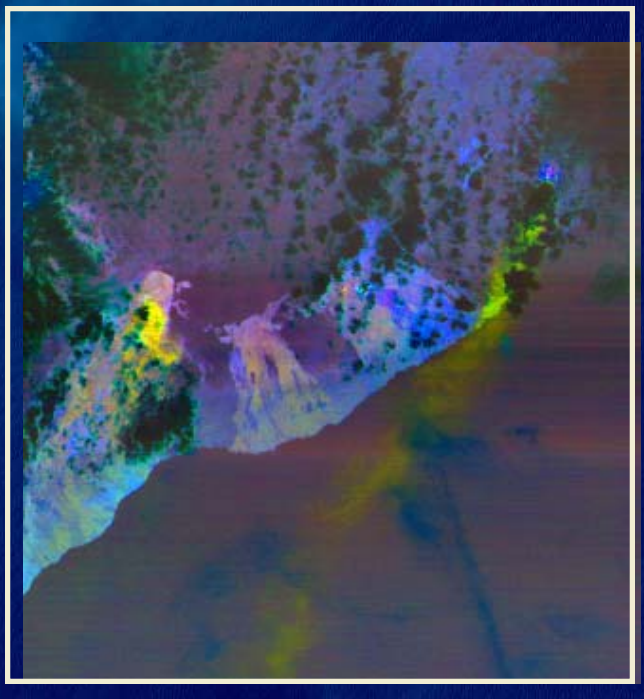
Galactic Observer

John J. McCarthy Observatory

Volume 11, No. 5 May 2018



As its fire burns and Cauldron Bubbles, Kilauea's Secrets are revealed from space Probes the Depths

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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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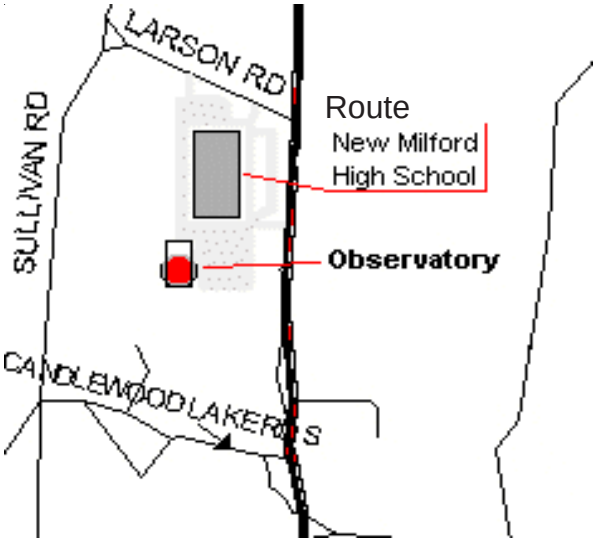

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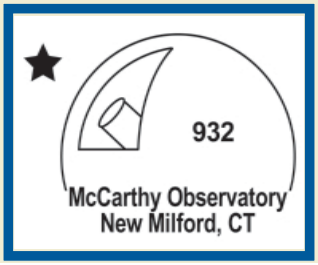
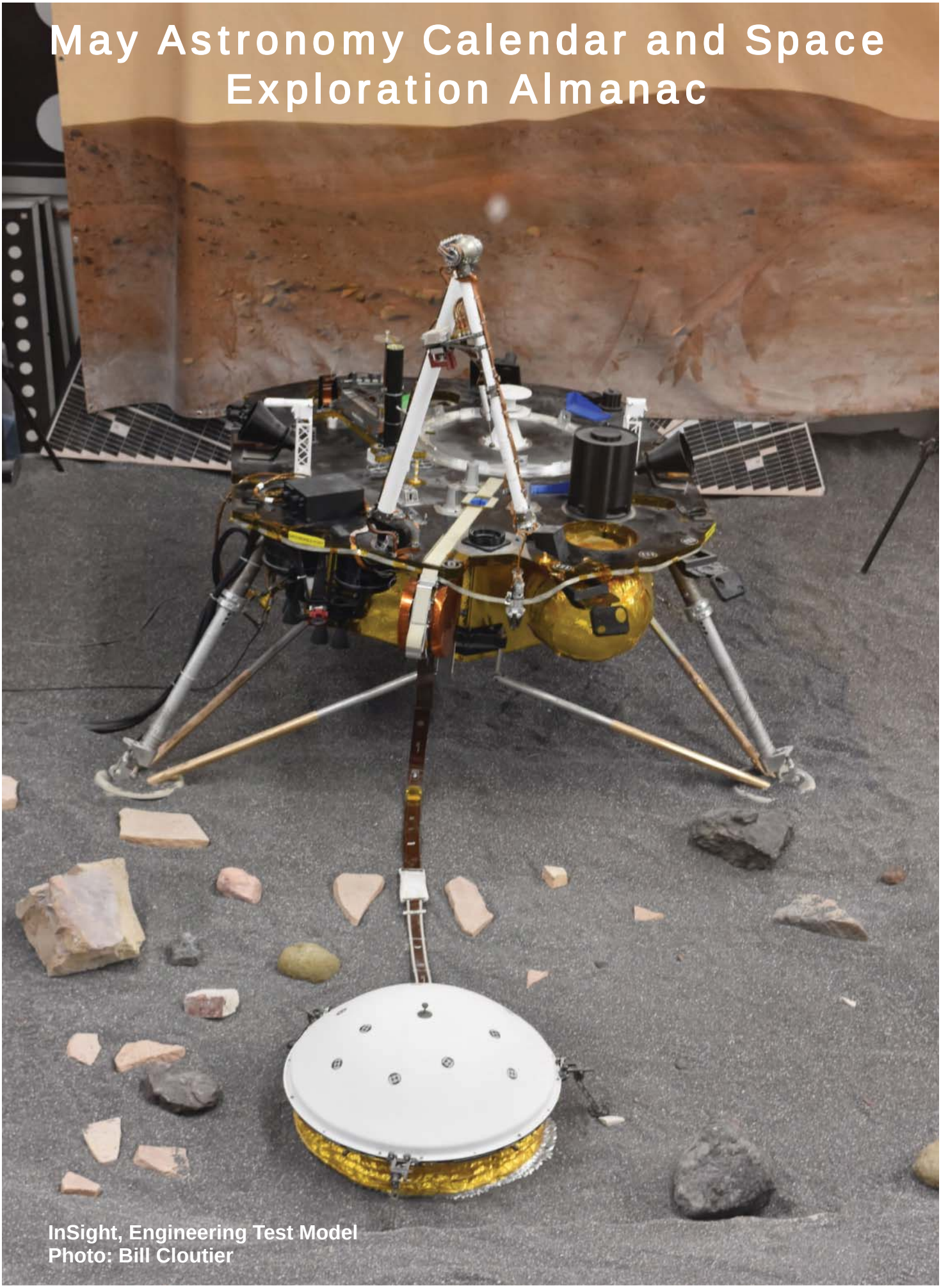


May Astronomy Calendar and Space Exploration Almanac



InSight, Engineering Test Model
Photo: Bill Cloutier

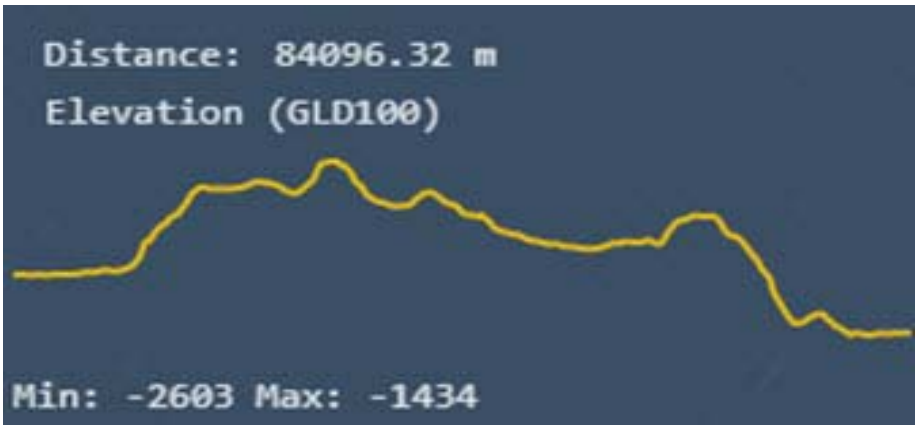
"Out the Window on Your Left"

IT'S BEEN MORE than 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

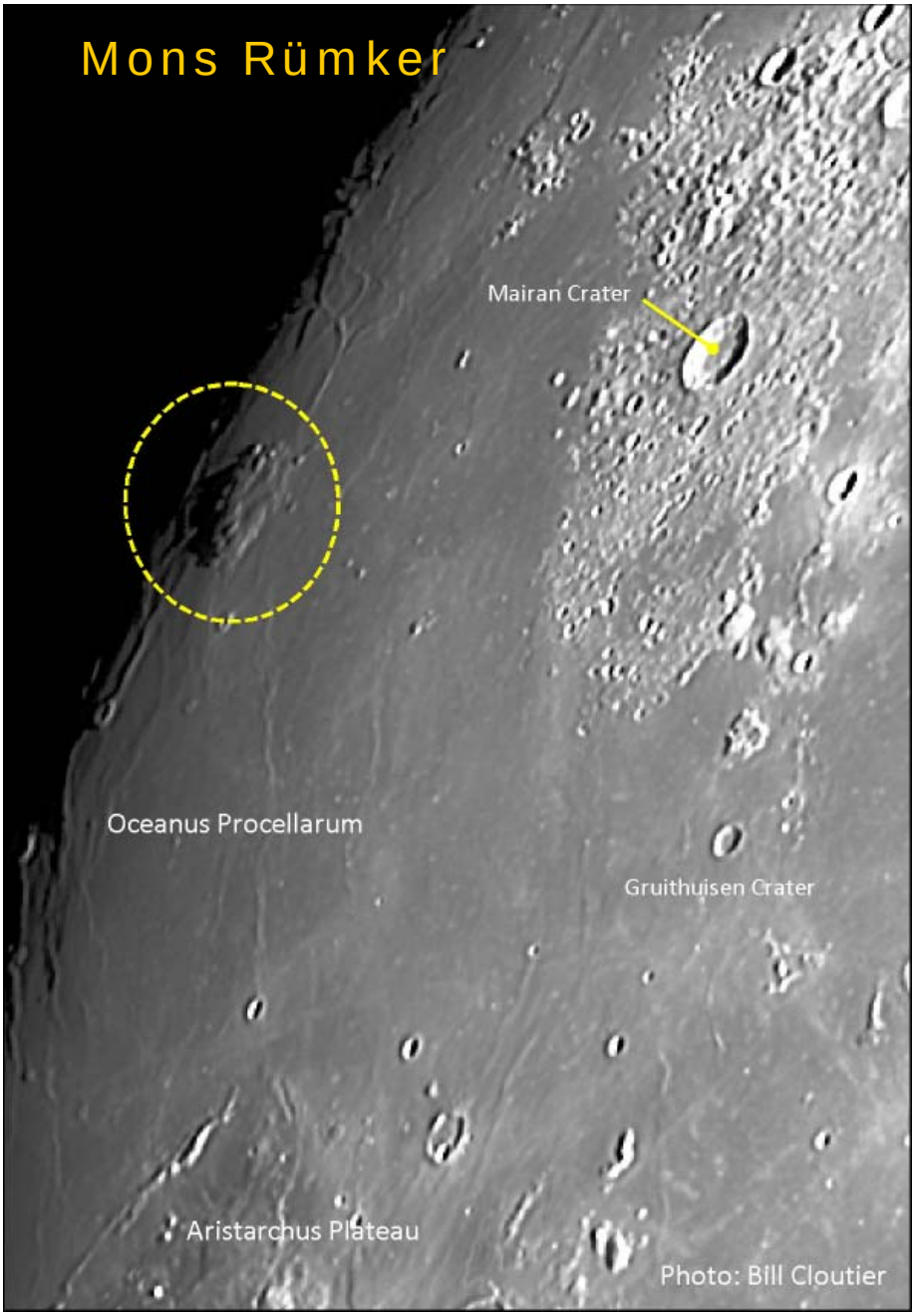
as a space-faring nation. But, what if the average citizen had the means to visit our only natural satellite; what would they see out the window of their spacecraft as they entered orbit around the Moon? This column may provide some thoughts to ponder when planning your visit (if only in your imagination).

With the intensity of the reflected sunlight from a nearly full Moon, features on the western rim are often overlooked. However, this area of Oceanus Procellarum ("Ocean of Storms") has an intriguing and varied topography, with impact and volcanic features, including domes, lava channels and subsurface cavities, as well as the most prominent and brightest lunar swirl, Reiner Gamma.

Located in the northwest region of Oceanus Procellarum, due west of Mairan Crater and north of the Aristarchus plateau and Marius Hills, is the volcanic feature, Mons Rümker. The elevated complex, rising 2,200 to 3,700 feet (700 to 1,100 meters) above the surrounding plain, is approximately 40 miles (65 km) in diameter and populated by multiple domes and vents (approximately 30 separate and irregularly



North - South profile of Mons Rümker Credit: LROC Quickmap



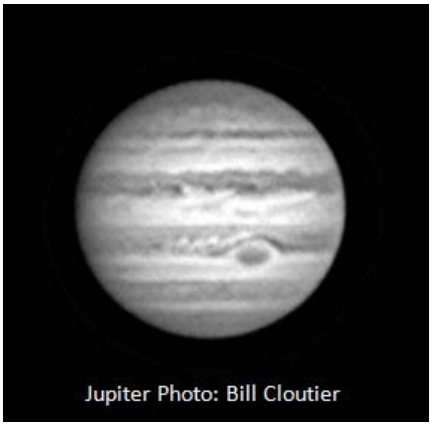
shaped volcanic domes have been identified) and overlapping lava flows.

The region has a very complex geology, with ancient mare basalts as old as 3.47 billion years adjacent to much younger basalts, and basalts with both high iron/titanium and low iron/titanium content in as many as six distinctly different geologic units. Spectral analysis of the region indicates that the areas adjacent to Mons Rümker could be as youthful as 1.33 billion years, significantly younger than lunar samples returned by the six Apollo missions which ranged 3 to 4 billion years in age.

China's Lunar Exploration Program has identified Mons Rümker as one of the candidate landing sites for its Chang'e-5 sample return mission, currently scheduled for launch in 2019. The proposed lander would collect up to 2 kilograms of rock, which would then be transferred to an orbiter by an ascent module before being returned to Earth (reminiscent of the Apollo landing/ orbital rendezvous sequence).

Jupiter at Opposition

The Earth comes between the Sun and Jupiter in its orbit on May 9th (an arrangement known as "Opposition" with Jupiter opposite the Sun in the sky, as viewed from Earth). On that day, Jupiter will rise with the setting Sun and be visible all night, appearing highest in the south just after midnight. Jupiter will remain in the evening sky until November when it disappears into the evening twilight and passes behind the Sun. Superior conjunction (when the Sun is directly between the Earth and Jupiter) occurs on November 26th.



Jupiter Photo: Bill Cloutier

Jupiter can be found in the constellation Libra (located between the bright stars Antares in the constellation Scorpius to the east and Spica in the constellation Virgo to the west). At magnitude -2.3, it will be one of the brightest, star-like objects in the night sky (except for Venus). On May 9th, the gas giant will be 409 million miles (658 million km or 4.40 AU) from Earth or 37 light minutes. The planet's south pole will be slightly tipped towards Earth (3.3°).

Jupiter reaches Opposition every 399 days (on average), about a month later each successive year. It is one of the only planets that displays surface (atmospheric) details through a moderately sized telescope. With its rapid rotation (approximately one complete revolution every 10 hours), the planet's cloud belts and storms provide the observer with a dynamic spectacle.

Jupiter's four Galilean moons (discovered by Galileo in 1610) appear as stars along the planet's equatorial plane. Their orbital motion is discernable over the course of a single night. The three inner moons, Io (1.77 day orbital period), Europa (3.55 day orbital period) and Ganymede (7.2 day orbital period), are tidally locked with one hemisphere always facing Jupiter. In their synchronistic orbits, Io completes four orbits and Europa two orbits in the time Ganymede completes one orbit. Furthest from Jupiter, Callisto, the fourth Galilean moon, is tidally locked but not in orbital resonance with the inner three Galilean moons.

Ganymede is Jupiter's largest moon, with a diameter greater than the planet Mercury. Callisto has the oldest and most heavily cratered surface, while Io has one of the youngest. Io is also the most volcanically active world in the solar system.

Three of the four Galilean moons (excluding Io) may have subsurface oceans. Europa will be the target of several future missions, including ESA's Jupiter Icy moons Explorer and NASA's Europa Clipper.

Since Europa is embedded in Jupiter's magnetosphere, the Europa Clipper will spend a majority of its time outside the high radiation regions, diving in for brief flybys of the icy moon. If the mission includes a lander, the orbiter could park the lander in a safe, low radiation orbit until a suitable landing area on Europa can be identified or the lander could follow the orbiter in a separate launch.

InSight

NASA's Discovery Program mission InSight (Interior Exploration using Seismic Investigations, Geodesy and Heat Transport) is scheduled to launch on May 5th from the Vandenberg Air Force Base in California aboard a United Launch Alliance Atlas V rocket. It will be the agency's first interplanetary mission launched from the west coast. InSight is currently scheduled to land on Mars' Elysium Planitia, a relatively smooth plain in Mars' northern hemisphere, and named after a mythical paradise of the afterlife, on November 26th.

The InSight lander is built on a platform similar to that used for the successful Phoenix mission that explored the planet's polar region, saving testing time and develop-

ment cost. The lander is equipped with two science instruments, a seismometer and heat probe, as well as communication antennae for a radio science experiment. A seismometer will provide information on the nature of the planet's crust, mantle and core by detecting seismic waves (vibrations) generated from marsquakes, meteorite impacts or other events, as they pass through and interact with the planet's interior. A heat probe will burrow into the soil, up to a depth of 16 feet (5 meters), to measure the heat from the planet's interior and pinpoint its source. The lander's antennae will be used to precisely determine its position in space as Mars orbits the Sun and measure the planet's wobble about its axis. From this data, the size, composition and state (solid or liquid) of the interior can be inferred.

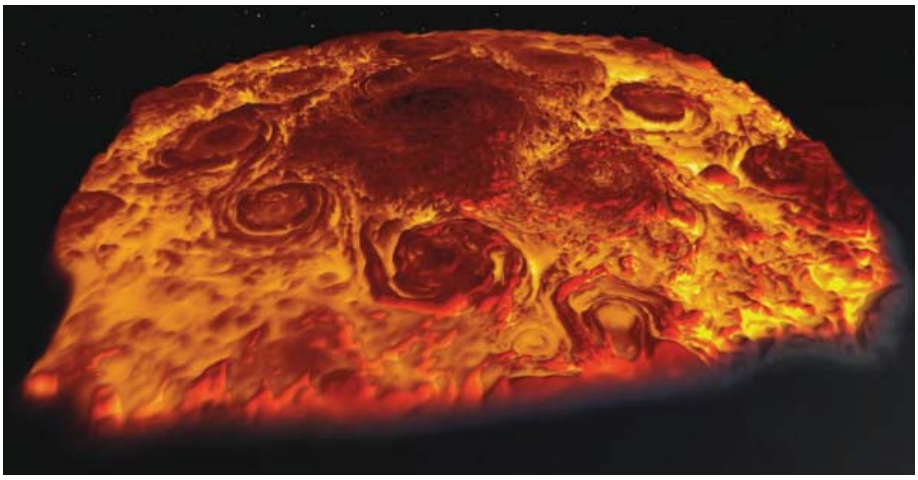
The InSight lander being readied for launch at Vandenberg AFB
Credit: NASA/JPL-Caltech

The science from InSight is expected to contribute to our understanding of the formation of other rocky and terrestrial planets.

By Jove, It's Stormy

The Juno spacecraft successfully entered into orbit around Jupiter in July 2016, after a five year voyage and a total of 1.74 million miles or 2.8 million km traveled that included a 2013 flyby of Earth for a gravity assist. The spacecraft is currently in a polar orbit that takes it as close as 2,600 miles or 4,100 km above the cloud tops once every 53.5 days. With each new flyby, additional data is collected on the gas giant's interior, atmosphere, magnetosphere and aurora.

Jupiter's north pole is dominated by a massive cyclone, as seen in the 3-D infrared image (above) captured by Juno's Jovian Infrared Auroral Mapper (JIRAM) instrument. Eight smaller cyclones, ranging from 2,500 to 2,900 miles (4,000 to 4,600 km) in diameter, encircle the central vortex. Warmer regions in the image are brighter



3-D infrared image of Jupiter's north pole and its cyclones
Image credit: NASA/JPL-Caltech/SwRI/ASI/INAF/JIRAM

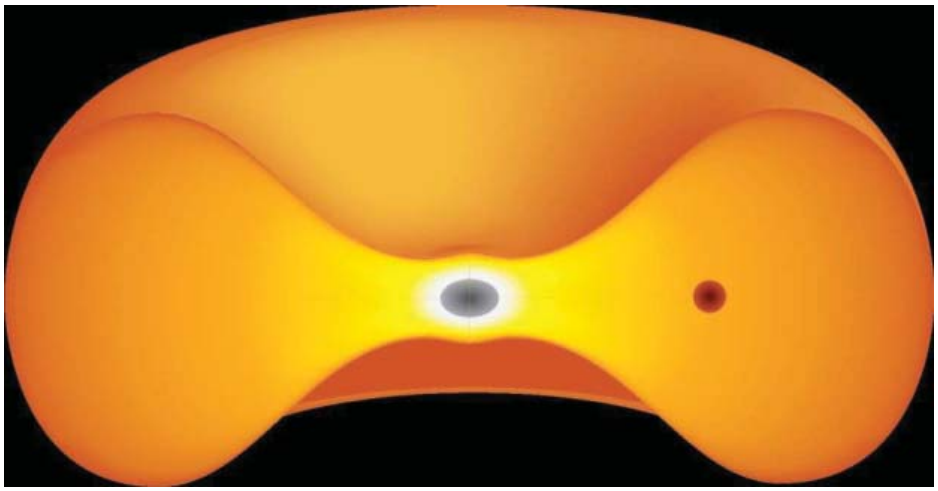
(the highest temperature shown is around 9°F or -13°C) and found deeper in the atmosphere, while conversely, the cooler regions are progressively darker (with temperatures reaching -117°F or -83°C), and at a higher altitude.

JIRAM can probe the gas giant's atmosphere to a depth of 30 to 45 miles (50 to 70 km), essential in developing a rotational model of Jupiter's interior and understanding the forces generating the planet's magnetic field. Scientists have found the field to be surprisingly non-uniform (for example, the field is more intense in the planet's northern hemisphere), with regions where the magnetic field is strongly positive surrounded by weaker regions where it is negative. At the

pressures deep inside Jupiter, hydrogen is likely in a metallic state and therefore, electrically conductive. It is believed that metallic hydrogen plays a major role in generating Jupiter's intense magnetic field.

The Juno spacecraft has completed 12 science passes of the planet since its arrival. The thirteenth pass (Perijove 13) is scheduled for May 24th.

New Theory for Moon Formation



An artist's impression of a synestia, a hypothetical cloud of vaporized and molten rock, created in a high-speed planetary collision in which a moon could form as the synestia cools. Credit: Simon Lock

Following the Cornell Satellite Symposium in August 1974, Drs. William Hartmann and Donald Davis published a paper in the journal Icarus that reintroduced and expounded upon a theory that the Moon's present day composition, attributes and uniqueness, as compared to Earth, was the result of a giant impact (i.e., the Moon formed from the debris of a relatively low-speed collision between the Earth and a rogue planetoid). While the "Big Whack" became the leading theory of formation (displacing other theories such as capture, fission and co-formation), questions remained, particularly on the similarities in the chemical and isotopic composition of the Earth and Moon (i.e., the debris should have included material from the proto-planet which would have contributed to differences in composition of the Moon as compared to the Earth).

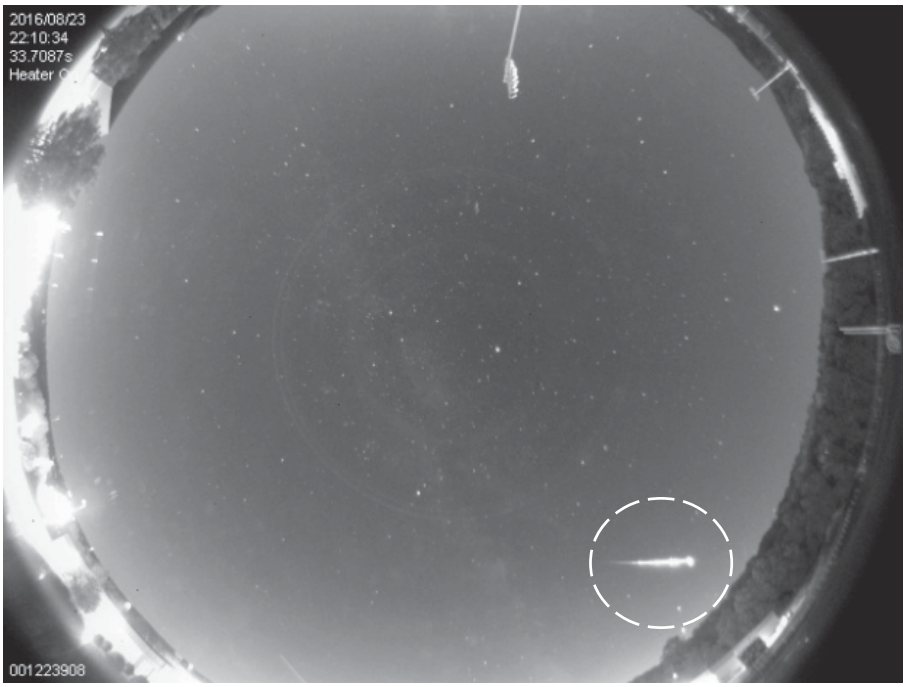
A new twist on the old theory has now been offered in which a high-speed impact of an embryonic Earth with a proto-planet effectively vaporizes both bodies, resulting in single, rotating cloud of debris (dubbed a "synestia"). Computer models, as described in a paper published in the Journal of Geophysical Research ("The origin of the Moon within a terrestrial synestia," S.J. Lock, et.al.) show that a satellite, such as our Moon, can form within the synestia as it cools and the vapor condenses. The Moon would then emerge as the synestia contracts. The model is also able to reproduce the similarities in the chemical and isotopic composition of the Earth and Moon, and, under the right conditions, recreate the current inclination of the Moon's orbit, with respect to Earth, and the total angular momentum of the two bodies.

If synestia is a viable model of formation, astronomers should be able to find evidence of this process in future surveys of young solar systems around other stars.

Breaking Up is Not So Hard to Do

Relatively small meteoroids (the Chelyabinsk meteor that exploded over Russia in February 2013 was estimated to be about 55-65 feet or 17-20 meters in diameter when it entered the atmosphere) encounter the Earth's atmosphere at speeds ranging from 25,000 mph to 160,000 mph (11 km/sec to 72 km/sec). As they enter the denser regions of the atmosphere, meteoroids are subjected to atmospheric drag and thermal stress. Stone meteoroids, in particular, tend to break up at higher altitudes, (7 to 17 miles or 11 to 27 km above the surface) and more quickly than scientists had expected, based upon the mechanical strength of fragments recovered on the ground.

In a study that appeared in the scientific journal Meteoritics and Planetary Science (titled "Air Penetration Enhances Fragmentation of Entering Meteoroids"), the authors describe the results of a computer simulation of the exchange of energy and momentum between the meteoroid and the atmosphere. The simulations revealed that air penetration (into the body of the meteoroid) was a significant contributor to the destabilization and deconstruction of the rocky matrix. The study further suggested that this previously unrecognized process could explain the more rapid fragmentation of meteoroids such as Chelyabinsk.



A fireball, (a meteor brighter than the planet Venus), as recorded by the McCarthy Observatory's all-sky camera

Philately

The U.S. Postal Service will be releasing a new postage stamp on May 23rd honoring astronaut Dr. Sally Ride (1951-2012), the first American woman to fly in space. Ride was selected as a mission specialist and flew on the space shuttle Challenger's second flight (STS-7) in June 1983. She flew a second mission, also on the space shuttle Challenger (STS-41G), in October 1984. In total, Ride spent 14 days and 8 hours in low-Earth orbit.

After retiring from NASA in 1987, Ride taught physics at the University of California, San Diego, authored several children's science books and, in 2001, co-founded Sally Ride Science, a non-profit to promote learning and careers in STEM (science, technology, engineering and mathematics).

The U.S. Postal Service is also releasing a set of four stamps dedicated to STEM education. The "Engineering" stamp includes an illustration of the Apollo spacecraft (command and service modules).

Dust in the Wind

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 2017, 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 and Endeavour crater where the Mars Exploration Rover Opportunity is working. Since Opportunity relies upon energy from its solar panels for power, any loss in the opacity (clarity) of the atmosphere is a concern to project managers.

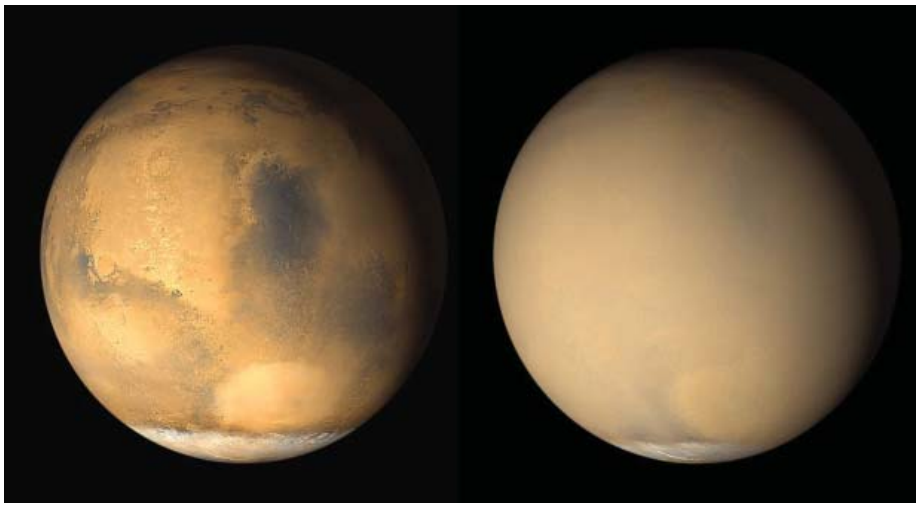
Martian weather is monitored daily by NASA's Mars Reconnaissance Orbiter. The spacecraft's Mars Color Imager (MARCI) camera can image the entire planet over 12 orbits (approximately every day). MARCI images are used to construct weather maps and to produce animated sequences that are available at http://www.msss.com/msss_images/latest_weather.html.

A fireball, (a meteor brighter than the planet Venus), as recorded by the McCarthy Observatory's all-sky camera

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.

Observations by several Mars orbiters as well as the Hubble Space Telescope suggest that dust storms contribute to the loss of the planet's atmosphere. During a dust storm, observers have found an increase in water vapor in Mars' middle atmosphere (about 30 to 60 miles or 50 to 100 km in altitude). The water vapor is believed to be carried aloft by the dust-filled air mass.



Mars on June 2001 (left) and July 2001 (right) as seen from the Mars Global Surveyor. Image Credit: NASA/JPL-Caltech/MSSS

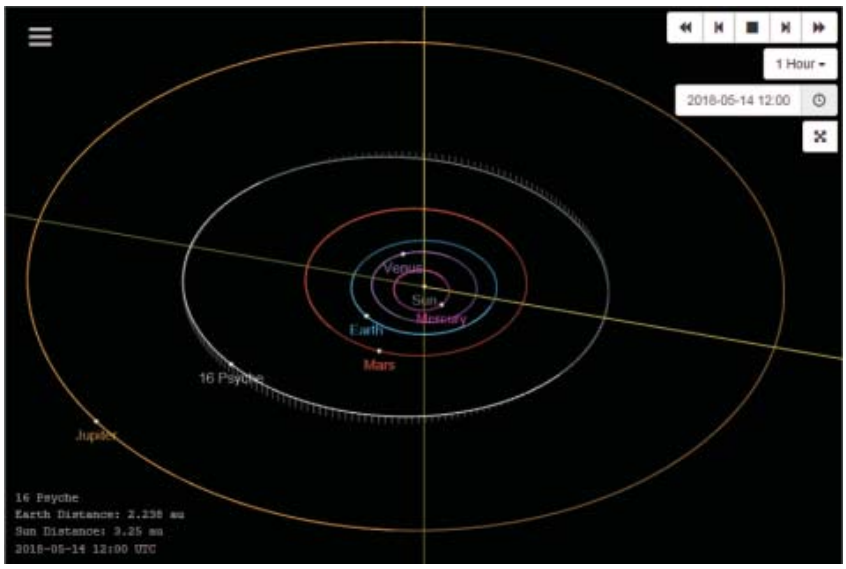
Researchers further believe that the increase in water vapor at the higher altitudes (driven by the planet's dust storms) is contributing to, and accelerating, the loss of hydrogen (and other gases) from the upper levels of the atmosphere; a loss that has been confirmed by NASA's MAVEN spacecraft which arrived on orbit in 2014.

Psyche Session

On May 14th, the asteroid 16 Psyche will make its closest approach to Earth (208 million miles or 2.238 AU). Psyche orbits the Sun between Mars and Jupiter and is unusual in that it appears to be comprised almost entirely of nickel-iron metal, similar to a core of a differentiated planet (where the heavier elements have accumulated in the core). Exposure of a planetoid's core, if Psyche represent a fragment of that core, would have required a planet-shattering collision.

The asteroid has been selected as a target of a NASA Discovery Mission (lower cost, highly focused robotic missions). The spacecraft is scheduled to launch in 2022. After a 3.5 year cruise, including a Mars flyby in 2023, the spacecraft would enter an orbit around the asteroid in 2026. The prime mission is expected to last 21 months.

The spacecraft's instruments include; a multispectral imager, a gamma ray and neutron spectrometer, and a magnetometer. The mission will also test a new communications system, using light rather than radio waves to transmit information. Expectations are that the system will allow a higher throughput of data. The spacecraft is solar powered with a recent design change that increased the size of the solar arrays to support a higher spacecraft velocity and shorter travel time to the asteroid.



16 Psyche's position with respect to the Earth at closest approach. Credit: JPL Small-Body Database Browser

The mission's science objectives and goals include determining Psyche's method of formation and the conditions under which it was formed, characterize its topography and the relative age(s) of distinct regions of the asteroid, and thoroughly explore a world of metal rather than one of ice and rock.

Public Astronomy

Eighty-three 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 observatory included a planetarium that 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.

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.

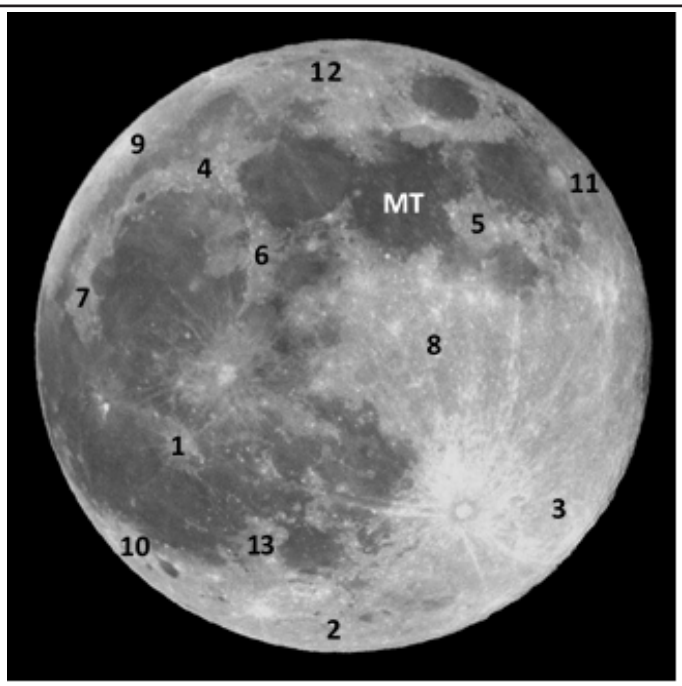
Lunar cartography or mapping was both limited and crude until Galileo first trained his telescope upon the Moon. With the ability provided by the telescope to resolve individual features came the need for a uniform or standard naming convention. The first such detailed map was created by Dutch astronomer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

ture 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.

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)



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 nondescript 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.

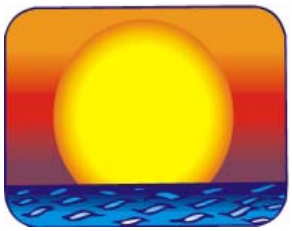
So, the next time you see the Moon in the sky, take a few minutes and reacquaint yourself with a part of history. Once you have located Mare Tranquillitatis (MT) or the Sea of Tranquility* on the moon's eastern (right) limb, look for Terra Sanitatis or the Land of Healthiness, the adjoining brighter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

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

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 cosmo-

Vehicle Assembly Building



Sunrise and Sunset (from New Milford, CT)

Sun	Sunrise	Sunset
May 1st (EDT)	05:51	19:52
May 15th	05:34	20:06
May 31st	05:22	20:21

naut 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.

Jovian Moon Transits

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.

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:

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 south-western sky with its reverse question mark arrangement of stars, punctuated by the star Regulus, forming the front of the lion, and a triangular arrangement of stars forming the back or tail of the creature. To the west of Leo is an open star cluster called the Beehive (M44) in the constellation Cancer. On a dark night it can be seen with the naked eye. East of Leo, towards the constellation Boötes is the globular cluster M3. Boötes is easily identified by its bright star Arcturus. Follow the arc in the handle of the Big Dipper to find Arcturus, at the base of the kite-shaped constellation. M3 is located further away than the center of our galaxy, the Milky Way, and is one of the many outstanding globular clusters that will grace the late spring and summer skies.

Astronomical and Historical Events

1st	Amor Asteroid 2018 DX3 near-Earth flyby (0.081 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	Kuiper Belt Object 2010 EK139 at Opposition (35.418 AU)
2nd	History: discovery of the first binary star (Xi Ursae Majoris) by William Herschel (1780)
3rd	Amor Asteroid 2015 JP near-Earth flyby (0.097 AU)
4th	Apollo Asteroid 2017 WY14 near-Earth flyby (0.052 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	Scheduled launch of NASA's InSight spacecraft (Mars lander) from the Vandenberg Air Force Base, California

Astronomical and Historical Events (continued)

5th Moon at apogee (furthest distance from Earth)
5th Eta Aquarids meteor shower peak (best viewing: early morning on the 5th and 6th)
5th History: launch of Freedom 7 and astronaut Alan Shepard aboard a Mercury-Redstone rocket, first American in space (1961)
6th Apollo Asteroid 1685 Toro closest approach to Earth (0.972 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 Last Quarter Moon
7th Apollo Asteroid 1999 FN19 near-Earth flyby (0.025 AU)
7th Apollo Asteroid 11311 Peleus closest approach to Earth (1.742 AU)
7th Kuiper Belt Object 2010 FX86 at Opposition (45.160 AU)
8th Apollo Asteroid 2016 JQ5 near-Earth flyby (0.016 AU)
8th Apollo Asteroid 3103 Eger closest approach to Earth (1.753 AU)
8th Centaur Object 144908 (2004 YH32) at Opposition (11.685 AU)
9th Scheduled launch of the Cygnus cargo-carrying spacecraft to International Space Station from Wallops Island, Virginia
9th Jupiter at Opposition (opposite the Sun in the sky and visible all night)
9th Apollo Asteroid 388945 (2008 TZ3) near-Earth flyby (0.017 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 Kuiper Belt Object 90568 (2004 GV9) at Opposition (38.560 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 Second Saturday Stars - Open House at McCarthy Observatory
12th Atira Asteroid 434326 (2004 JG6) closest approach to Earth (0.937 AU)
12th History: first planetarium (Adler Planetarium in Chicago) opens in United States (1930)
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 Asteroid 16 Psyche closest approach to Earth (2.238 AU)
14th History: Griffith Observatory, one of the first institutions in the U.S. dedicated to public science, opens in Los Angeles (1935) 14th History: launch of the Herschel infrared telescope and the Planck microwave observatory (2009)
14th History: launch of Skylab, the United States' first space station (1973)
14th History: the American Interplanetary Society (later renamed the American Rocket Society) launches its first liquid fueled (liquid oxygen and gasoline) rocket from Staten Island, N.Y. (1933)
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 New Moon
15th Aten Asteroid 1999 LK1 near-Earth flyby (0.034 AU)
15th Apollo Asteroid 101955 Bennu closest approach to Earth (0.352 AU)

Astronomical and Historical Events (continued)

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 2015 KJ19 near-Earth flyby (0.061 AU)
16th Apollo Asteroid 2012 WS3 near-Earth flyby (0.095 AU)
16th Atira Asteroid 2013 JX28 closest approach to Earth (0.870 AU)
16th Kuiper Belt Object 65407 (2002 RP120) at Opposition (29.547 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 Moon at perigee (closest distance from Earth)
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 Kuiper Belt Object 2015 KH162 at Opposition (58.714 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 Scheduled launch of the GRACE Follow-On spacecraft from the Vandenberg Air Force Base, California
19th History: launch of the first Army Hermes A-1 rocket from White Sands, NM (1950)
20th Scheduled launch of an Orbital ATK Cygnus cargo freighter to the International Space Station from Wallops Island, Virginia
20th Apollo Asteroid 24761 Ahau closest approach to Earth (0.867 AU)
20th History: launch of the Pioneer Venus 1 spacecraft (1978)
21st First Quarter Moon
21st History: launch of the Japanese Venus Climate Orbiter Akatsuki or Planet-C spacecraft and the Ikaros solar sail (2010)
22nd Mars Autumnal Equinox (northern hemisphere)
22nd History: launch (and recovery) of monkeys Patricia and Mike on an Aerobee rocket, reaching a record altitude of 30 miles (1952)
23rd U.S. Postal Service releases stamp honoring astronaut, Dr. Sally Ride
23rd Apollo Asteroid 2016 WL7 near-Earth flyby (0.080 AU)
24th History: launch of Aurora 7 and astronaut Scott Carpenter aboard a Mercury-Atlas rocket; second American to orbit Earth (1962)
24th Apollo Asteroid 2018 FS3 near-Earth flyby (0.074 AU)
24th History: launch of Midas 2; first Experimental Infrared Surveillance Satellite (1960)
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)
26th Apollo Asteroid 2017 LF near-Earth flyby (0.085 AU)
26th Plutino 2006 HJ123 at Opposition (33.096 AU)

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 66391 (1999 KW4) near-Earth flyby (0.078 AU)
27th Atira Asteroid 481817 (2008 UL90) closest approach to Earth (0.580 AU)
27th Plutino 38628 Huya at Opposition (27.633 AU)
28th History: launch of Mars 3 (USSR) lander and rover; lander became the first spacecraft to attain soft landing on Mars, although transmissions ceased after 15 seconds (1971)
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 Full Moon (Full Flower Moon)
29th Aten Asteroid 68347 (2001 KB67) near-Earth flyby (0.024 AU)
29th Apollo Asteroid 2014 WG365 near-Earth flyby (0.061 AU)
28th Amor Asteroid 2018 ER4 near-Earth flyby (0.064 AU)
29th Kuiper Belt Object 2010 JO179 at Opposition (57.435 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 Amor Asteroid 2013 LE7 near-Earth flyby (0.046 AU)
31st Aten Asteroid 5381 Sekmet closest approach to Earth (1.081 AU)
31st Kuiper Belt Object 2007 JH43 at Opposition (39.551 AU)
31st History: European Space Agency's birthday (1975)

Commonly Used Terms

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

References on Distances

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

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

International Space Station and Iridium Satellites

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

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).

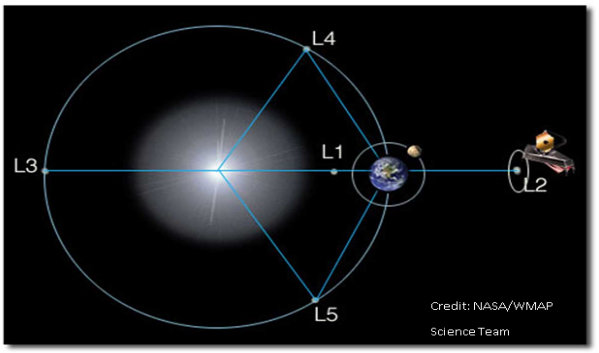


Image Credits

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

Front Page Graphics

Recent eruptions of the Kilauea volcano provide vivid detail of the destructive forces and human suffering from our earth's geological processes. But images of fiery swells, bursts of magma and residents fleeing their homes only captures a glimpse of the global effects of vulcanism on our natural environment.

The image on the front page was taken from orbit by the Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) instrument on NASA's Terra spacecraft. ASTER is a joint project of NASA, Japan's Ministry of Economy, Trade and Industry (METI), and Japan Space Systems (J-spacesystems).

The ASTER images on page 17 were taken on May 6, 2018. Superimposed on the image in yellow are hotspots detected on the thermal infrared bands. The easternmost hot spots show the newly formed fissures and the lava flow spilling to the northwest. The color composite (bottom right) depicts vegetation in red, and old lava flows in black and gray. The inset shows the massive sulfur dioxide plume in yellow and yellow-green, extracted from ASTER's multiple thermal bands. A smaller, but thicker, sulfur dioxide gas plume can be seen coming from Kilauea.

The coordinated system of EOS (Earth Observing System) satellites, including Terra, are major components of NASA's Science Mission Directorate and the Earth Science Division. The goal of NASA Earth Science is to develop a scientific understanding of the Earth as an integrated system, its response to change, and to better predict variability and trends in climate, weather and natural hazards.

Environmental monitoring has long been a priority of NASA development, but one with major challenges. The Hyperspectral Infrared Imager or HyspIRI satellite mission was proposed in the 1970's to study the world's ecosystems and provide critical information on natural disasters such as volcanoes, wildfires and drought. The program was sidelined by Reagan administration budget cuts. As a surrogate or proxy, NASA has recently installed HyspIRI instruments on an ER-2 Cold War era spyplane to take images from 65,000 feet (19,800 meters).

The data collected by NASA's space-based instruments will help create a composite image of the effects of human activity and natural forces on our planet's ever changing environment.

A night view of Hawaii's Kilauea Volcano, one of Earth's most active volcanoes. A NASA-led team is studying Hawaiian volcanoes from the air, ground and space to better understand volcanic processes and hazards. *Source: https://www.jpl.nasa.gov/news/news.php?feature=6739.*

NASA's ER-2 aircraft is prepped for flight at Marine Corps Base Hawaii on the island of Oahu. Credit: NASA. Source: *https://aviris.jpl.nasa.gov/index.html*

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Second Saturday Stars

FREE EVENT

Every Month at the

John J. McCarthy Observatory

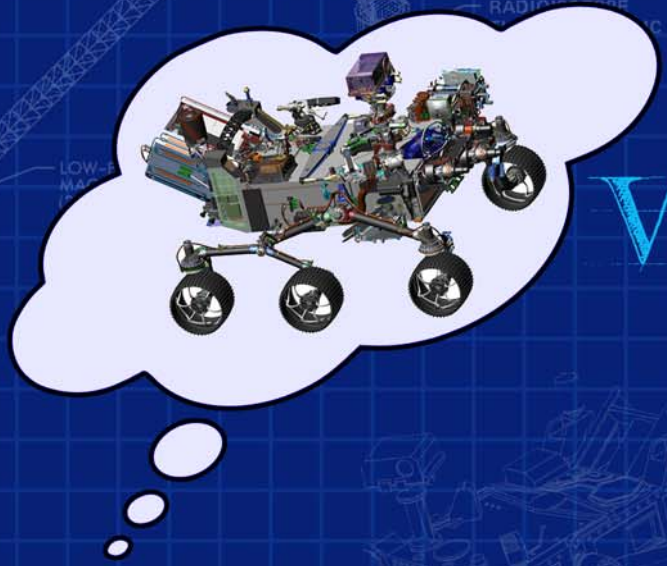
Behind the New Milford High School

860.946.0312

www.mccarthyobservatory.org

May 12th

8:00 - 10:00 pm



What it takes

TO

MAKE IT FLY

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

Map

May 2018

Celestial Calendar

Phases of the Moon

May 7 May 15

May 21 May 29

Tuesday

1

Gerard Kuiper discovers Neptune's Moon Nereid 1949

Discovery of Mars meteorite *Dar al Gani* 1998

Wednesday

2

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

Asteroid 1992 JD Near-Earth Flyby (0.024 AU)

Thursday

3

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

Friday

4

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

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

Space Day

Saturday

5

Moon at apogee (farthest from Earth)

Eta Aquarids meteor shower peak

Alan Shepard first American in space 1961

6

Groundbreaking for the John J. McCarthy Observatory (2000)

7

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

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

8

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

9

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

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

10

Estherville, Iowa meteorite shower - 1897

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

11

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

12

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

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

2nd Saturday Stars Open House McCarthy Observatory

13

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

14

Griffith Observatory opens in Los Angeles (1935).

Launch of Skylab 1973

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

15

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

Launch of Faith 7 - Final Mercury mission 1963

16

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

Space Shuttle Endeavour final launch (2011)

17

Moon at perigee (closest to Earth)

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

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

18

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

19

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

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

20

Launch of Pioneer Venus 1 spacecraft (1978)

21

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

22

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

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

23

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

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

24

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

Scott Carpenter, second American in space (1962)

25

Launch of Skylab 1 crew (1973

Comet Halley chronicled by Chinese astronomers (240 BC)

Phoenix lander on Martian soil 2008

JFK Moon goal speech (1961)

26

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

27

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

28

Abel and Baker 1st primates in orbit (1959)

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

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

29

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

30

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

European Space Agency Born 1975

31

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

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