a small object orbiting between two of Neptune’s other moons in images captured by NASA’s Hubble Space Telescope. The moon, designated S/2004 N1, is no more than 12 miles across. By comparison, Neptune’s largest moon, Triton, has a diameter of 1,680 miles (2,700 km). Triton is the only large moon in the solar system that orbits in a direction opposite that of its host planet’s rotation, suggesting that that the moon was captured and did not form nearby. Triton’s crust of frozen nitrogen is believed to cover a core of rock. It is also one of the few moons found to be geologically active, with icy geysers.

Voyager 2, during its 1989 flyby, imaged a large dark spot or vortex in Neptune’s southern hemisphere. While that spot has since disappeared, new one(s) emerged in images captured by the Hubble Space Telescope in 2016. The spot(s) are high pressure systems and are typically accompanied by bright clouds. Unlike Jupiter’s Red Spot, the dark storms on Neptune last only a few years before dissipating.

Martian Weather and Rover Update

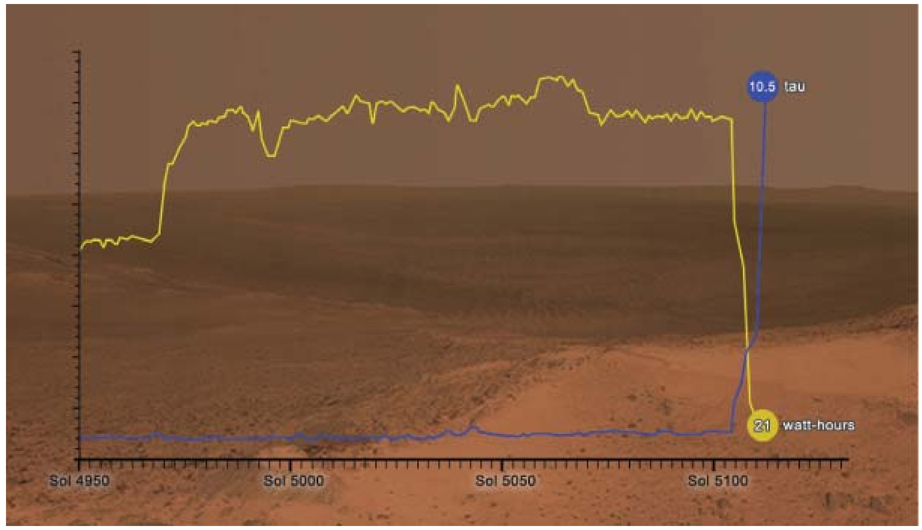
The Mars Reconnaissance Orbiter’s (MRO) Mars Color Imager (MARCI) acquires almost 300 images each week, using three different color filters. The images are used to monitor changes in the Martian weather. As the planet moves closer to the Sun in its highly elliptical orbit, the additional heating of the surface can spawn dust storms (around perihelion, sunlight can be 20% more intense than average). Dust storms can grow exponentially over a matter of days, with global dust storms occurring every three Martian years, on average.

During the week of May 28th, MARCI recorded two large regional dust storms in the northern hemisphere. By mid-week, a new dust storm had formed over the Acidalia Planitia region and was propagating eastward. By week end, the storm covered an area equivalent to North America and was affecting surface operations of the Mars Exploration Rover, Opportunity, at Endeavor crater.

Conditions at Endeavour crater quickly deteriorated as midday became dark as night. Tau values (a measurement of the clarity of the sky) exceeded 10 (the highest recorded value during the 2007 storm was around 5.5). Since Opportunity is solar powered, all surface operations were suspended to conserve power reserves. By June 10th, the output of the rover's solar arrays had dropped to 22 watt hours (from a high of 645 watt hours prior to the storm) and all communications from the rover ceased.

At a power level this low, only the rover's mission clock was running, with the rover in a programmed sleep mode. Below 22 watt hours, a mission clock fault would occur and the rover would have to periodically check the output from the solar arrays to determine if the Sun was in the sky (once conditions improve). If the mission clock is lost, the rover can't call home at a predetermined time. As a precaution, NASA has requested emergency assistance from the Deep Space Network, so when conditions improve and power levels allow communications, NASA is able to respond when Opportunity calls.

Unlike Spirit (Opportunity's twin) that entered a low power fault condition in the winter and was unable to recover, it's spring in the southern hemisphere. The atmosphere dust also provides some insulation against temperatures dropping too low. As such, the mission team does not expect temperatures at the Endeavour site to drop below the design limits for the rover. The rover´s essential systems are contained within a Warm Electronics Box (WEB), which is designed to operate within a temperature range of -40º F to +104º F (-40º C to +40º C). At night, when outside temperatures can drop to -140º F (-96º C), eight radioisotope heater units provide a total of 8 watts to warm the WEB through the decay of a plutonium isotope.



Energy production of Opportunity's solar arrays (in watt-hours) compared to tau value from December 26, 2017 through June 10, 2018 when Opportunity was engulfed in a dust storm
Credit: NASA/JPL-Caltech/New Mexico Museum of Natural History

The last data transmission before Opportunity went into hibernation reported a WEB temperature of -20° (-29° C). The storm has continued to grow and on June 19th, almost three weeks after it was first detected, the storm was officially classified as a "global event," as it circled the planet. The storm itself is not as large as the one Opportunity encountered in 2007. It is also more dispersed and asymmetrical than previous global storms that completely obscured the globe.

Mars in May (left) with a few regional storms and July (right) with the global dust storm. Image credit: NASA/JPL-Caltech/MSSS

During the week of August 13th, weather reports from MARCI show a continued decay of the dust storm, with surface features in many areas beginning to re-appear. However, dust levels at both the Opportunity and Curiosity sites remain elevated. Opportunity's science team continues to listen for signals from the rover and send up commands, should the rover awaken from hibernation. If they do hear back from the rover, recovery to full operations (if possible) is expected to take some time, depending, in part, on the condition of the rover's batteries after the deep discharge and long period of inactivity.

The Carrington Event

One hundred and fifty nine years ago, on the morning of September 1st, Richard Carrington was at his observatory in Surrey, England, sketching sunspots from an image projected by his telescope. At 11:18 am, two bright flares emerged from a group of sunspots. After realizing that the blinding points of light were coming from the Sun and not stray light or reflections entering the observatory, he hastened to find another witness to what he had observed. Unfortunately, the flares faded quickly and all but disappeared within five minutes. While he remained at his telescope for several hours, the sunspots did not display any additional activity.

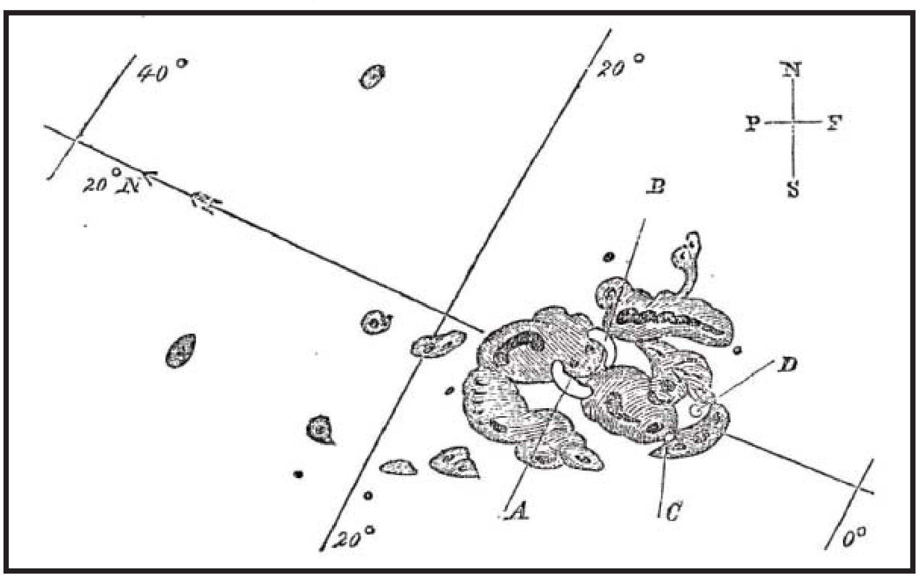
The following morning, the sky as far south as Hawaii and the Caribbean erupted in filaments of color as aurora bright enough to easily read a newspaper were visible. Sailors reported compass needles swinging wildly, making it impossible to navigate, and power surges in telegraph wires damaged equipment, sending sparks that set nearby paper on fire.

Carrington subsequently traveled to the observatory at Kew Gardens in London, looking for confirmation to what he had witnessed. While the observatory didn't have any images of the Sun on September 1st, it did have records from its magnetometer (an instrument measuring changes in the Earth's magnetic field).

The Kew Gardens magnetometer showed a significant magnetic disturbance approximately 17 hours after Carrington had seen the flares. Today, we know that Carrington had seen a white-light (visible in only the most intense solar eruptions) and that the magnetic disturbance was the result of a Coronal Mass Ejection (cloud of solar plasma) that had traveled the distance between the Earth and Sun (approximately 93 million miles or 150 million km) in less than 24 hours. In the 1800's, when sunspots were thought by some to be localized phenomena in the Sun's atmosphere, the concept that activity on the Sun could affect the Earth was ground-breaking.

In November of 2003, the most powerful flare in the "space age" was recorded (twice as powerful, by some measurements, as the most powerful, previously recorded flares), saturating the detector of the satellite monitoring the Sun. Eruptions on the Sun have been linked to communication disruptions on Earth, widespread damage to the electrical grid and transmission equipment, and power blackouts. Flares have also been responsible for damaging the sensitive electronics in orbiting satellites and sending astronauts scampering into shelters on the International Space Station.

It is believed that the Carrington event was even more powerful than what has been observed to date. Instead of a sparse network of land lines and telegraphs of the 1800's, today's global economy is satellite-based, with fleets of spacecraft providing instantaneous communications, global positioning (in air, on sea and land), with national security applications, weather forecasting, as well as supporting multi-national transactions and business operations. The Federal Emergency Management Agency has identified extreme space weather as one of its greatest challenges as severe damage to the U.S. electrical grid could take years to fully recover and leave a large portion of the population without life-saving power and essential services.



Sunspots sketched by Richard Carrington on Sept. 1, 1859
Copyright: Royal Astronomical Society

Mars

On July 27th (EDT), Earth and Mars were at their closest (approximately 35.9 million miles (57.8

Photo:Bill Cloutier

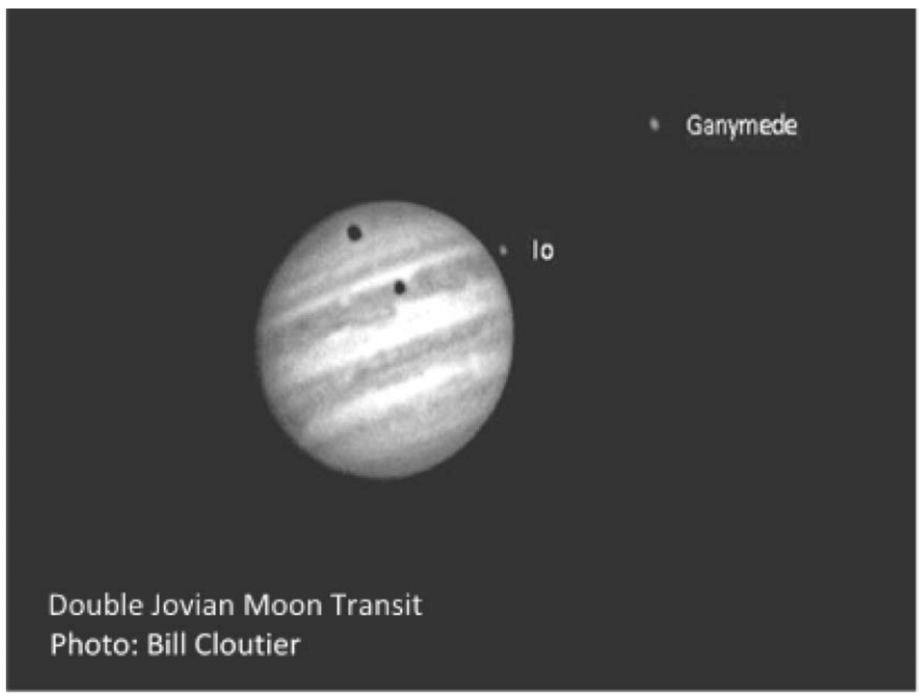
km) apart). Although dimmer than it was in July (as the distance between the two planets increase), Mars will be highest in the southern sky around 10:18 pm EDT on the September 1st, and setting well after midnight. The Red Planet will rise and set earlier each successive evening and is currently located in the constellation Capricornus.

Observing Mars this year has been challenging, appearing low in the sky for viewers in the northern hemisphere and its features obscured by a global dust storm that developed in early June. However, with oppositions occurring approximately every 26 months, observers will have to wait until 2020, if conditions don't improve shortly, for another opportunity to scrutinize this enigmatic world.

For telescopic observers attempting to view the planet's surface features as the dust storm subsides, Martian weather reports can be found on the Malin Space Science Systems website (http://www.msss.com/). Mars rotates once every 24 hours and 37 minutes, so the view will change little if you observe at the same time each night. To see the entire planet, you will need to observe at different times of the night or over a relatively long period of time (a month or more). On nights of good seeing (steady atmospheric conditions), the bright polar ice caps should be visible. The south pole of the planet is currently tipped towards Earth.

Jupiter

Jupiter reached Opposition in early May when the two planets were at their closest. Since that time, the distance between the Earth and Jupiter has been steadily increasing (the Earth has a higher orbital speed being closer to the Sun). In September, Jupiter is still visible in the western sky after sunset, but closer to the horizon each night. The gas giant sets around 10:13 pm EDT on the September 1st and almost 2 hours earlier by month's end. It may be your last chance (for this year) to catch a glimpse of this storm-shrouded world and its planet-sized moons. Jupiter can be found in the constellation Libra.



Double Jovian Moon Transit
Photo: Bill Cloutier

Saturn

The Earth and Saturn were closest on June 27th when only 841.1 million miles (1.35 billion km) separated the two worlds. As with Jupiter, the Earth's higher orbital velocity has been carrying it away from Saturn. The ringed-world is still well placed in evening sky, highest in the sky an hour after sunset on September 1st (8:20 pm EDT) and almost two hours earlier by month's end. Saturn can be found deep in the core of the Milky Way in the constellation Sagittarius.

Saturn's axial tilt is almost 27° (as compared to Earth's 23.5° or Jupiter's 3°). The axial tilt produces seasons which last more than 7 years, since it takes Saturn

Photo: Bill Cloutier

almost 29½ years to complete an orbit around the Sun. It was summer in the southern hemisphere when the Cassini spacecraft arrived in 2004, with the planet's north pole in perpetual darkness. Saturn's vernal equinox occurred in August 2009 with both hemispheres experiencing equal amounts of sunlight (at equinox, the rings appear almost edge on). Since that time, our view of the rings has improved. The northern summer solstice occurred in May 2017, the rings are now wide open with the planet's north pole sunlit and tipped towards Earth. This year the ring tilt is one of the best at 26° (slightly less than in 2017).

Autumnal Equinox

The Sun crosses the celestial equator at 9:54 pm (EDT) on the evening of September 22nd, marking the beginning of the fall season in the northern hemisphere.

Aurora and the Equinoxes:

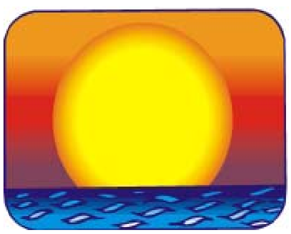
Geomagnetic storms that are responsible for auroras happen more often during the months around the equinox (March and September). Check your evening sky or log onto *www.spaceweather.com* for the latest on solar activity.

September Nights

Enjoy the jewels of the summer Milky Way while the nights are still warm and the skies are clear. From Cygnus to Sagittarius, follow the star clouds and dust lanes that comprise the inner arms of our spiral galaxy. In the south after sunset, the stars in the constellation Sagittarius form an asterism, or pattern, of a teapot. The spout of the teapot points the way to the center of the Milky Way galaxy with its resident black hole. Check out the July/August calendar for more details.

Present and Future Pole Stars

Vega, the fifth brightest star and located in the constellation Lyra, is placed high in the evening sky during September. Vega is also destined to become the Pole Star in 12,000 years. Precession, or the change in the direction of the rotational axis of the Earth over time, is best exemplified in a comparison of the position of Vega to that of Polaris (the current Pole Star).



Sunrise and Sunset (from New Milford, CT)

Sun	Sunrise	Sunset
September 1st (EDT)	06:20	19:27
September 15th	06:34	19:03
September 31st	06:49	18:37

Astronomical and Historical Events

1st Comet 2P/Encke at Opposition (3.055 AU)
1st Apollo Asteroid 2017 RL16 near-Earth flyby (0.096 AU)
1st Atira Asteroid 2015 DR215 closest approach to Earth (0.650 AU)
1st Apollo Asteroid 2201 Oljato closest approach to Earth (1.468 AU)
1st Centaur Object 7066 Nessus at Opposition (27.311 AU)
1st Kuiper Belt Object 2003 QX113 at Opposition (59.148 AU)
1st History: flyby of Saturn by the Pioneer 11 spacecraft (1979)
2nd Last Quarter Moon
2nd Plutino 175113 (2004 PF115) at Opposition (40.571 AU)
2nd Apollo Asteroid 2001 RQ17 near-Earth flyby (0.049 AU)
2nd Apollo Asteroid 2011 CX46 near-Earth flyby (0.061 AU)
2nd History: discovery of asteroid 3 Juno by Karl Harding (1804)
3rd Apollo Asteroid 2015 FP118 near-Earth flyby (0.031 AU)
3rd Apollo Asteroid 2017 DQ35 near-Earth flyby (0.100 AU)
3rd Kuiper Belt Object 120178 (2003 OP32) at Opposition (41.368 AU)
3rd History: controlled impact of the SMART-1 spacecraft on the lunar surface at the conclusion of a successful mission; precursor of NASA's LCROSS mission (2006)
3rd History: Viking 2 spacecraft lands on the Martian surface (1976)

Astronomical and Historical Events (continued)

3rd History: Apollo 12 third stage rediscovered (J002E3), by amateur astronomer Bill Yeung, after temporarily transferring from a heliocentric orbit to an Earth orbit (2003)
4th History: Dawn spacecraft leaves Vesta orbit for two and one-half year journey to Ceres (2012)
5th Asteroid Aten Asteroid 2100 Ra-Shalom closest approach to Earth (0.895 AU)
5th Apollo Asteroid 7092 Cadmus closest approach to Earth (3.291 AU)
5th History: flyby of Asteroid 2867 Steins from a distance of 500 miles (800 km) by the Rosetta spacecraft (2008)
5th History: launch of Voyager 1 to the planets Jupiter and Saturn (1977); at 13.3 billion miles (21.3 billion km) from Earth, Voyager 1 has entered the interstellar space
7th Moon at perigee (closest distance to Earth)
7th Neptune at Opposition
7th Amor Asteroid 2007 RZ8 near-Earth flyby (0.096 AU)
7th Aten Asteroid 5381 Sekmet closest approach to Earth (0.993 AU)
7th Apollo Asteroid 5731 Zeus closest approach to Earth (2.436 AU)
7th Kuiper Belt Object 145452 (2005 RN43) at Opposition (39.617 AU)
7th Connecticut Star Party, Ashford, CT, http://www.asnh.org/ (through 9th)
8th Second Saturday Stars - Open House at the McCarthy Observatory
8th Kuiper Belt Object 2010 RF43 at Opposition (52.738 AU)
8th History: launch of OSIRIS-REx (asteroid sample return mission) to the near-Earth asteroid Bennu for arrival in 2018 (2016)
8th History: sample return canister from the Genesis spacecraft crashes back to Earth when drogue parachute fails to deploy. Spacecraft was returning to Earth from Lagrange Point 1 with its collection of solar wind particles (2004)
8th History: launch of the Surveyor 5 spacecraft (lunar science mission); landed on Mare Tranquillitatis three days later (1967)
8th History: first Star Trek episode airs on television (1966)
8th History: discovery of Comet Ikeya-Seki by Kaoru Ikeya and Tsutomu Seki (1965)
8th History: Marshall Space Flight Center's dedication by President Eisenhower (1960)
9th New Moon
9th Apollo Asteroid 2102 Tantalus closest approach to Earth (1.620 AU)
9th History: launch of Conestoga I, first private rocket (1982)
9th History: launch of Soviet spacecraft Venera 11 (Venus lander) to the planet Venus (1978)
9th History: discovery of Jupiter's moon Amalthea by Edward Barnard (1892)
10th Scheduled launch of a Japanese H-2 Transfer Vehicle from the Tanegashima Space Center in Japan, carrying equipment and supplies to the International Space Station
10th History: launch of the GRAIL spacecraft aboard a Delta 2 rocket from the Canaveral Air Force Station; lunar gravity mapping mission (2011)
10th History: debut flight of the Japanese H-2 Transfer Vehicle (or HTV) to the International Space Station (2009)
11th Apollo Asteroid 2008 KZ5 near-Earth flyby (0.075 AU)
11th Apollo Asteroid 504800 (2010 CO1) near-Earth flyby (0.081 AU)
11th History: Mars Global Surveyor enters orbit around Mars (1997)
11th History: flyby of Comet Giacobini-Zinner by the International Cometary Explorer (ICE), first spacecraft to visit a comet (1985)
12th History: astronaut Mae Jemison becomes the first African American woman in space as a member of the space shuttle Endeavour crew (STS-47) (1992)
12th History: launch of Soviet Luna 16; first robotic probe to land on the Moon and return a coring sample (101 grams) of lunar regolith to Earth (1970)
12th History: launch of Gemini XI with astronauts Charles Conrad and Richard Gordon (1966)
12th History: launch of the Soviet spacecraft Luna 2, first to impact the Moon's surface (1959)

Astronomical and Historical Events (continued)

13th Apollo Asteroid 2017 SK21 near-Earth flyby (0.094 AU)
13th History: launch of the Japanese Moon orbiter "Kaguya" (Selene 1) (2007)
14th History: launch of Soviet spacecraft Venera 12 (Venus lander) to the planet Venus (1978)
14th History: discovery of Jupiter's moon Leda by Charles Kowal (1974)
14th History: launch of the Zond 5 spacecraft from the Baikonur Cosmodrome - first successful Soviet circumlunar Earth-return mission (1968)
14th History: John Dobson born, architect of the Dobsonian alt-azimuth mounted Newtonian telescope (1915)
15th Scheduled launch of NASA's ICESat 2 from the Vandenberg Air Force Base in California to observe ice-sheet elevation change and sea-ice
16th First Quarter Moon
16th Apollo Asteroid 144332 (2004 DV24) near-Earth flyby (0.056 AU)
16th Apollo Asteroid 2018 FO3 near-Earth flyby (0.067 AU)
16th Atira Asteroid 2013 JX28 closest approach to Earth (0.712 AU)
16th Amor Asteroid 3552 Don Quixote closest approach to Earth (1.391 AU)
16th History: discovery of Saturn's moon Hyperion by William and George Bond and William Lassell (1848)170th Anniversary (1848)
17th History: Konstantin Tsiolkovsky born in Izhevskoye, Russia; one of the fathers of rocketry and cosmonautics, along with Goddard and Oberth (1857)
17th History: discovery of Saturn's moon Mimas by William Herschel (1789)
18th History: launch of Vanguard 3, designed to measure solar X-rays, the Earth's magnetic field, and micrometeoroids (1959)
19th Moon at apogee (furthest distance from the Earth)
19th Atira Asteroid 164294 (2004 XZ130) closest approach to Earth (1.334 AU)
19th History: NASA unveiled plans to return humans to the moon (2005)
19th History: first launch of the Wernher von Braun-designed Jupiter C rocket from Cape Canaveral (1956)
20th Apollo Asteroid 2017 SL16 near-Earth flyby (0.022 AU)
20th Apollo Asteroid 2012 TT5 near-Earth flyby (0.092 AU)
21st History: MAVEN (Mars Atmosphere and Volatile Evolution) spacecraft enters orbit around Mars (2014)
21st History: second flyby of Mercury by the Mariner 10 spacecraft (1974)
21st History: Gustav Holst born, composer of the symphony "The Planets" (1874)
21st History: Soviet spacecraft Zond 5 returns after circumnavigating the Moon (1968)
21st History: Galileo spacecraft impacts Jupiter after completing its mission (2003)
22nd Autumnal Equinox at 9:54 pm (EDT)
22nd History: Deep Space 1 spacecraft passes within 1,400 miles (2,200 km) of the 5 mile long potato-shaped nucleus of Comet Borrelly (2001)
23rd Apollo Asteroid 719 Albert closest approach to Earth (0.517 AU)
23rd History: Johann Galle discovers the planet Neptune (1846)
24th Full Moon (Full Harvest Moon)
24th Apollo Asteroid 2015 EP7 near-Earth flyby (0.053 AU)
24th Apollo Asteroid 1981 Midas closest approach to Earth (1.240 AU)
24th Kuiper Belt Object 2010 RE64 at Opposition (50.896 AU)
24th History: India's MOM (Mars Orbiter Mission) spacecraft enters orbit around Mars (2014)
24th History: John Young born (1930), first person to fly in space six times, including Gemini 3 (1965), Gemini 10 (1966), Apollo 10 (1969), Apollo 16 (1972), STS-1, the first flight of the Space Shuttle (1981), and STS-9 (1983)
25th Apollo Asteroid 2007 TV18 near-Earth flyby (0.052 AU)
26th Apollo Asteroid 1865 Cerberus closest approach to Earth (0.611 AU)
26th Amor Asteroid 2013 US8 near-Earth flyby (0.094 AU)
26th Kuiper Belt Object 120347 Salacia at Opposition (43.898 AU)

Astronomical and Historical Events (continued)

26th History: Cosmonauts V. Titov and Strekalov escape moments before Soyuz T-10-1 explodes on the pad (1983)
27th Atira Asteroid 434326 (2004 JG6) closest approach to Earth (0.699 AU)
27th History: Zhai Zhigang becomes first Chinese taikonaut to spacewalk during Shenzhou 7 mission (2008)
27th History: launch (2007) of the Dawn spacecraft to Vesta (2011) and Ceres (2015)
27th History: launch of SMART-1, the first European lunar probe (2003)
28th History: launch of Soviet lunar orbiter Luna 19; studied lunar gravitational fields and mascons (mass concentrations), radiation environment, and the solar wind (1971)
28th History: launch of Alouette, Canada's first satellite (1962)
28th History: discovery of Jupiter's moon Ananke by Seth Nicholson (1951)
29th Aten Asteroid 2015 SO2 near-Earth flyby (0.099 AU)
29th History: launch of Salyut 6, first of a second generation of Soviet orbital space station designs (1977)
30th Kuiper Belt Object 308933 (2006 SQ372) at Opposition (27.468 AU)
30th Plutino 469372 (2001 QF298) at Opposition (42.486 AU)
30th History: controlled descent of the Rosetta spacecraft to the surface of Comet 67P/Churyumov-Gerasimenko (mission complete) (2016)
30th History: all instruments deployed on the Moon by the Apollo missions are shut off (1977)
30th History: discovery of Jupiter's moon Themisto by Charles Kowal (1975)

Commonly Used Terms

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

References on Distances

• The apparent width of the Moon (and Sun) is approximately one-half a degree (½°), less than the width of your little finger at arm's length which covers approximately one degree (1°); three fingers span approximately five degrees (5°)
• One astronomical unit (AU) is the distance from the Sun to the Earth or approximately 93 million miles

International Space Station/Iridium Satellites

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

Solar Activity

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

Lagrange Points

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

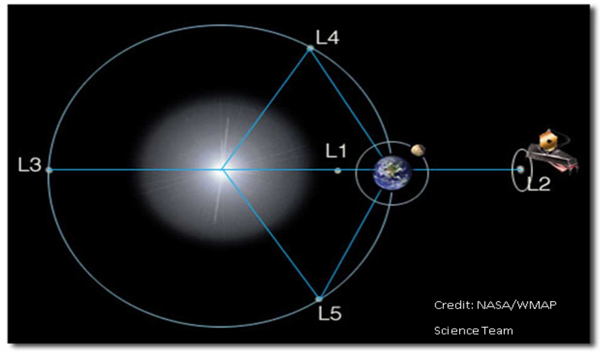


Image Credits

Front page design and graphic calendar: Allan Ostergren

Second Saturday Stars poster: Marc Polansky

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

Cover Page

The nation of Madagascar, off Africa's east coast, has earned the nickname "Great Red Island" for the rusty hue from laterite leaching from the clayey iron and aluminum oxides of its mineral-rich central highlands. But what had once been a slow geological process has become a festering wound due to clearcutting, overdevelopment and habitat destruction. Torrential rains from tropical storms and cyclones sweep through the landscape, carrying rivers of red sediment down the Betsikoba estuary to the ocean.

Madagascar's isolation from the African continent made it a haven for numerous species that exist nowhere else, but are now facing extinction from human development. You can find more information on these unique species at Fauna and Flora International (*https://www.fauna-flora.org/*).

The image on page 1 was taken by NASA astronaut Ricky Arnold from the International Space Station. Source: NASA: *https://www.nasa.gov/image-feature/the-heart-of-madagascar; https://earthobservatory.nasa.gov/images/4388/betsiboka-estuary-madagascar*.

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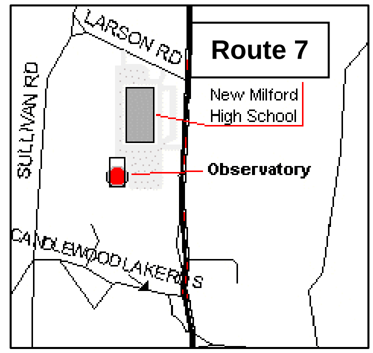
www.mccarthyobservatory.org



www.mccarthyobservatory.org

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Second Saturday Stars

FREE EVENT

Every Month at the

John J. McCarthy Observatory

Behind the New Milford High School

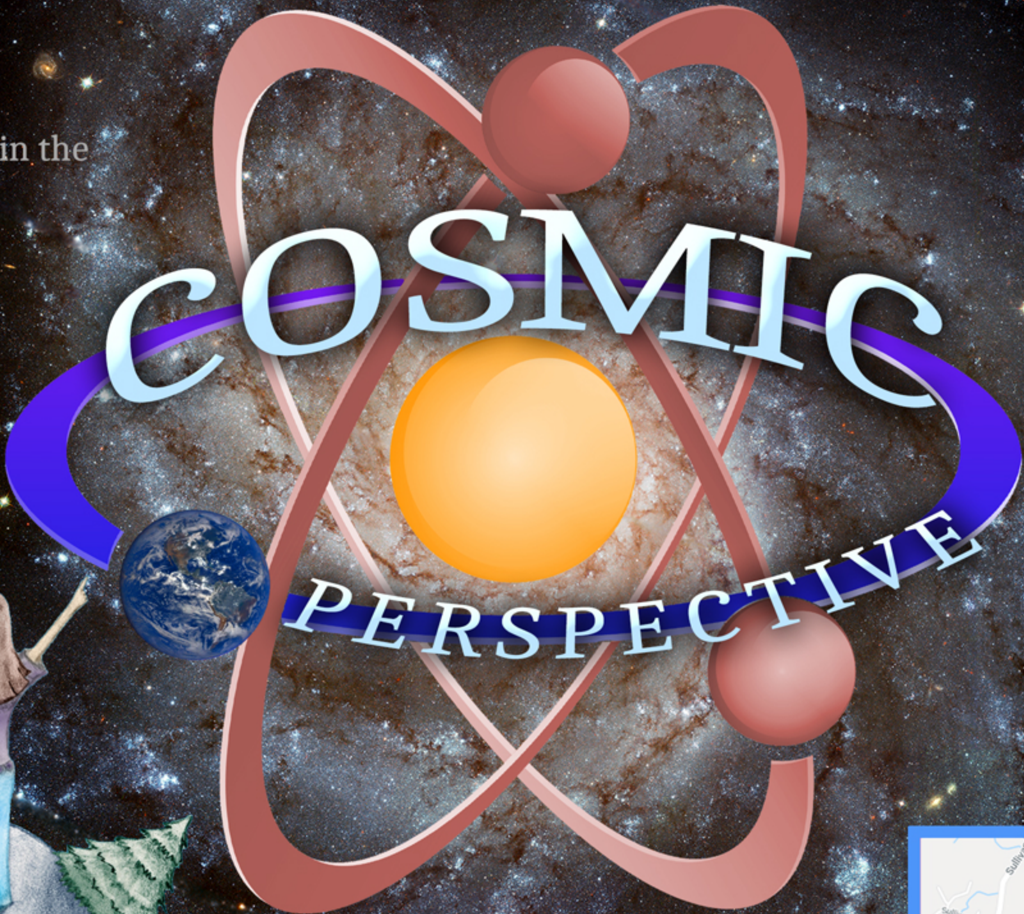
860.946.0312

www.mccarthyobservatory.org

September 8th

8:00 - 10:00 pm

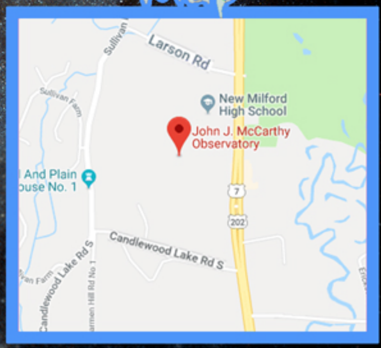
Every one of us is, in the



precious.

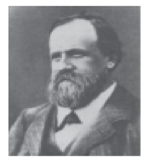
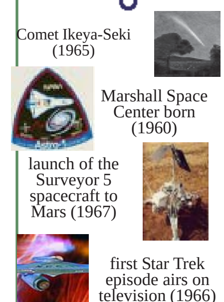
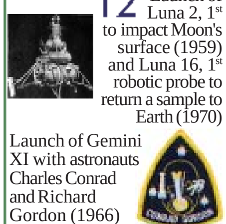
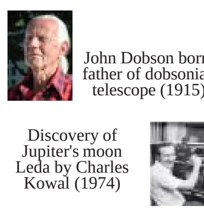
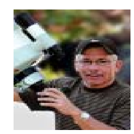
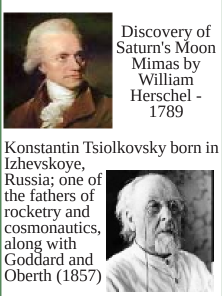
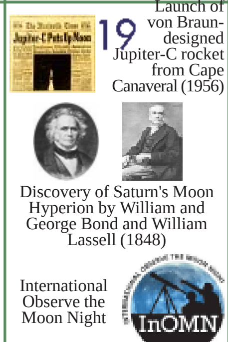
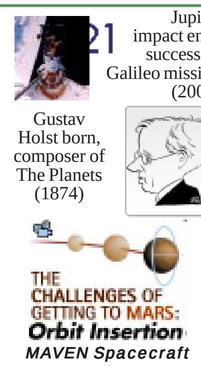
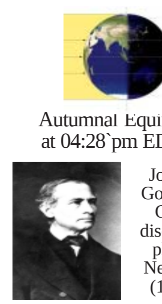
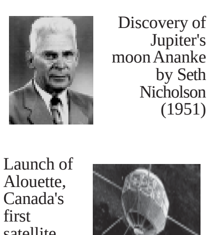
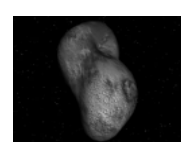
Refreshments
Family Entertainment
Handicapped Accessible
ASL Interpretation Available
with Prior Notice
Rain or Shine

Map



September 2018

Celestial Calendar

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
Phases of the Moon  Sep 6 Sep 13 Sep 20 Sep 27					**1**  Oscar E. Monnig born, American amateur astronomer, contributed to the study of Meteoritics - a science that deals with meteorites and other extraterrestrial materials (1902)	**2**  Launch of Voyager 1 to Jupiter and Saturn (1977)
3  Flyby of Saturn by Pioneer spacecraft (1979)	**4**  Discovery of asteroid 3 Juno by Karl Harding (1804)	**5**  Viking 2 lands on Mars (1976) SMART-1 spacecraft controlled impact on Moon (2006)	**6**  John Henry Dallmeyer born - Anglo-German optician, who developed the rapid rectilinear lens that is symmetrical about its stop to reduce radial distortion (1830)	**7**  James Alfred van Allen born, an American space scientist whose proposal to use geiger counters on Explorer missions to detect charged particles gave his name to the van Allen Belt (1914)	**8**  Comet Ikeya-Seki (1965) Marshall Space Center born (1960) launch of the Surveyor 5 spacecraft to Mars (1967) first Star Trek episode airs on television (1966)	**9**  Launch of Conestoga 1, first private rocket 1982 Discovery of Jupiter's moon Analthea by Edward Barnard (1892) 2nd Saturday Stars Open House McCarthy Observatory
10  GRAIL spacecraft launch to study Moon's gravity (2011) James Edward Keeler, American astronomer, discovered gap in Saturn's rings; later gave name to Keeler Gap, discovered by Voyager (1857)	**11**  Mars Global Surveyor enters orbit around Mars (1997) Flyby of Comet Giacobini-Zinner by the ICE spacecraft, first to visit a comet (1985)	**12**  Launch of Luna 2, 1st to impact Moon's surface (1959) and Luna 16, 1st robotic probe to return a sample to Earth (1970) Launch of Gemini XI with astronauts Charles Conrad and Richard Gordon (1966)	**13**  Trans-Neptunian dwarf planet, 2003 UB313, is officially named "Eris", after Greek goddess of strife and conflict; estimated to be 27% more massive than pluto (2006)	**14**  John Dobson born, father of dobsonian telescope (1915) Discovery of Jupiter's moon Leda by Charles Kowal (1974)	**15**  Jean-Sylvain Bailly, French astronomer, mathematician, and political revolutionary leader; predicted return of Halley's Comet and researched the satellites of Jupiter; died on guillotine (born 1736)	**16**  Robert Jay GaBany born, American amateur astro-nomer and astrophotographer, developed use of smaller telescopes and CCD cameras to produce long-exposure high resolution images of distant galaxies (1954)
17  Discovery of Saturn's Moon Mimas by William Herschel - 1789 Konstantin Tsiolkovsky born in Izhevskoye, Russia; one of the fathers of rocketry and cosmonautics, along with Goddard and Oberth (1857)	**18**  Launch of Vanguard 3, designed to measure solar x-rays, the Earth's magnetic field and micrometeoroids (1959)	**19**  Launch of von Braun-designed Jupiter-C rocket from Cape Canaveral (1956) Discovery of Saturn's Moon Hyperion by William and George Bond and William Lassell (1848) International Observe the Moon Night	**20**  Surveyor 2 lunar lander launched, loses mission control, tumbles and crashes onto surface of Moon two days later (1966)	**21**  Jupiter impact ends successful Galileo mission (2003) Gustav Holst born, composer of The Planets (1874)	**22**  Flyby of comet Borrelly by Deep Space 1 (2001)	**23**  Autumnal Equinox at 04:28`pm EDT) Johann Gottfried Galle discovers planet Neptune (1846)
24  John Young born - first to fly six times in space (1930) Soviet spacecraft Luna 16 returns 101 grams of lunar soil to Earth (1970)	**25**  Launch of NASA Mars Observer spacecraft, also known as the Mars Geoscience/Climatology Orbiter, a robotic space probe; communication with the spacecraft was lost on August 21, 1993, 3 days prior to orbital insertion. (1992)	**26**  Cosmonauts V. Titov and Strelkov escape moments before Soyuz T-10-1 explodes on pad (1983)	**27**  Total Lunar Eclipse Launch of SMART-1, 1st European lunar probe - 2003 Launch of Dawn spacecraft to Vesta and Ceres (2007)	**28**  Discovery of Jupiter's moon Ananke by Seth Nicholson (1951) Launch of Alouette, Canada's first satellite (1962)	**29**  SpaceshipOne X1 achieves altitude of 102.9 kilometers, first of two flights to win X Prize competition (2004) Launch of Salyut 6, first of a second generation of Soviet orbital space station designs (1977)	**30**  Discovery of Jupiter's moon Themisto by Charles T. Kowal (1975)