Galactic Observer

John J. McCarthy Observatory

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In the Universe the Stronger Don't Last Longer

See inside, pages 8 and 18

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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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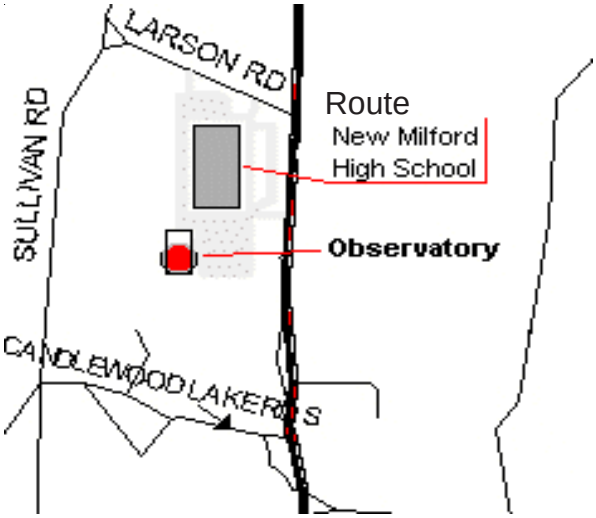


In This Issue

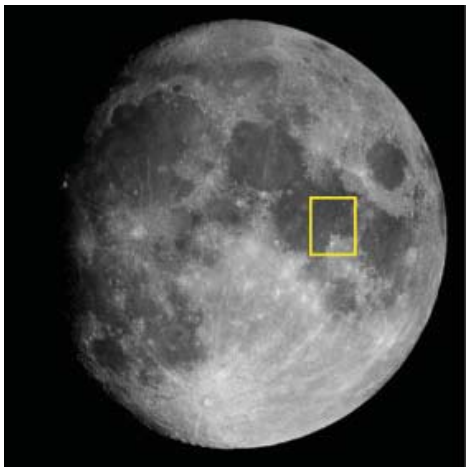
May Astronomy Calendar and Space Exploration Almanac

Catching a Dragon
NASA Photo

Cygnus, Soyuz and Progress
NASA Photo

"Out the Window on Your Left"

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



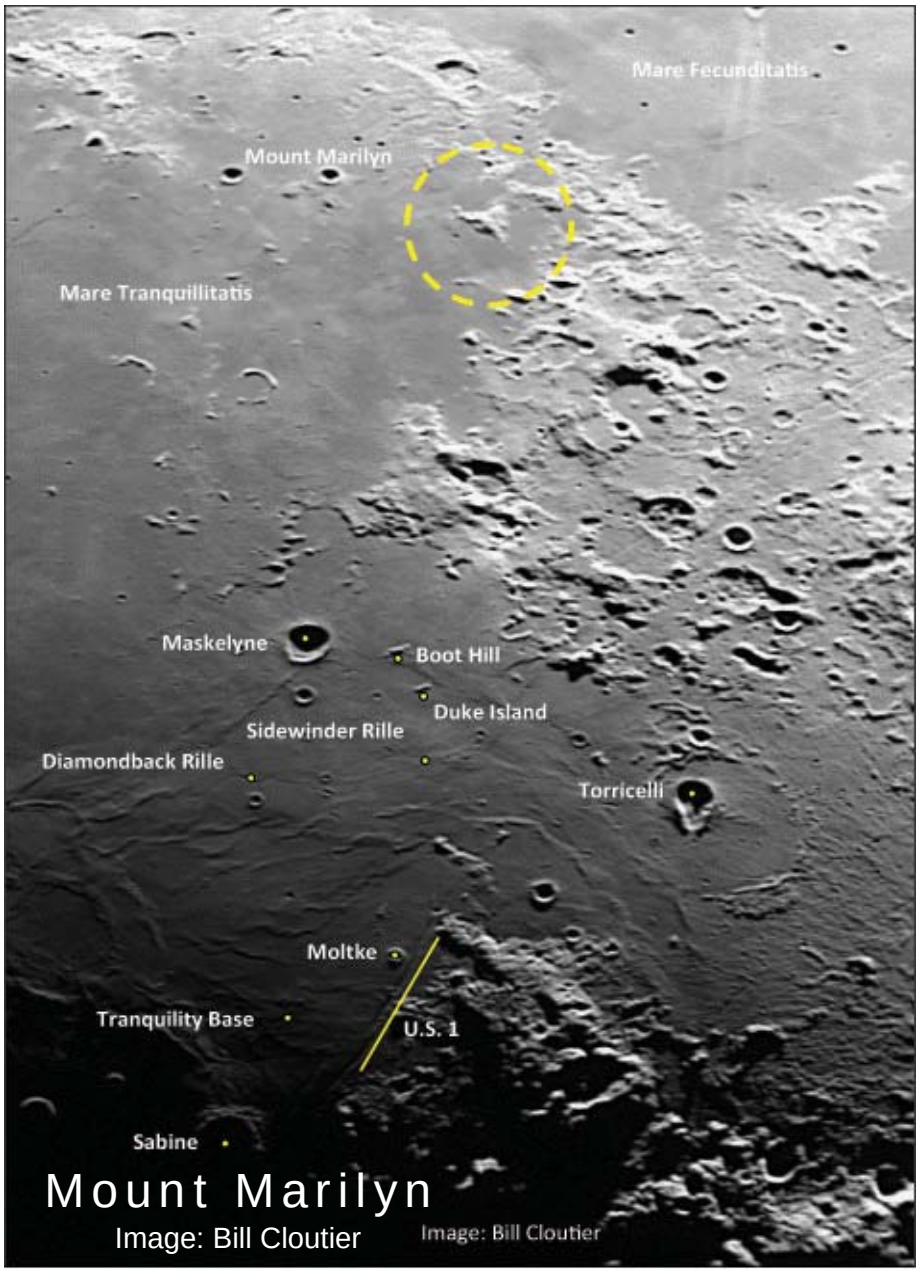
the means to visit our only natural satellite; what would they see out the window of their spacecraft as they entered orbit around the Moon? This column may provide some thoughts to ponder when planning your visit (if only in your imagination).

Prior to 1968, a triangular-shaped outcrop of rock located between two dark patches of lava (Mare Tranquillitatis and Mare Fecunditatis) was noteworthy only for a small crater (Theta Secchi) located on its flank. Jim Lovell, the Command Module Pilot on the crew of Apollo 8, was one of the first people to circumnavigate the Moon. He named that ancient rock outcrop "Mount Marilyn" as a tribute to his wife. Although unofficial, the name became part of the Apollo program lexicon and a landmark for the first Moon landing.

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

The 4,593 foot (1,400 m) high Mt. Marilyn is just one of the landmarks identified on the following page. It was likely created over 4

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



billion years ago in the aftermath of the impact that formed the nearby basins. Following to the conclusion of the Apollo program, the International Astronomical Union (IAU) named the outcrop "Mount Secchi." Lovell would like the IAU to reconsider and officially recognize Mt. Marilyn's place in history.

Transit of Mercury

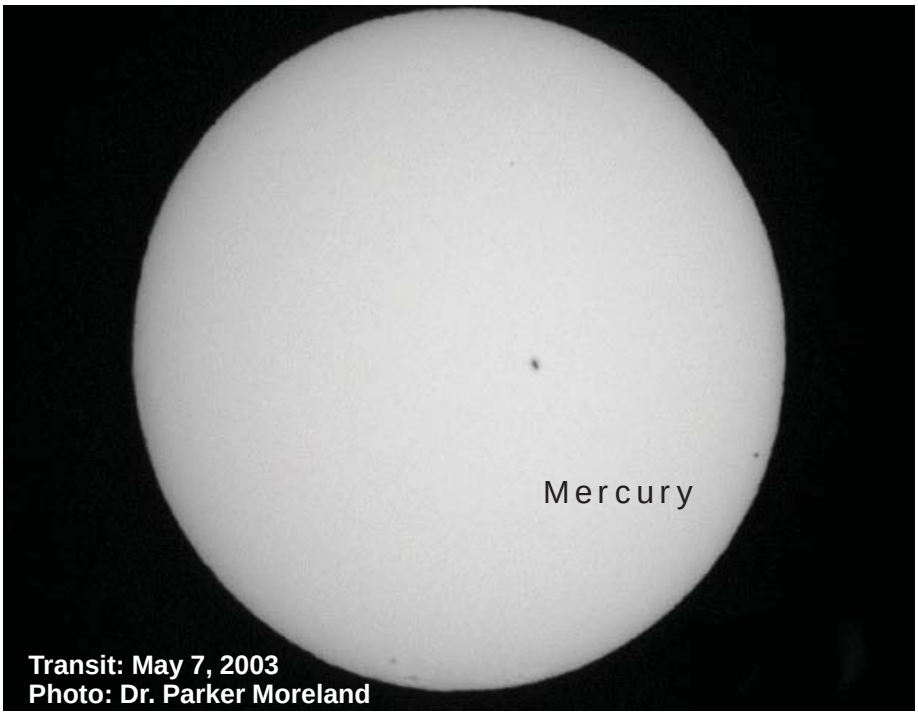
Mercury's orbit crosses the Earth's orbital plane each year in early May and early November. If the inner-most planet is passing between the Earth and Sun at that time, the silhouette of Mercury can be seen crossing (transiting) the Sun's bright disk. The alignment occurs infrequently, on average only thirteen times each century. The last transit occurred in November 2006.

Unlike the transit of Venus which could be seen by the unaided eye (properly protected), finding the more diminutive Mercury will likely require optical aid.

On May 9th, the entire transit will be visible to observers along the east coast, beginning at 7:12 am EDT and lasting approximately 7½ hours. Mercury will cross the Sun in a descending direction from east to west. It will appear as a small black dot against the bright solar disk, approximately 1/158 the size of the Sun (1/5 the size of Venus in 2012).

The photo of Mercury during the 2003 transit (below) was taken through a small telescope (to magnify the view). With solar activity relatively low, Mercury should be distinguishable from any small sunspots, particularly as it moves in front of the Sun over the course of the day. The transit should not be viewed without proper eye protection (to do otherwise risks serious eye damage and blindness). Binoculars and telescopes should be properly filtered as the Sun's concentrated light and heat can shatter glass and/or melt internal components.

The McCarthy Observatory will have updated information on the transit on its webpage (*www.mccarthyobservatory.org*) with possible viewing opportunities, weather permitting.



Transit: May 7, 2003
Photo: Dr. Parker Moreland

Mars at Opposition

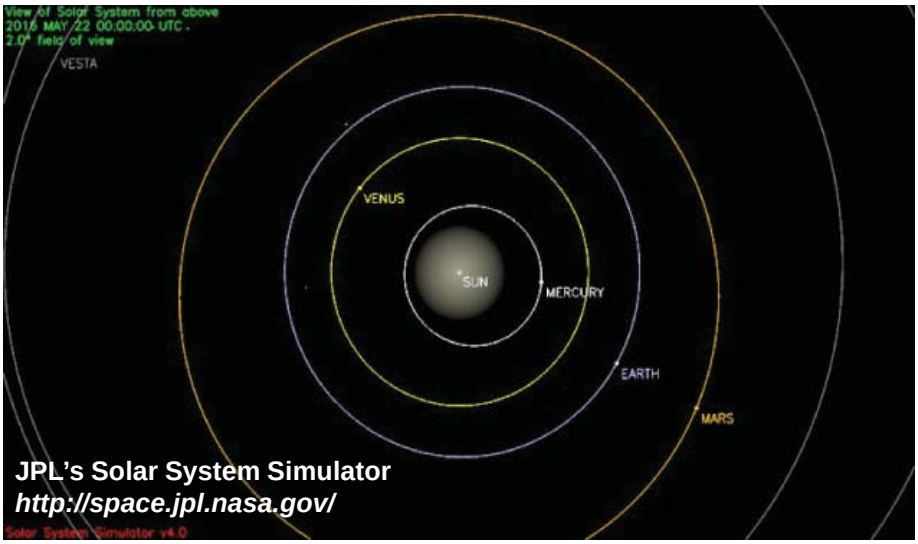
The Earth will come between Mars and the Sun on May 22nd, an arrangement called Opposition. On that day, Mars will rise with the setting Sun and be visible the entire night. At closest approach, Mars will be approximately 46.8 million miles (75.3 km) from Earth (the distance at Opposition can vary from 34.6 million miles to 63 million miles due to Mars' highly elliptical orbit). The planet will appear larger than in its previous 2014 Opposition (being almost 10 million miles closer), but unfortunately for northern hemisphere observers, 16.5° lower in sky.

Mars can be found in the constellation Scorpius during the month of May. The planet will be relatively bright with an apparent magnitude of -2.0. Mars will be relatively close to Antares (5° at the beginning of the month and 12° at month's end), the brightest star in the constellation Scorpius and the 15th brightest star in the night sky. The red supergiant is also known as the "Heart of the Scorpion." The name Antares is derived from ancient Greek, meaning the rival or equal of Mars due to its similar reddish-orange hue.

For telescopic observers attempting to view the planet's surface features, Martian weather reports can be found on the Malin Space Science Systems website *(http://www.msss.com/)*. The development of regional dust storms can be of particular interest since they can quickly grow to engulf the entire planet for months as they did in 2001. 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. In May, it is late summer in the northern hemisphere and the northern pole is tipped towards Earth.

Surface markings are difficult to discern on Mars due to its relatively small size and great distance, even in the largest telescope. A map or guidebook such as William Hartman's "A Traveler's Guide to Mars" can be helpful in identifying those Martian landmarks that are visible.



JPL's Solar System Simulator
http://space.jpl.nasa.gov/

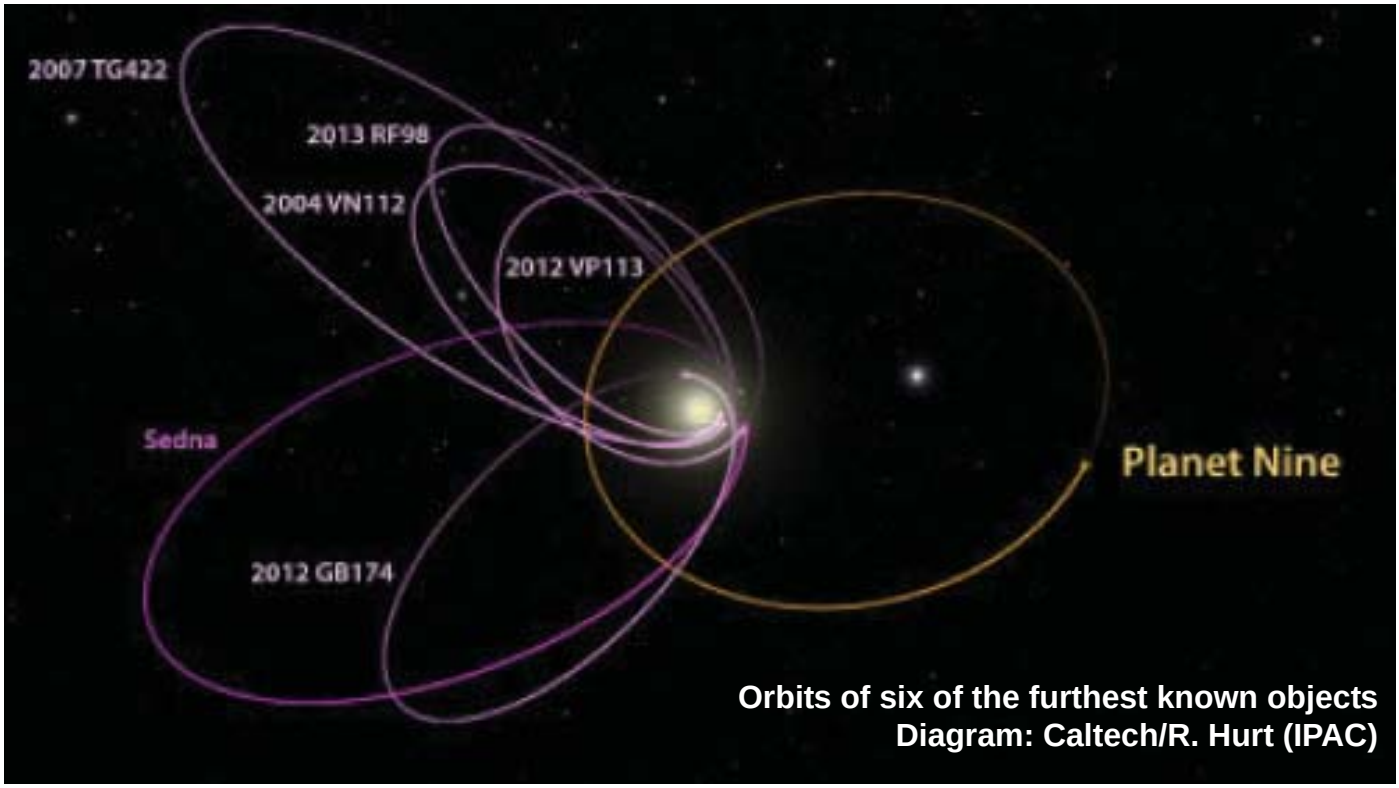
Number Nine?

Astronomer Mike Brown (discoverer of the dwarf planet Eris) and planetary scientist Konstantin Batygin have proposed the existence of a large planet at the outer edge of the solar system as a possible explanation for the unusual clustering of distant Kuiper Belt objects. Their calculations suggest that the planet, if it exists, would have to be more than 10 times the mass of the Earth and closer to the size of Neptune to produce the desired effects.

While astronomers have been working out potential orbits for the hypothetical planet (informally called "Planet 9"), detecting the planet may prove to be more difficult, particularly if it is close to aphelion (the furthest part of its elliptical path around the Sun).

New Martian Maps

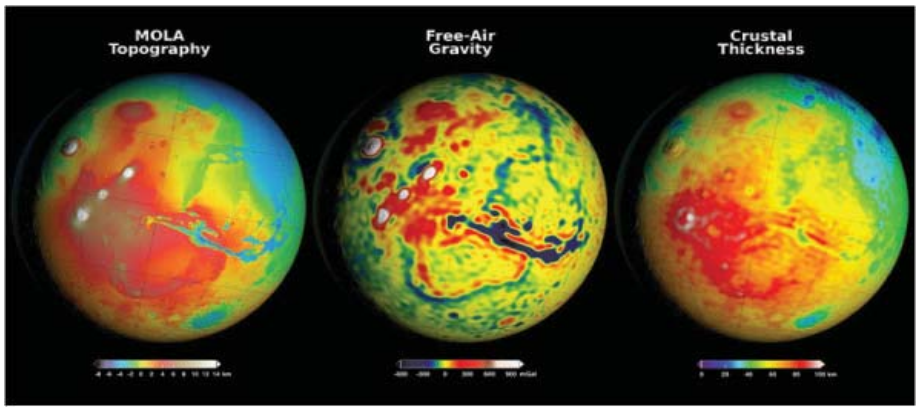
Small deviations in the positions and velocities of the Mars Global Surveyor, Mars Odyssey and Mars Reconnaissance Orbiter spacecrafts as they orbit Mars have been used to generate a detailed map of the local variations in Mars' gravity. The information was superimposed on the topographical data collected by the Mars Global Surveyor's



Orbits of six of the furthest known objects
Diagram: Caltech/R. Hurt (IPAC)

Mars Orbiter Laser Altimeter (MOLA) to create a global gravity map. Crustal thickness was derived from the gravity map. The massive Tharsis plateau or bulge is visible in all three maps with its three large volcanoes.

The red and white colors on the gravity map (next page) show areas where the gravity is higher than average. This is particularly noticeable around the shield volcanoes where a thick crust is also indicated. The dark blue color indicates areas with lower than average gravity (and a thinner crust). The 2,500 mile (4,000 km) long Valles Marineris runs along the Martian equator from the Tharsis plateau. The canyon's dark blue color in the gravity map corresponds to the low altitude trench in the topographic map.



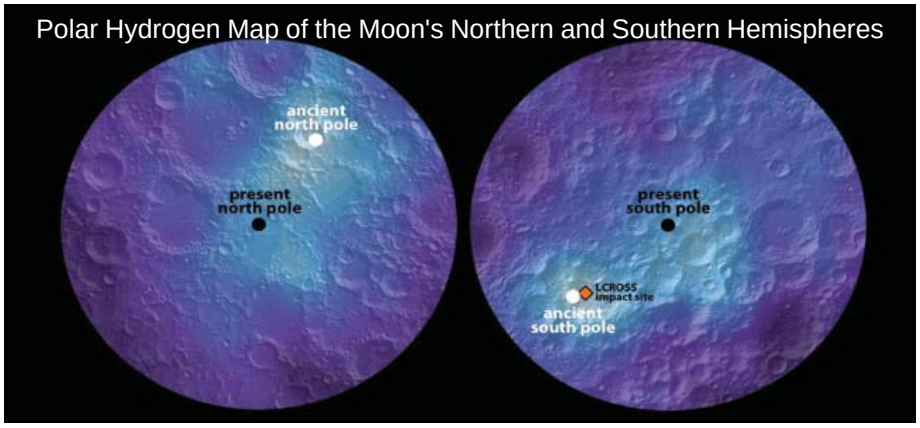
Global Topography, Gravity and Crustal Maps Produced by Orbiting Spacecraft Credits: NASA/GSFC/Scientific Visualization Studio

A Tilted Moon

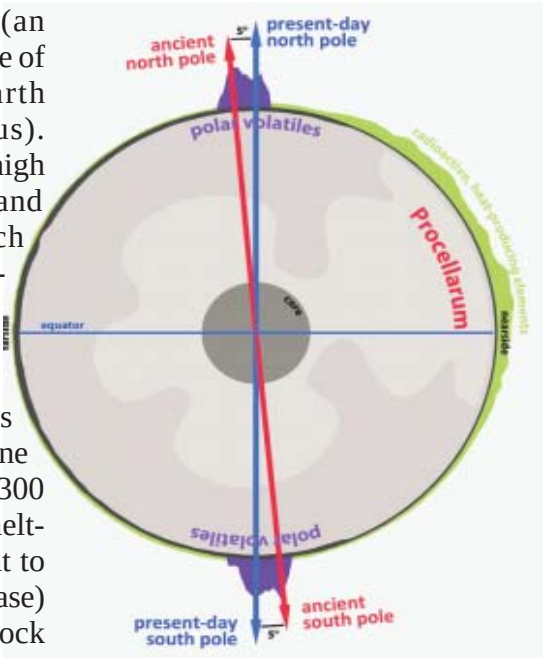
Researchers studying ice deposits at the Moon's poles believe that there is evidence to suggest that a shift occurred in the Moon's spin axis approximately 3 billion years ago. The hypothesis is supported by data collected from several missions, including Lunar Prospector, Lunar Reconnaissance Orbiter, Lunar Crater and Observation Sensing Satellite, and the Gravity Recovery and Interior Laboratory.

Ice has been detected in the permanently shadowed areas of the Moon near the poles. However, researchers also found remnants of ice deposits that suggest that the pole may have been originally offset 5° from the current location. The shift in the axis exposed much of the original ice deposits to the Sun. While most of the ice sublimated into space, enough remained to record the direction and degree of the axial shift.

What caused the axial shift is less certain. One theory offers that it was the result of a redistribution of mass, possibly from the formation of Oceanus Procellarum (the Ocean of Storms). The rock under this expansive lunar mare contains high concentrations of KREEP (an acronym representing a mixture of K-potassium, REE-rare earth elements, and P-phosphorus). KREEP basalts also contain high concentrations of uranium and thorium, the decay of which produces heat. Radiogenic heating could have kept the Moon's mantle molten beneath Procellarum for billions of years. Depending upon the mass of the KREEP layer, the melt zone may have extended more than 300 miles below the surface. The melting would have been sufficient to cause a localized change (increase) in the density of the mantle rock and shift the Moon's rotational axis to the degree indicated by the polar ice deposits.



Credits: James Keane, University. of Arizona; Richard Miller, University of Alabama at Huntsville



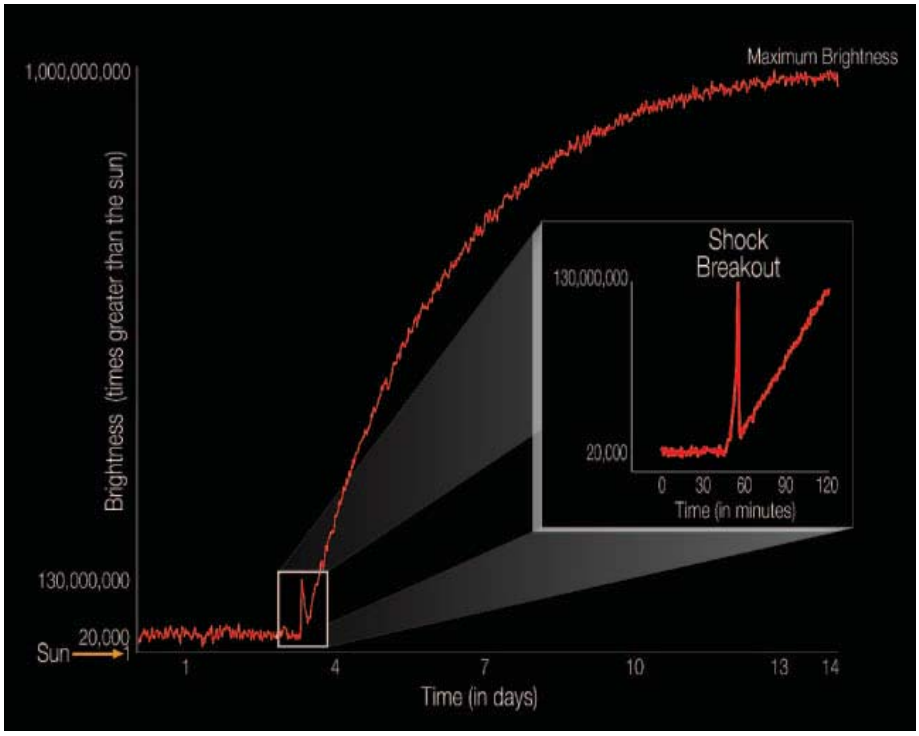
Proposed Reorientation of the Moon's Spin Axis Credits: James Tuttle Keane, University of Arizona

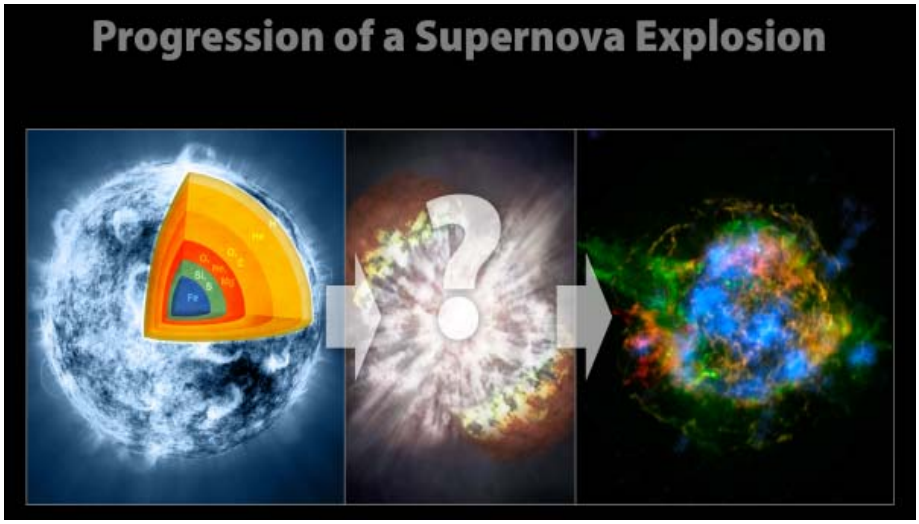
Supernova Breakthrough

Stars fuse hydrogen into helium for almost their entire lifespan. As the hydrogen is depleted and energy production slows, gravity begins to collapse the core. The collapse increases the temperature in the core and hydrogen fusion moves out into the layers surrounding the core. The energy released expands the star's outer layers, which cool and the star becomes a red giant.

The increase in the star's core temperature allows fusion of heavier elements, beginning with helium to carbon, carbon to oxygen, oxygen to neon and so on. The fusion of progressively heavier elements requires an increasingly higher temperature and yields less and less energy as a result. Energy production ends with iron (and nickel) as fusion to more massive elements require more energy than released by the fusion process. The buildup of inert iron in the core accelerates the collapse of the core which can be halted by neutron degeneracy (no two neutrons can occupy identical states). As a result, the iron rich core becomes a high density, incompressible soup of neutrons and neutrinos. With the cessation of meaningful energy production in the core, the outer layers of the star quickly collapse. The collision of the star's outer layers with the incompressible core produces a cataclysmic shock wave that races outward in a violent explosion. The energy (in visible light) produced by the explosion produces the most luminous event in the galaxy (peaking at about 1 billion times the brightness of our Sun).

Scientists, for the first time, have captured the breakout (from the surface of the star) of the shock wave during a supernova explosion. Since the event lasts only 20 minutes or so, catching the breakout required the international science team led by Peter Garnavich, to review data from 50 trillion stars from 500 galaxies over a three year period. The team found that the Kepler spacecraft recorded the explosion of two massive stars in 2011



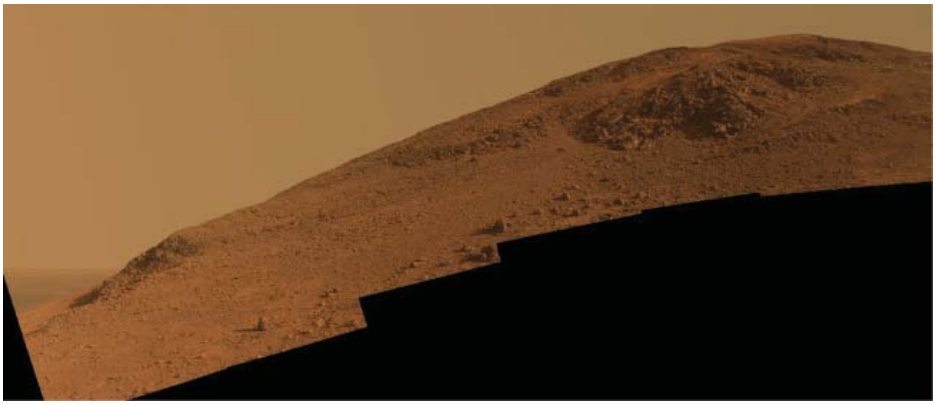


Artist impressions of the progressive stages of a supernova, as heavy elements mass in its interior, it explodes, and sheds its outer layers as a supernova remnant. The images can be found at *http://chandra.harvard.edu/photo/2012/casa/more.html* (left); *http://chandra.harvard.edu/photo/2007/sn2006gy/index.html* (center) and *http://www.nasa.gov/nustar and http://www.nustar.caltech.edu/*.

(KSN 2011a, approximately 300 times the size of our Sun and KSN 2011d, approximately 500 times our Sun).

The diagram above shows the light curve for the KSN 2011d supernova. The supernova reaches maximum brightness (y-axis) in about 14 days (x axis). An early flash of light (130 million times brighter than our Sun) occurs much earlier and reveals the breakout of the shockwave from the surface of the star.

Some of the energy released in the explosion creates elements heavier than iron. Those elements, such as gold, zinc, and uranium seed the interstellar space around the star and are incorporated into the formation of a new generation of stars. The metal-rich content of our Sun (and Earth) suggests that our Sun is a second and possibly third generation star (first generation stars being metal poor).



Off-Roading on Mars

NASA's Mars rover Opportunity set another record in its exploration of Endeavour Crater. While climbing Knudsen Ridge in search of clay deposits, the diminutive rover's tilt hit 32°. Unfortunately, the slippage of the rover's wheels on the inclined surface was so great that Opportunity was unable to reach its target (by inches) and after three attempts, had to retreat. The climb surpassed the record (also held by Opportunity) for the steepest slope attempted by a rover.

Opportunity spent the Martian winter exploring Marathon Valley, an east-west cut in the rim of Endeavour crater. The valley's topography provided the rover with sun-facing slopes for its solar panels and potential science targets (deposits of clay bearing minerals have been detected in the area by orbiting spacecraft). Marathon Valley also provided Opportunity an excellent vantage point from which to view the interior of the 14-mile diameter crater. On March 31st, the rover's navigation camera caught a dust devil churning across the crater's floor. While dust devils were relatively common at Gustev Crater, the landing site of Spirit, Opportunity's twin, sightings at Meridiani Planum have been rare.

Dust devils are rotating columns of warm air. Small dust particles are drawn up into the column, making the column visible to the observer.

The Astronomers Monument at Griffith Observatory

Astronomers Hipparchus, Copernicus, Galileo, Kepler, Newton (center) and Herschel
Photo: Bill Cloutier

Public Astronomy

Eighty-one 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 laterThe planetarium was only the third of its kind in the United States; the technology was not even invented until four years after Griffith's death.

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

Space Shuttle History

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

Endeavour flew its 25th and final mission (STS-134) in May 2011 (the next to last shuttle flight). Commander Mark Kelly was the last astronaut to disembark from the shuttle at the conclusion of the mission. In September 2012, the shuttle was flown to Los Angeles on top of a Boeing 747 for permanent display at the California Science Center. Endeavour is currently in temporary storage at the museum and will be displayed in a launch configuration (vertical) once construction of the Samuel Oschin Air and Space Center is complete. The Science Center had previously acquired a pair of solid rocket boosters (currently in storage at NASA's Armstrong Flight Research Center at Edwards, California) for the display. Last year (May 2015), they announced that they had acquired the only flight-qualified external tank in existence. The tank had been built in 2000 for the Columbia shuttle but never flew (it was replaced by a lighter version before it was assigned to a flight).

The external tank left NASA's Michoud Assembly Facility for California on April 12th. The tank is traveling by barge and has recently passed through the Panama Canal. It is scheduled to arrive in Marina del Rey in late May.

The External Tank (ET-94) is 28 feet in diameter, 154 feet long and weight approximately 65,000 pounds. The tank is scheduled to be moved through the streets of Los Angeles to the Science Center on May 21st, following the route previously taken by Endeavour.

External Tank on the Barge
Credit: Francine Orr-Los Angeles Times

Sometime in the next three years, the refurbished tank will be lifted into a vertical configuration to form the structural support for the Endeavour orbiter and the twin solid rockets for display in Samuel Oschin Air and Space Center.

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. The New Moon is on the 6th this year and will not interfere with viewing the shower.

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.

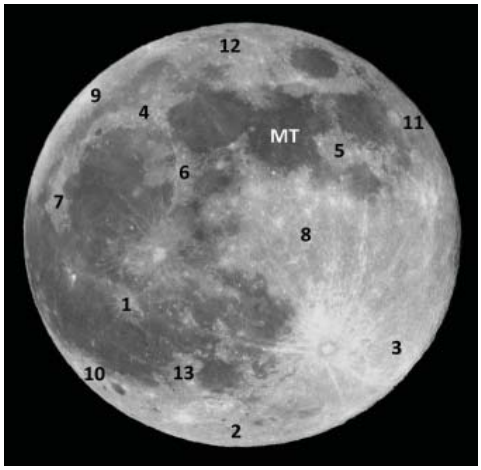
Lunar cartography or mapping was both limited and crude until Galileo first trained his telescope upon the Moon. With the ability provided by the telescope to resolve individual features came the need for a uniform or standard naming convention. The first such detailed map was created by Belgian astronomer Michel Langren in 1645. Features on Langren's map were named for prominent eaders 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" ncluded maps of every lunar phase developed over several years of observing. Unlike Langren, Hevelius used the names of terrestrial features for his lunar maps, specifically from ancient Greece and Rome. His naming convention was widely used by European astronomers for over a century. However, Hevelius' lunar nomenclature was gradually replaced by a naming convention developed by Jesuit astronomer Giovanni Riccioli.

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

Many of Riccioli's original names remain in use today after being officially recognized by the International Astronomical Union in 1935. What have been lost are the names of the areas between the seas or the Moon's bright crust. Riccioli originally

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)



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

assigned names to these areas in a manner similar (although sometimes opposite) to what he used for the lunar seas (Land of Heat, Hail, Frost, Dryness and Sterility).

Today, references to the lunar crust or "land" are generally non-descript and sterile in comparison (south polar region, eastern limb, Descartes highlands) to Riccioli's imaginative and sometimes poetic labels. Several of the areas described by Riccioli on Grimaldi's maps (shown above) are indicated on the next page.

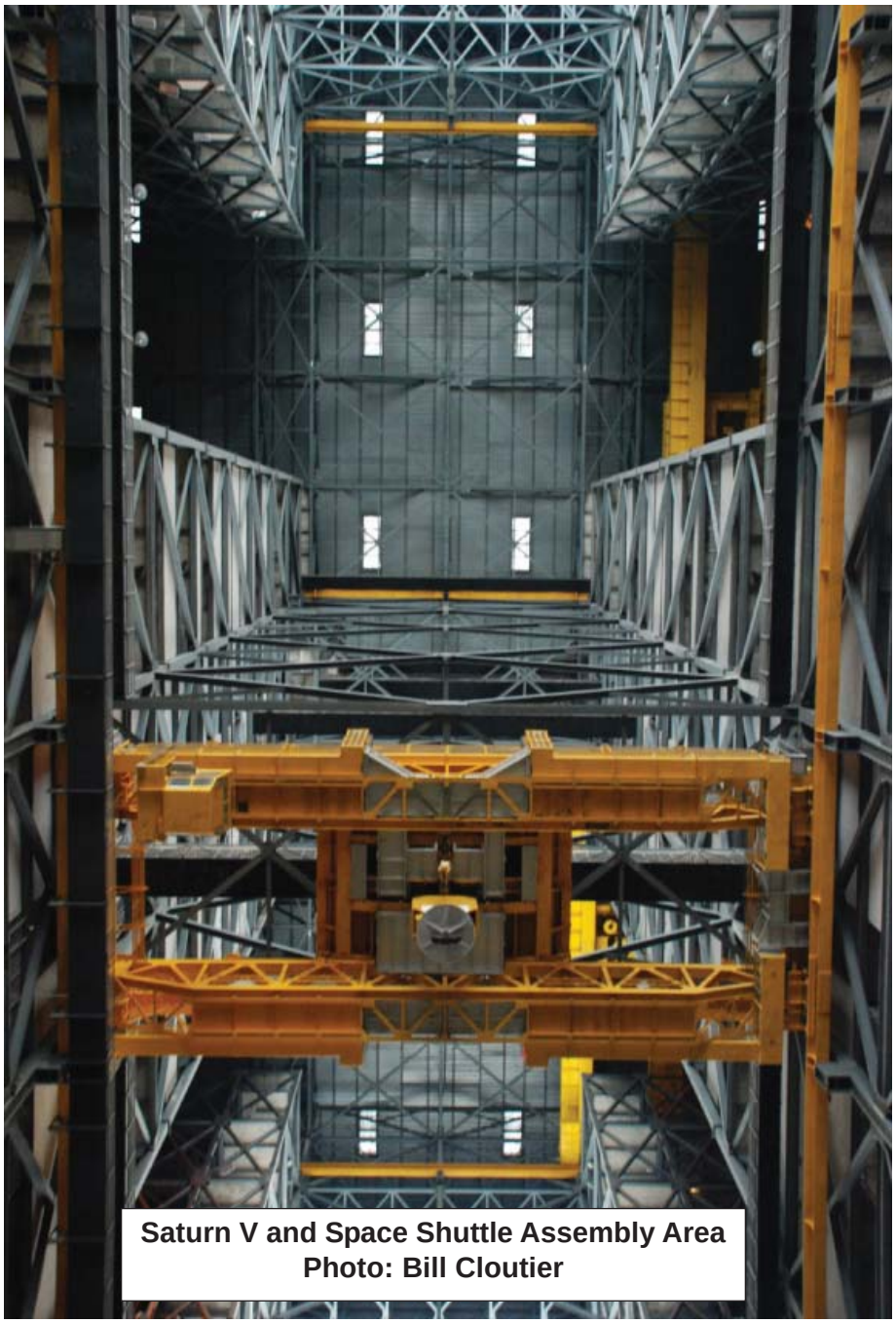
So, the next time you see the Moon in the sky, take a few minutes and reacquaint yourself with a part of history. Once you have located Mare Tranquillitatis (MT) or the Sea of Tranquility* on the moon's eastern (right) limb, look for Terra Sanitatis or the Land of Healthiness, the adjoining brighter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

May History

On May 25, 1961, President Kennedy, in an address before a joint session of Congress, set forth a challenge to the American people: "I

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

Lost in the political posturing and often overlooked is that, in less than 10 years, on May 20th, 1969, the 456 foot tall doors on the Vehicle Assembly Building at the Kennedy Space Center opened to reveal AS506, the official designation of the Saturn V rocket that would carry Apollo 11 to the moon. More than 20,000 private firms and hundreds of thousands of workers participated in this program, for a fraction of the cost of the Vietnam War. Not only did the United States reach the Moon, it built a national infrastructure of technology, manufacturing and education that has not been rivaled. In 1969, the United States was truly on top of the world.



Saturn V and Space Shuttle Assembly Area
Photo: Bill Cloutier

Jupiter and its Moons

Jupiter reached Opposition and its closest approach to Earth in early March. During the month of May, Jupiter is still well placed in evening sky after sunset. Jupiter will be at its highest approximately an hour after sunset on May 1st (9:15 pm) and almost two hours earlier by month's end. As the Earth moves ahead of Jupiter on its inside orbit, Jupiter will diminish slightly in brightness and apparent size. As one of the brightest star-like objects in the night sky, Jupiter can be found in the constellation Leo.

Photo: Bill Cloutier

One of the more interesting and easier events to observe through a telescope is the projection of a shadow from one of Jupiter's moons on the Jovian disk as the moon passes in front of (or transits) the planet. The photo on the right shows the shadow of Ganymede on the Jovian disk. On nights of good visibility the following events should be viewed through a moderately-sized telescope.

The Red Spot is a large cyclone in the upper Jovian atmosphere. The rapid rotation of this gas giant (10 hours) may be responsible for the longevity of this storm, which has been observed for over 300 years. The Red Spot will cross the center line of the planetary disk on the following evenings during the hours between 8 pm to midnight local time:

Jovian Moon Transits

Date	Moon	Transit Begins	Transit Ends
5th	Ganymede	7:41 pm	10:53 pm
6th	Callisto	11:18 pm	1:42 am (8th)
7th	Io	1:39 am	2:53 am
8th	Io	7:07 pm	9:21 pm
10th	Europa	6:43 pm	9:27 pm
12th	Ganymede	11:40 pm	2:51 am (13th)
15th	Io	9:02 pm	11:16 pm
17th	Europa	9:20 pm	12:04 am (18th)
22nd	Io	10:57 pm	1:11 am (23rd)
24th	Europa	11:57 pm	2:40 am (25th)

Red Spot Transits

Date	Transit Time	Date	Transit Time
2nd	8:22 pm	18th	11:36 pm
4th	10:01 pm	21st	9:06 pm
6th	9:09pm	23rd	10:45 pm
11th	10:48 pm	26th	8:15 pm
14th	8:18 pm	28th	9:54 pm
16th	9:57 pm	30th	11:33 pm

Sunrise and Sunset

Sun	Sunrise	Sunset
May 1st (EST)	05:50	20:07
May 31st	05:22	20:21

May Nights

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

Astronomical and Historical Events

1st Apollo Asteroid 2014 US115 near-Earth flyby (0.024 AU)
1st Apollo Asteroid 3752 Camillo closest approach to Earth (1.598 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 History: discovery of the first binary star (Xi Ursae Majoris) by William Herschel (1780)
3rd Apollo Asteroid 444584 (2006 UK) near-Earth flyby (0.046 AU)
4th Apollo Asteroid 2016 EK56 near-Earth flyby (0.081 AU)
4th Kuiper Belt Object 2010 FX86 at Opposition (45.281 AU)
4th History: launch of the AQUA satellite to study precipitation, evaporation, and the cycling of Earth's water (2002)
4th History: launch of the Magellan/Venus radar mapping spacecraft and attached Inertial Upper Stage from the space shuttle Atlantis (STS-30) (1989)
5th Eta Aquarids meteor shower peak (best viewing: early morning on the 5th and 6th)
5th Apollo Asteroid 388945 (2008 TZ3) near-Earth flyby (0.034 AU)
5th Centaur Object 144908 (2004 YH32) at Opposition (11.747 AU)
5th History: launch of Freedom 7 and astronaut Alan Shepard aboard a Mercury-Redstone rocket, first American in space (1961)
6th New Moon
6th Moon at perigee (closest distance from Earth)
6th Flyby of Saturn's largest moon Titan by the Cassini spacecraft
6th Atira Asteroid 434326 (2004 JG6) closest approach to Earth (0.825 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 Second Saturday Stars - Open House at McCarthy Observatory
7th Kuiper Belt Object 90568 (2004 GV9) at Opposition (38.458 AU)
8th Apollo Asteroid 2014 JG55 near-Earth flyby (0.020 AU)
8th Apollo Asteroid 2010 KP10 near-Earth flyby (0.076 AU)
9th Mercury Transit (crosses in front of the Sun)
9th Apollo Asteroid 2063 Bacchus closest approach to Earth (0.878 AU)
9th History: launch of MUSES-C (Hayabusa), Japanese sample return mission to asteroid Itokawa (2003)
9th History: first Earth-based laser aimed at the Moon: crater Albategnius (1962)
9th History: launch of first production model of the Project Mercury capsule from Wallops Island, Virginia to test the escape system (1960)
10th History: President Truman signs Public Law 507, creating the National Science Foundation (1950)
10th History: Estherville Meteorite Shower: a 455 pound meteorite fell to earth in Emmet County, just north of Estherville, Iowa, where it buried itself 15 feet in the ground - largest meteorite known to have fallen in North America (1879)
11th History: launch of the space shuttle Atlantis (STS-125), final Hubble Space Telescope servicing mission (2009)
12th History: first planetarium (Adler Planetarium in Chicago) opens in United States (1930)
13th First Quarter Moon
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 Apollo Asteroid 1866 Sisyphus closest approach to Earth (1.576 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)

Astronomical and Historical Events (continued)

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 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 2016 BX14 near-Earth flyby (0.058 AU)
16th Kuiper Belt Object 2015 KH162 at Opposition (58.159 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 Aten Asteroid 5381 Sekmet closest approach to Earth (0.489 AU)
17th Atira Asteroid 164294 (2004 XZ130) closest approach to Earth (0.667 AU)
17th Kuiper Belt Object 65407 (2002 RP120) at Opposition (26.911 AU)
17th History: Soviet spacecraft Venera 6 returns 51 minutes of data while descending by parachute through the atmosphere of Venus and before impacting the surface (1969)
17th History: discovery of Jupiter's cloud belts by Italian Jesuit, astronomer, and physicist Niccolo Zucchi (1630)
18th Moon at apogee (furthest distance from Earth)
18th History: launch of Apollo 10 with astronauts John Young, Tom Stafford and Gene Cernan; the lunar module Snoopy was flown within 50,000 feet of the lunar surface while the command module Charlie Brown orbited the Moon (1969)
19th History: launch of the first Army Hermes A-1 rocket from White Sands, NM (1950)
20th History: launch of the Pioneer Venus 1 spacecraft (1978)
21st Full Moon (Full Flower Moon)
21st Plutino 38628 Huya at Opposition (27.569 AU)
21st Plutino 2006 HJ123 at Opposition (33.726 AU)
21st History: launch of the Japanese Venus Climate Orbiter Akatsuki or Planet-C spacecraft and the Ikaros solar sail (2010)
22nd Mars at Opposition, rising with the setting Sun and visible all night
24th Apollo Asteroid 2009 DL46 near-Earth flyby (0.016 AU)
24th Amor Asteroid 2016 CF194 near-Earth flyby (0.053 AU)
24th History: launch of Aurora 7 and astronaut Scott Carpenter aboard a Mercury-Atlas rocket; second American to orbit Earth (1962)
24th History: launch of Midas 2; first Experimental Infrared Surveillance Satellite (1960)
25th History: the Phoenix spacecraft lands in the Martian arctic (2008)
25th History: launch of Skylab I crew; astronauts Pete Conrad, Paul Weitz and Joseph Kerwin (1973)
25th History: President John F. Kennedy's Moon goal speech to Congress (1961)
25th History: science fiction writer and futurist Arthur C. Clark proposes communication satellites in geosynchronous orbit (1945)
25th History: first recorded perihelion passage of comet Halley by Chinese astronomers (240 BC)

Astronomical and Historical Events (continued)

26th History: launch of the first "Navaho Missile," a pilotless aircraft consisting of a missile and a booster; program goal was to determine the feasibility of an intercontinental missile (1948)
28th Asteroid 588 Achilles (Jupiter Trojan) closest approach to Earth (4.895 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 Last Quarter Moon
29th Kuiper Belt Object 2007 JH43 at Opposition (39.549 AU)
29th History: launch of Luna 22 (USSR), lunar orbiter mission that included imaging as well as studying the Moon's magnetic field, the composition of lunar surface rocks, and the gravitational field (1974)
29th History: measurements during solar eclipse agree with predictions based on Einstein's General Relativity theory (1919)
30th History: launch of Mariner 9, Mars orbiter and first artificial satellite of Mars; mapped Martian surface and imaged moons Phobos and Deimos (1971)
30th History: launch of Surveyor 1, Moon lander; transmitted over 11,000 images from Oceanus Procellarum (1966)
31st Apollo Asteroid 2015 YU1 near-Earth flyby (0.072 AU)
31st Apollo Asteroid 37655 Illapa closest approach to Earth (1.017 AU)
31st Kuiper Belt Object 278361 (2007 JJ43) at Opposition (40.132 AU)
31st History: European Space Agency's birthday (1975)

Commonly Used Terms

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

References on Distances

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

• 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

Image Credits

Front page design and graphic calendars: Allan Ostergren

Cover image: In the Universe, size is not all that matters, and nothing is forever. The biggest and brightest stars tend to burn hotter and faster, depleting their essential fuel (hydrogen, helium and other heavy elements) while smaller stars liike our own just power along.

When a massive star begins to run out of fuel it expands—but its core ultimately collapses to form a neutron star or black hole, while its outer layers of ionized gas are scattered through the celestial neighborhood as a planetary nebula.

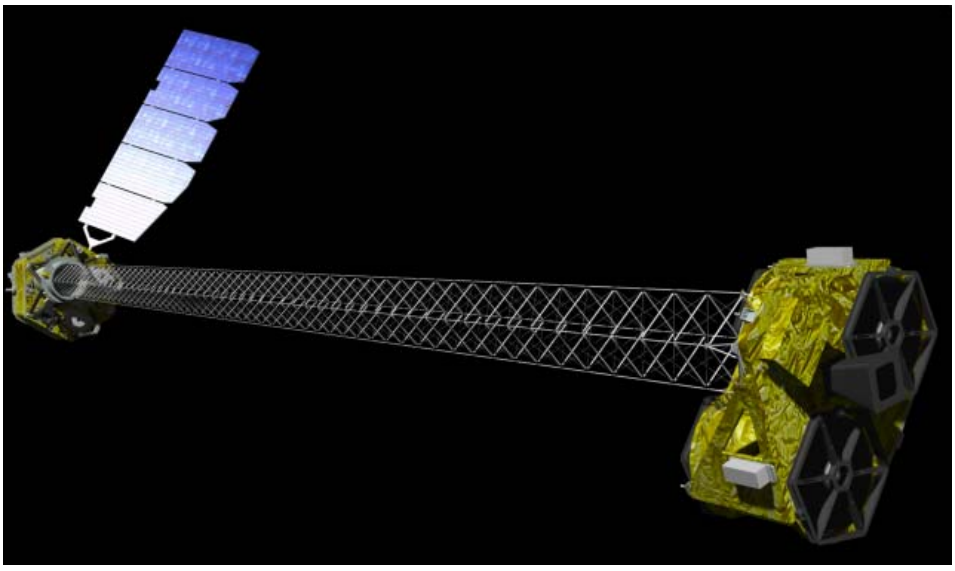
Cassiopeia A is a familiar supernova remnant first seen on Earth about 350 years ago. The image on page 1 was generated by NuSTAR, NASA's space-based x-ray telescope, which can detect and map the diverse ejecta released in the conflagration - including titanium-44, as well as the non-radioactive elements of stardust like iron and calcium, that we have all inherited. The data captured by NuSTAR will open a new perspective on the powerful life and death processes powering the universe.

Image credit: NASA/JPL-Caltech/CXC/SAO

Page 3 graphic: With the arrival and capture of the SpaceX Dragon cargo-carrying spacecraft on April 10th (top photo), the International Space Station was home to six spacecraft. The bottom photo shows Orbital ATK's Cygnus cargo-carrying spacecraft on the left (with a portion of one of its two circular solar arrays visible), a Russian Soyuz crew-carrying spacecraft (center), and a Russian Progress cargo-carrying spacecraft (right). Two other spacecraft (a Russian Soyuz and a Russian Progress) are also docked at the station.

For more on supernovae, go to page 8 within. Information on NuStar can be found at *http://science.nasa.gov/missions/nustar/*.

Second Saturday Stars poster: Marc Polansky



Artist's impression of the NuStar x-ray telescope.
Source: NASA/JPL-Caltech

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 14th

8:00 - 10:00 pm

Pluto Revealed:

The New Horizons Mission

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

Map

May 2016

Celestial Calendar

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
1  Gerard Kuiper discovers Neptune's Moon Nereid 1949 Discovery of Mars meteorite *Dar al Gani* 1998  Space Day	**2**  Cassini, Enceladus Flyby Cassini: Distant Flyby of Polydeuces, Atlas & Dione  Asteroid 1992 JD Near-Earth Flyby (0.024 AU)	**3**  Edmund Halley observes total eclipse phenomenon "Baily's Beads" (1715)	**4**  Launch of Magellan spacecraft to Venus by space shuttle Atlantis (1989)  Launch of the AQUA satellite to study precipitation, evaporation, and the cycling of Earth's water (2002)	**5**  Eta Aquarids meteor shower peak Alan Shepard first American in space 1961 	**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  Moon at perigee (closest distance to Earth)  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)	**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)   2nd Saturday Stars Open House McCarthy Observatory Hubble Birthday Party
15  6th docking of a space shuttle (Atlantis) with Russian space station Mir (1997) Launch of Faith 7 - Final Mercury mission 1963 	**16**  Soviet spacecraft Venera 5, 6 send data on Venus, then impact planet May 16-17,(1969)  Space Shuttle Endeavour final launch (2011)	**17**  Norman Lockyer born, co-discoverer of helium (1836) Discovery of Jupiter's cloud belts by Italian Jesuit, astronomer, and physicist Niccolo Zucchi (1630) 	**18**  Moon at apogee (farthest from Earth)  Apollo 10 to Moon Young/Stafford/ Cernan (1969)	**19**  Launch of first Army Hermes A-1 rocket from White Sands, NM (1950)	**20**  Launch of 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 spacecraft lands 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 European Space Agency Born 1975	**30** Launch of Luna 22 (USSR), orbiter mission to study the Moon's magnetic field, geology and gravitation (1974) Measurements during solar eclipse confirm Einstein's relativity theory - 1919 	**31** Mariner 9, 1st artificial satellite of Mars (1971) Launch of Surveyor 1 Moon lander; transmitted over 11,000 images from Oceanus Procellarum (1966)				

Phases of the Moon

May 6 May 13

May 21 May 29