Galactic Observer

John J. McCarthy Observatory

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Celestial Home Invasion

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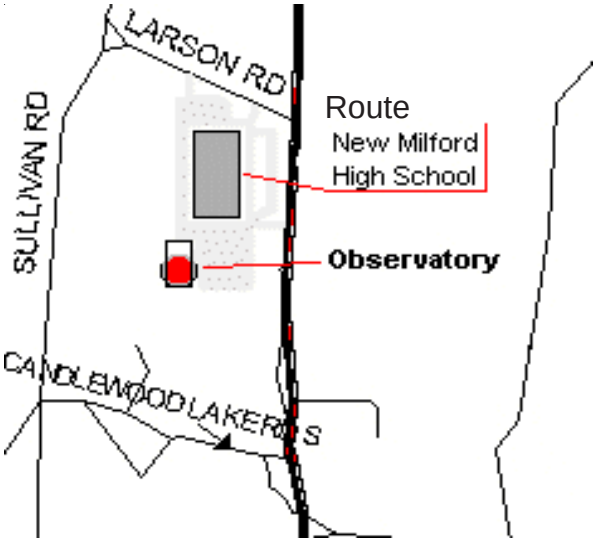

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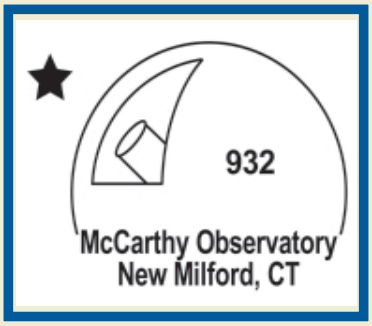
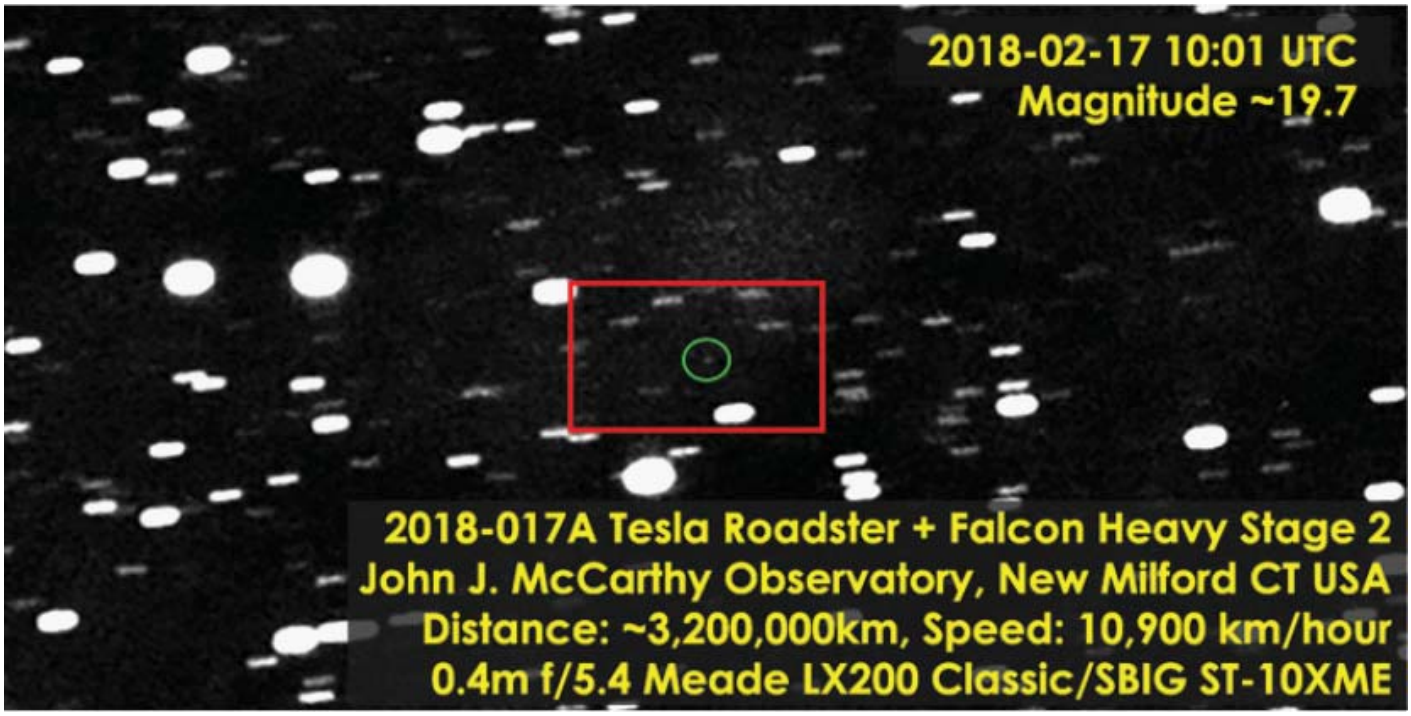




In Pursuit of Starman

On February 6th, the Falcon Heavy booster took flight from Pad 39A at the Kennedy Space Center on its maiden journey. Instead of a traditional and sacrificial payload for a test flight, Elon Musk donated his cherry red Tesla roadster, complete with a space-suited mannequin behind the wheel. Approximately six hours after launch, the second stage engine was reignited, propelling the payload out of Earth orbit and into a helio-centric orbit that will extend beyond the orbit of Mars.

Since that time, astronomers around the world have been recording its trajectory, setting new records almost daily for the most distant image of the Tesla (which is still attached to the second stage). In the early hours of February 17th, a group of sleep-deprived observers from the McCarthy Observatory imaged the object from 3.2 million kilometers (2 million miles) as it raced through the constellation Hydra at 10,900 kph (7,000 mph). It was a new (but short-lived) distance record, but nonetheless a remarkable achievement for a 0.4 meter telescope located near sea level, observing an object at almost magnitude 20, low in the sky, with sky glow from the lights of near-by towns and occasional bands of pesky clouds (while under a winter weather warning).

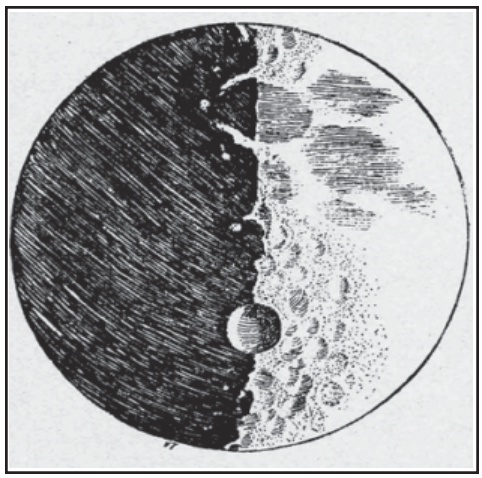
The team was able to image the target again on the morning of the 19th at a distance of almost 3.8 million kilometers (2.4 million miles) and fainter than 20 magnitude.

[On a clear, dark night, stars as faint as 5th magnitude are visible to the human eye without aid. The Tesla on February 17th was more than 700,000 times dimmer.]

Image by Marc Polansky (McCarthy Observatory)

"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).



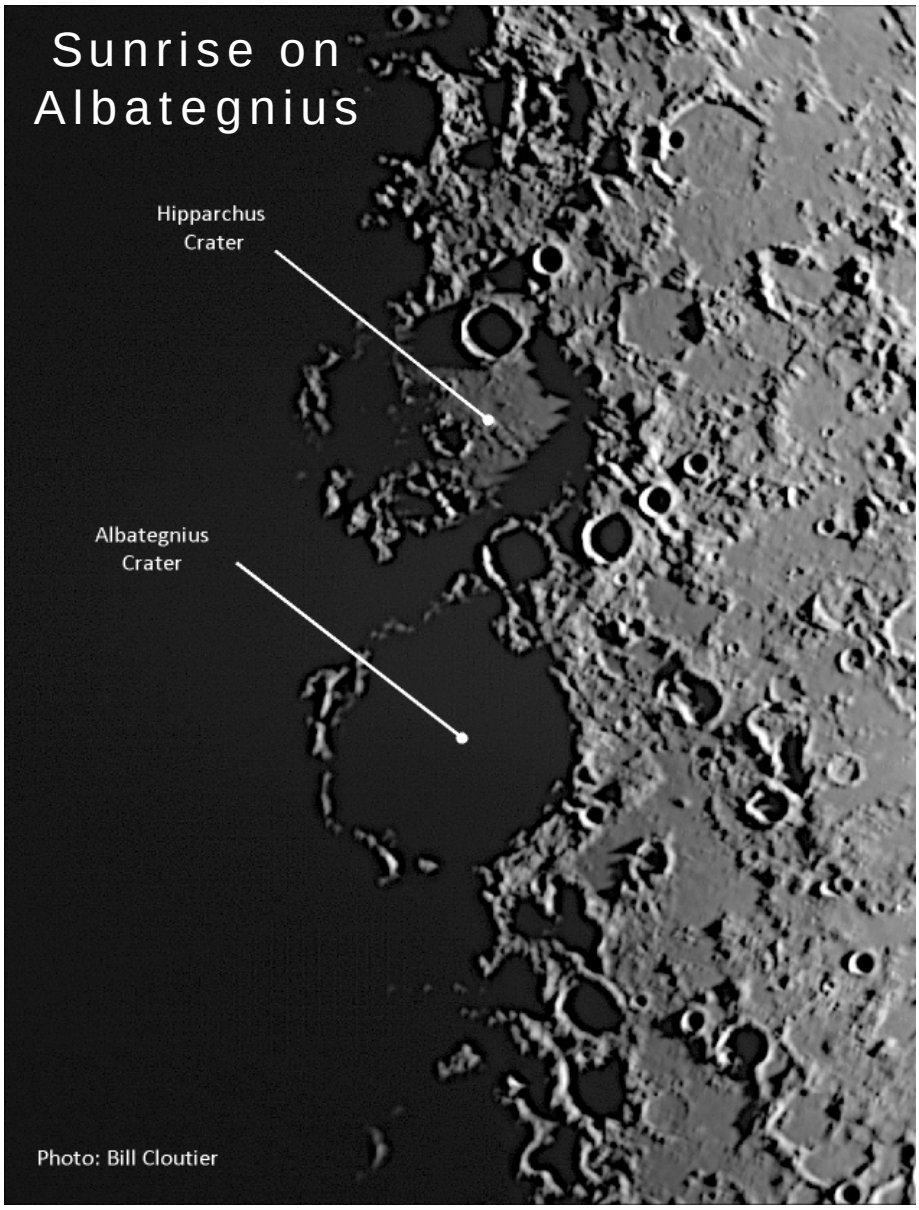
Sketch of a seven day old Moon with what is believed to be the crater Albategnius on the terminator, south of the lunar equator

On March 13, 1617, Galileo Galilei took receipt of his Sidereus Nuncius, or "Starry Messenger" from a printer in Venice, Italy. The 60-page treatise described his discoveries with the telescope, including the rugged surface of the Moon with prominences "loftier than those of the Earth," the moons of Jupiter in orbit around the gas giant, and the star-filled Milky Way.

The pamphlet includes drawings of the Moon in four different phases. Late selenographer Ewan Whitaker (University of Arizona), dated the drawings based upon events described by Galileo, the location of the terminator, the Sun and Moon's position in the sky, and local weather (whether the conditions were suitable for viewing).

Whitaker provides compelling evidence that Galileo started observing the Moon on November 30, 1609, producing a sketch of the four day old Moon. Three days later he recorded the features of the first quarter Moon, including the craters Aristoteles and Eudoxus just east of the terminator in the far north, the shadow bisecting Mare Senenitatis, and the cratered highlights in the southern hemisphere, punctuated by an exaggerated crater Albategnius. (In his analysis, Whitaker determined that the Moon would have been below the horizon, as seen from Padua, Italy, on alternative dates in early November and January when the terminator would have bisected Albategnius at sunrise.)

Galileo would sketch a third quarter moon on December 18th, again highlighting Albategnius, but with the sun setting. While Albategnius, at 85 miles (136 km) in diameter, is normally much less conspicuous than the large maria to the north, it can cast an imposing presence at sunrise (or sunset), as seen in the photo below.



Another large crater in the southern hemisphere is Hipparchus at 93 miles (150 km) in diameter. However, the crater's features are considerably degraded, with its rim damaged by ejecta from the impact that created the Imbrium basin to the north, and may not have been as well-defined to Galileo through his rudimentary telescope.

Finishing the Lesson

NASA designated the twelve months extending from September 2017 to 2018, the "Year of Education on Station," acknowledging and celebrating crew members with backgrounds in education on the International Space Station (ISS or Station).

Educator-astronauts Joe Acaba, (arrived on the ISS in mid-December 2017 and scheduled to return to Earth at the end of February 2018), and Ricky Arnold (will join the ISS crew in March 2018) are planning to present the science lessons originally prepared by Christa McAuliffe for her flight in 1986 aboard the space shuttle Challenger. McAuliffe was a payload specialist on STS 51-L and had been selected as the first teacher in space, before a tragic accident destroyed the orbiter, taking the lives of all seven crew members shortly after takeoff.

NASA's Year of Education on Station logo. Credit: NASA

The two educator-astronauts will recreate and film four of McAuliffe's six planned lessons/demonstrations on microgravity, effervescence and chromatography and Newton's laws of physics. The lessons will be filmed and made available through the non-profit, Challenger Centers (a global network at more than 40 locations, established to carry on McAuliffe's vision and mission to "Engage students and teachers in dynamic, hands-on exploration and discovery opportunities that strengthen knowledge in science, technology, engineering, and mathematics (STEM), inspire students to pursue careers in these fields, and provide an outlet to learn and apply important life skills.")

Barbara Morgan was McAuliffe's backup on the Challenger flight. She went back to teaching after the accident before being selected as the first educator-astronaut in January 1998. Morgan went on to fly on the space shuttle Endeavour in 2007, as a member of the crew on STS-118. NASA began (for the second time) formal recruitment of educator mission specialists in 2003 (more than 12,000 applications were received in 1984 in the original solicitation, from which McAuliffe was ultimately selected).

Christa McAuliffe in pre-flight weightlessness training. Credit: NASA

"Not Dead Yet"

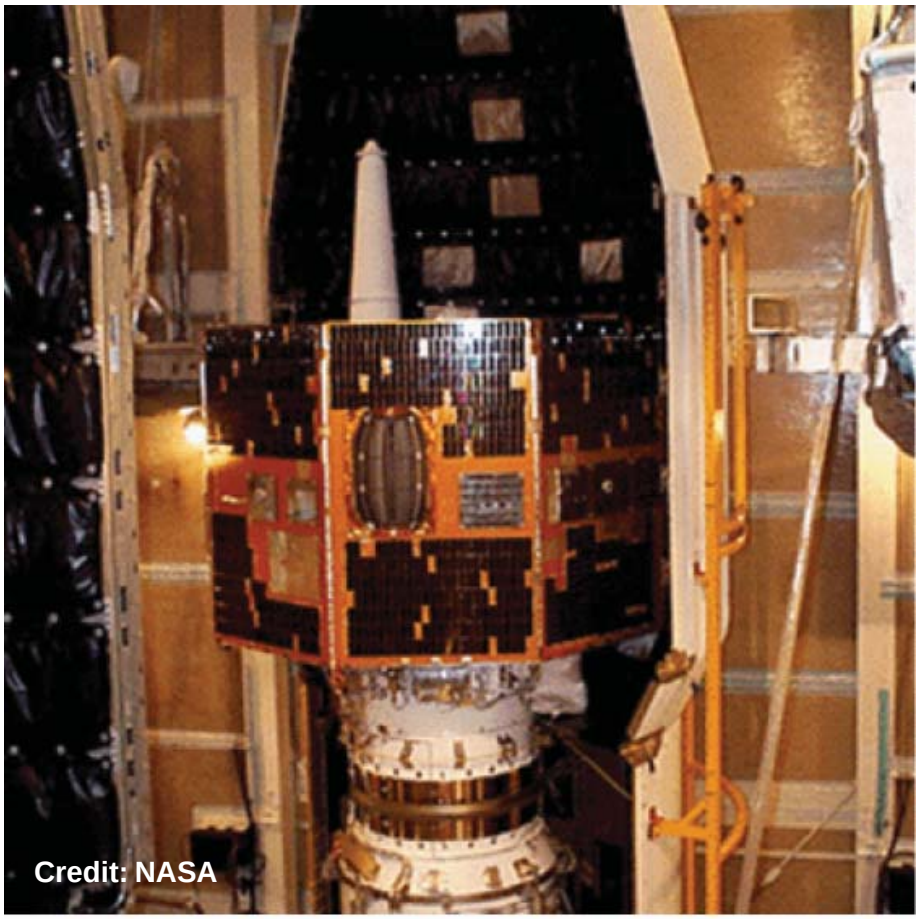
In the early morning hours of Saturday, January 20th, amateur astronomer Scott Tilley of Roberts Creek, British Columbia, started an automated scan of the night sky with a homemade rig in search of artificial satellites and orbiting spacecraft before going to bed. Later that day, while reviewing the previous night's data, Tilley noted an unexpected radio frequency signal. Upon further review and analysis of the frequency modulation, he was able to identify the source as NASA spacecraft 26113 (the Imager for Magnetopause-to-

Aurora Global Exploration, or IMAGE mission). However, not only had he not detected this satellite before, it appeared from his research that no one else had since 2005 when NASA reported a mission-ending power failure.

IMAGE was the first satellite dedicated to imaging the Earth's magnetosphere and the tenuous plasma trapped within its inner regions.

Additional research by Tilley found that NASA had monitored the spacecraft for a reboot that would have restored power, but the spacecraft remained silent and was eventually declared lost. Uncertain as to whether someone would believe that "some guy in his basement with a coil of copper wire on his roof" could find a lost spacecraft, Tilley decided to contact Dr. James Burch, former principal investigator for the IMAGE mission at the Southwest Research Institute in San Antonio, Texas. Tilley's e-mail along with some follow-up observations, however, sent engineers clambering to find the now antiquated hardware and software code needed to establish contact with the spacecraft, including a 4 mm tape cartridge reader that was borrowed from the 1995 Solar and Heliospheric Observatory (SOHO) mission to read the 16-year-old data tapes. Within a week, five antennae, from California to Virginia, were brought online in an attempt to lock onto the satellite's telemetry signal.

The first telemetry files received by the ground stations confirmed the identity of the lost IMAGE spacecraft and showed that its batteries were fully charged. The spacecraft appears to be powered by the bus that had originally failed in 2004, suggesting that a reboot did occur sometime after 2007. Review of data from other sky watchers indicated that IMAGE may have been transmitting since October 2016. While engineers have been able to eavesdrop on the spacecraft, the challenge remains as to whether IMAGE is listening and whether its science instruments can be brought on line. Several of the spacecraft's six instruments may be powered, based upon the telemetry that has been received. Still, it may take some time to recreate the infrastructure needed to establish two way communications with IMAGE and evaluate its operational capabilities.

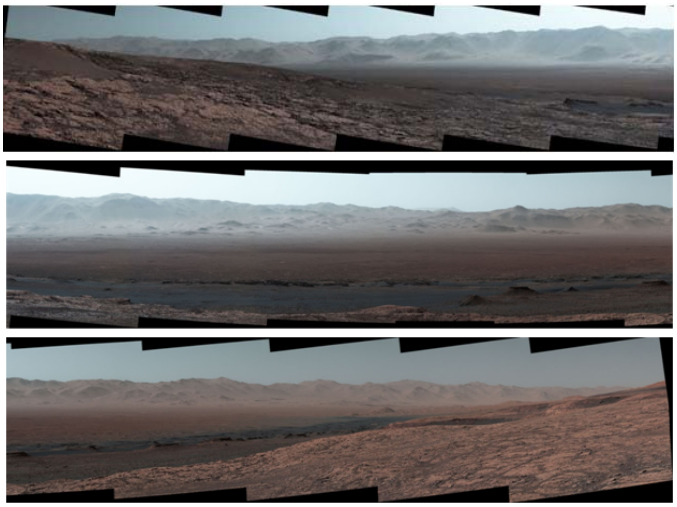


The IMAGE spacecraft installed within the fairing of the Delta II rocket prior to launch on March 25, 2000 from Vandenberg AFB

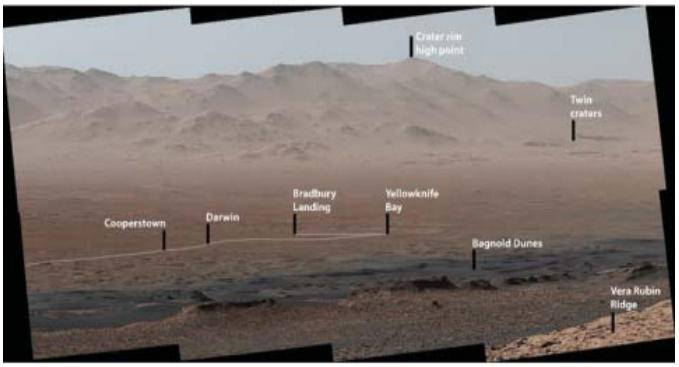
Postcards from the Mars Science Laboratory Curiosity

NASA's Curiosity rover was lowered onto the Martian surface in the summer of 2012 by a rocket powered skycrane. The landing site, designated "Bradbury Landing" after the science fiction writer and author of the Martian Chronicles Ray Bradbury, was near the center of the 96 mile (154 km) diameter Gale Crater and at the base of Mount Sharp, a 3 mile (5 km) high layered mound of sediment.

The rover's ridge top panorama was created from sixteen individual images. At the time the images were taken, the rover had driven 10.95 miles (17.63 km) from its landing site and had gained 1,073 feet (327 meters) in elevation from the crater floor. The crater rim (about 40 miles or 25 km away) was about 1.2 miles (2 km) higher than the rover's elevation.



Composite, wide-angle panorama of Gale Crater from a ridge on Mount Sharp. The images have been white balanced so that the rocks appear as they would under Earth lighting. Credit: NASA/JPL-Caltech/MSSS



The annotated version above shows the area where the rover landed in 2012 and the route taken into the foothills of the mountain. Exploration of Yellowknife Bay in 2013 revealed the first evidence of an ancient freshwater-lake and an environment favorable to microbial life.

The self-portrait was taken with the rover's Hands Lens Imager. Curiosity's next target is the rich clay layer just above its current location. The summit of Mount Sharp is partially obscured by the rover's mast.

Falcon Heavy Takes Flight

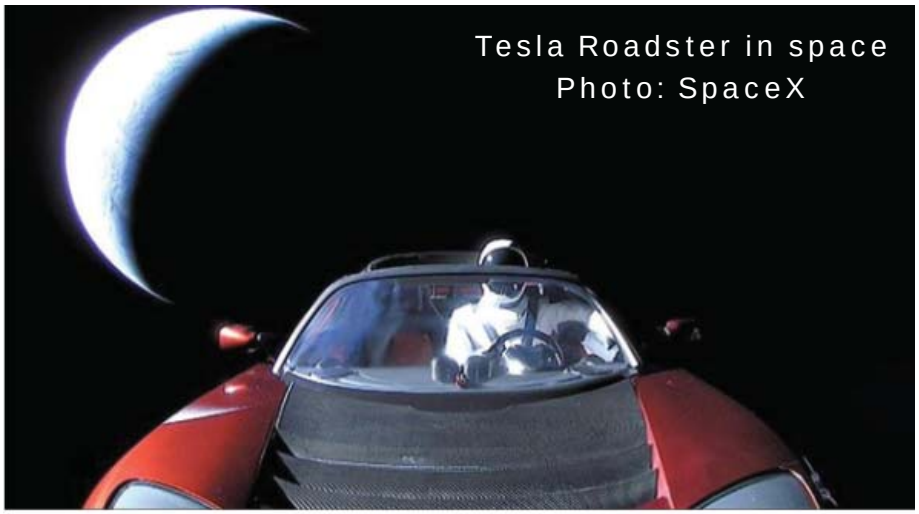
Photo: SpaceX

Falcon Side Boosters Return to the Roost

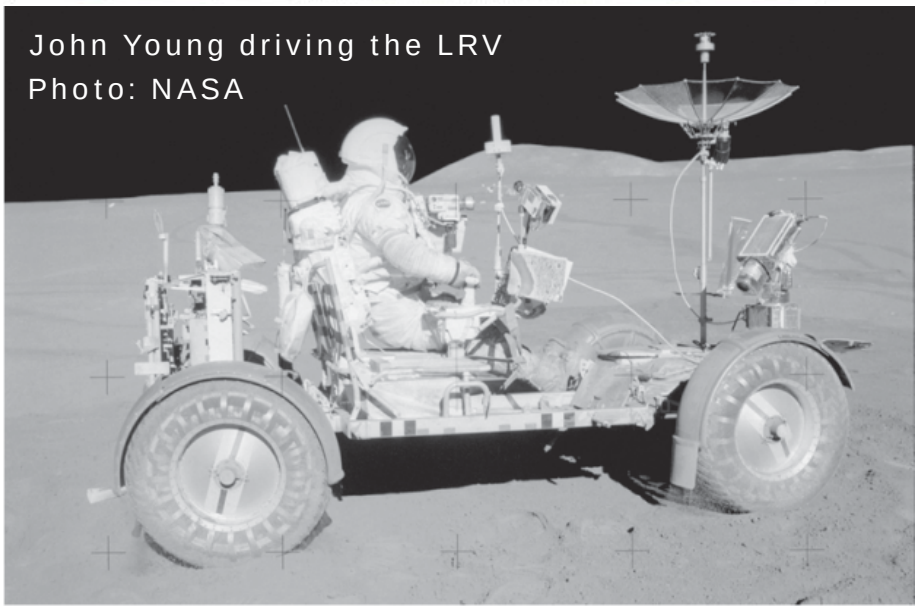
Photo: SpaceX

Electric Cars in Space

Elon Musk's electric cherry red Tesla Roadster was lofted into space aboard the Falcon Heavy rocket on its maiden flight on February 6th. Two days later, the car (still attached to the second stage), crossed the orbit of the Moon, where the three previous electric cars launched from Earth (the Lunar Roving Vehicle or LRV) remain parked awaiting the return of their owners.



Tesla Roadster in space
Photo: SpaceX



John Young driving the LRV
Photo: NASA

The LRV was an all-electric vehicle designed to operate on the lunar surface. The vehicle was included on Apollo missions 15, 16 and 17, folded up against the side of the spidery lunar modules (LMs). Astronauts Gene Cernan and Harrison Schmitt (Apollo 17) hold the current lunar driving records with a total cumulative distance of almost 25 miles (39.4 km), the longest single excursion of 12.5 miles (20.1 km), and the greatest distance driven from the LM at almost 5 miles (7.6 km).

The tubular aluminum LRV weighed 463 pounds (210 kg) on Earth and could carry a payload of 1,080 pounds (480 kg), on the Moon. Harrison Schmitt said, "....the Lunar Rover proved to be the reliable, safe and flexible

lunar exploration vehicle we expected it to be. Without it, the major scientific discoveries of Apollo 15, 16, and 17 would not have been possible; and our current understanding of lunar evolution would not have been possible."

Vehicle Comparison

	Lunar Roving Vehicle	Tesla Roadster
Curb Weight (pounds)	463	2,723
Top Speed (mph)	<10	250+
Seats	2	4
Wheels	Steel wire strands with aluminum hub	Aluminum alloy wheels with Michelin tires
All Wheel Drive Motors	4 (0.25 hp motors)	3 (one front and two rear)
Unit Cost	Approximately $10 million (including development)	$250,000 (not including development costs)
Drivable on the Moon	Yes	No

Year in Space Plus 2

NASA astronaut Scott Kelly and Russian cosmonaut Mikhail Kornienko returned to Earth in March 2016 after spending almost a year aboard the International Space Station (ISS). Astronaut Kelly's participation in the long-duration flight had an added benefit since he is an identical twin. His brother, Mark Kelly, remained on Earth and volunteered to be a control subject, providing biological samples before, during and after Scott's return.

Credit: NASA

In 2017, researchers provided their initial findings at NASA's Human Research Program 2017 Investigators' Workshop. Areas of research included:

- Changes in physical performance
- Behavioral health and the psychological effects of long-duration spaceflight including confinement
- Visual impairment possibly due to pressure changes in the brain and spinal fluid in a weightless environment
- Changes to the immune system
- Atherosclerosis (hardening and narrowing of the arteries)
- Human factors (for example, retention of fine motor skills and training, decision making, alertness and reasoning)
- Changes in the major organs, muscle and brain over time
- Changes in the digestive system and organisms within the gastrointestinal tract

At the 2018 Workshop, researchers confirmed their initial findings, with some additions. In most instances, the physical changes that researchers observed in Scott Kelly during his year-long stay in orbit were reversed within hours or days of his return to Earth, with a few lasting as long as six months. A report summarizes the work of the ten research teams is expected to be published later this year.

The twins DNA and RNA were also compared, pre- and post-flight. While unique differences are not unusual in the generic material of even identical twins, more than 200,000 RNA molecules were found to be expressed differently between the twins. Approximately 93% of Scott's genes returned to normal after his return. The remaining 7%, suggest that some changes are more permanent, particularly in the genes associated with the immune system, DNA repair (likely from radiation exposure from cosmic rays and solar charged particles and lower calorie intake), bone formation (likely from weightlessness), hypoxia, and hypercapnia (likely from lower levels of oxygen and high CO_2 levels). If you've had the opportunity to read Scott Kelly's book and chronicle of his year in space "Endurance" (highly recommended), you might recall his sensitivity to CO_2 levels on the ISS as being a recurring grievance about station living.

With the exception of radiation, it appears that many, if not most, of the root causes are environmental or linked to diet deficiencies and could be addressed in long-duration flights with current technologies. Radiation exposure, as discussed in previous newsletters, can be mitigated by shortening the transit time and with futuristic concepts such as deployable magnetic fields to deflect charged particles.

The ISS provides an unparalleled environment in which to study the human body in a simulated spaceship without leaving Earth orbit. Lesser-known and appreciated are the lessons-learned and medical breakthroughs from human spaceflight that improve the quality of life back on Earth.

5,000 Sols

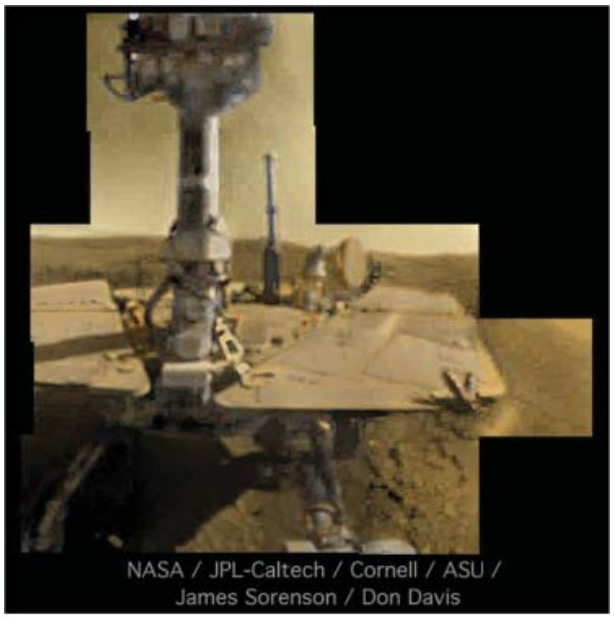
On Saturday, February 17th, the sol (a Martian day or sol is approximately 40 minutes longer than a day on Earth) began like many others over the past 14 years, with a cold, dusty Martian sunrise. The sunrise, however, was the 5,000th sol experienced by the Mars Exploration Rover, Opportunity. Long past its 90-sol prime mission and over 28 miles (45 km) from its landing site, the rover found conclusive evidence of Mars' watery past at multiple sites.

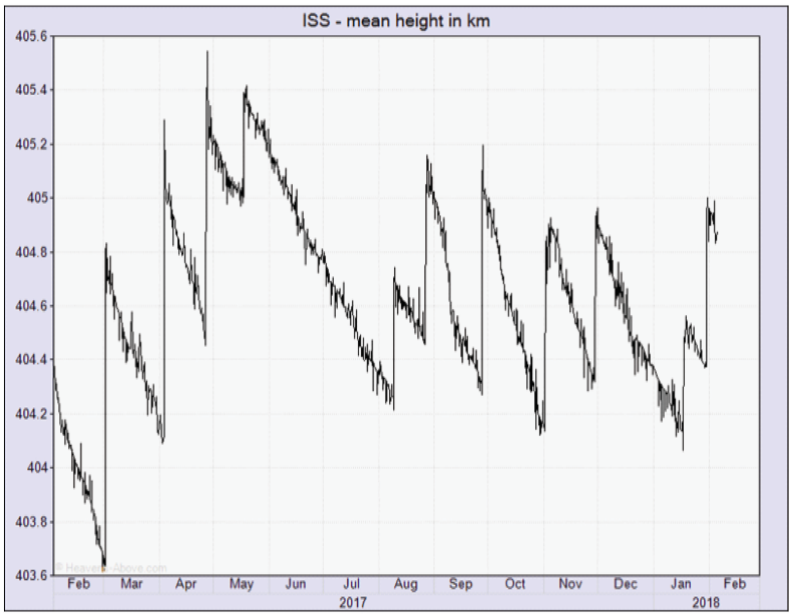
Opportunity is currently exploring a shallow gorge that cuts through the western rim of the 14 mile (22 km) diameter Endeavour Crater. "Perseverance Valley" was identified by orbiting spacecraft as showing indications that water played a role in its formation.

To celebrate 5,000 sols, Opportunity used its Microscopic Imager (MI), at the end of its robotic arm to capture 17 selfie frames which were then assembled into a mosaic by James Sorenson and colorized by Don Davis. The MI is a combination microscope and CCD camera. By design it is intended for up-close work, examining the structure of Martian rock and soil. As a portrait camera, it lacks resolution, but the final image still manages to elicit an emotional response from Earthlings that built, launched, nurtured and followed the intrepid little rover's exploits from tens of millions miles away since it left the cradle of humanity those many years ago.

A Russian Sunset

Political and economic support for future International Space Station (ISS) operations has waned with persistent posturing by the two major partners of the international collaboration, Russia and the





United States. Russia has threatened to remove its modules and use them to construct their own station (or possibly team with China for a joint project) and the Trump administration is looking to terminate U.S. financial support for the station by 2025.

Russia's participation, it turns out, is more critical to ISS's survival than the withdrawal of monetary support. The most significant Russian contribution to ISS construction was the service module ("Zvezda"). Launched in 2000, Zvezda was the third component in the station's assembly and served as the initial living quarters for the first visiting crews. The module was also equipped with rocket engines, initially used to rendezvous with the ISS and later to provide periodic reboosts of the station to a higher orbit.

The Earth's upper atmosphere, while very tenuous, imparts a persistent drag on the ISS. As a result, the station loses 50 to 100 meters per day in altitude, on average, requiring monthly reboosts. Reboosts are accomplished with thrusters on the Russian Zvezda and Zarya modules or from visiting spacecraft (the Space Shuttle's thrusters were used, when the shuttle was docked to the station, to gradually move the station into a higher altitude). The situation becomes more serious when the Sun is active and UV radiation heats the Earth's outer atmosphere causing it to expand. Between 1999 and 2000, during solar maximum, the station's altitude dropped by almost 50 miles in one year. Without the capabilities of the Russian modules to counter atmospheric drag, the ISS is projected to fall well below 200 miles by 2024. As drag increases, at lower altitude, control of the ISS becomes more difficult and eventually, the station will need to be abandoned.

The ISS is currently orbiting at an altitude of 260 miles or 415 km (average). It was lower when the station was being assembled to facilitate access by the Space Shuttle (220 miles or 355 km prior to 2011 when the shuttle was retired).

The chart (above-right) shows the gradual deterioration of the ISS's altitude with time, countered by the periodic reboosts by the Russian thrusters.

Twist of Fate

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

A year earlier, the crew of Apollo 9 (astronauts James McDivitt, David Scott and Russell Schweickart) had been assigned to Apollo 8, with the same mission objectives. However, by mid-year 1968, it was clear that the lunar lander, due to numerous manufacturing and technical challenges, would not be ready for a year-end flight. With a growing concern that the Soviets were ready to resume flying their new Soyuz spacecraft (after a fatal accident on its first flight), NASA decided to send Apollo 8 on a flight around the Moon without the lunar lander.

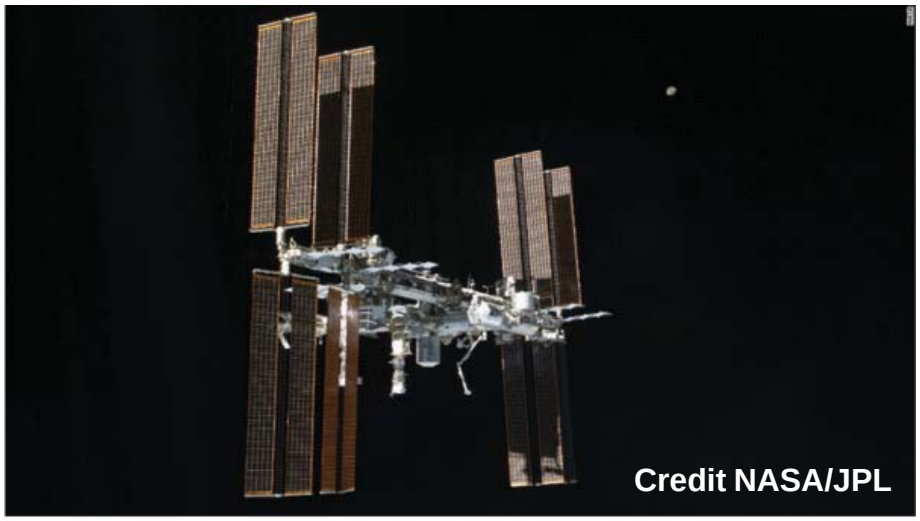
McDivitt considered the mission no more than a publicity stunt and turned it down, opting to switch with the Apollo 9 crew in anticipation that the lunar lander would then be available for that flight. McDivitt's decision would ultimately determine who would be the first to walk on the Moon, as the backup crew for Apollo 8 would become the prime crew for Apollo 11. With the crew switch, Pete Conrad went from the commander of Apollo 11 to the commander of Apollo 12 and from the first to the third person to walk on the Moon.

March History

On March 16, 1926, in Auburn, Massachusetts, Robert Goddard launched the first liquid fueled rocket on a flight that lasted only

Dr. Goddard with his a liquid oxygen-gasoline rocket "Nell" in its launching frame (NASA photo).

2½ seconds. A graduate of Worcester Polytechnic Institute, despite discharging a powder rocket from the basement of the physics building, the significance of Goddard's feat is compared by space flight historians to the first aircraft flight at Kitty Hawk. Among his achievements, Goddard was first to prove that rockets would work in a vacuum and to mathematically explore the practicality of using rocket propulsion to reach high altitudes and even the Moon (1912). While he was eventually banished from the fields of Auburn by the fire marshal, the site is commemorated by markers on what is now the Pakachoag Golf Course. The next time you are driving on the Massachusetts Turnpike towards Boston and points north, look to your left as you pass Exit 10. Just beyond the large shopping mall is where history was made.



More March History

Caroline Herschel was born in Hanover, Germany on March 16, 1750, the fifth of six children. Her four brothers were brought up to be musicians like their father, a talented musician and bandmaster. Caroline's mother saw no need for a girl to be educated and preferred that Caroline become a house servant to the rest of the family. Unfortunately, Caroline contracted typhus at age 10. It permanently stunted her growth (she was just over four feet tall as an adult), further convincing her mother that she wouldn't amount to much. Caroline's brother William escaped to England during the French occupation of Hanover in 1757. Her father Isaac, who had left to fight the French, returned home in poor health. Caroline lived at home as a servant until his death in 1767. Against her mother's will, she then left Hanover to join her brother William in England.

William Herschel was an accomplished musician although he gained considerable fame with his hobby as an astronomer and telescope maker. His reputation as a craftsman allowed him to quit his job as a musician and concentrate on astronomy. Caroline became her brother's apprentice, helping him design and build larger and more powerful telescopes. She also assisted her brother in recording his observations, sitting in a

window and writing by candlelight while her brother called out what he saw through the telescope's eyepiece.

Astronomy became a full-time occupation when William discovered the planet Uranus in 1781 and received an annual endowment from King George III. When her brother was away, Caroline would use her own telescope to sweep the

sky looking for comets. On August 1, 1786, Caroline discovered her first comet, the first comet to be discovered by a woman. Between 1786 and 1797 she would discover eight comets, as well as a number of deep sky objects.

With the marriage of William to Mary Pitt in 1788 and the birth of their son John in 1792, Caroline became involved in the education of her nephew. Under his father's and aunt's tutelage, John would become the first astronomer to thoroughly survey the southern hemisphere. Following William's death in 1822, Caroline continued to assist John in his astronomical work.

Caroline catalogued every discovery she and William made. Two of her catalogues are still in use today. She lived to be 98 and was recognized by the King of England, the Royal Astronomical Society, the King of Prussia and the King of Denmark for her life-long scientific achievements. After her death, Caroline Herschel was honored by the astronomical community by the naming of a lunar crater after her (C. Herschel) and an asteroid (281) Lucretia (her middle name).

Zodiacal Light

The solar system is filled with tiny dust particles from the passing of comets and collisions of asteroids. The dust orbits in the same plane as the Earth and the other planets. Shortly before sunrise and just after sunset, sunlight can be seen reflecting off this disk of debris. Called the zodiacal light, it is best observed when the ecliptic (the apparent path of the Sun and planets) is nearly perpendicular to the horizon (on spring evenings and autumn mornings). The best time to glimpse the zodiacal light is when the Moon is absent from the evening sky (for example, between March 9th and the 17th).

March, the month named for the planet Mars, denotes the end of the long winter nights. The Sun crosses the celestial equator at 12:15 m (EDT) on the 20th marking the Vernal Equinox and the beginning of the spring season in the northern hemisphere.

Sunrise and Sunset (New Milford, CT)

Sun	Sunrise	Sunset
March 1 (EST)	06:28	17:44
March 15	07:05	19:00
March 31	06:38	19:18

Astronomical and Historical Events

1st Full Moon (Full Sap Moon)

N1 Rockets
Credit: RKK

1st History: U.S. astronaut Scott Kelly and Russian cosmonaut Mikhail Kornienko return to Earth after a one-year stay on the International Space Station (2016)

1st History: Soviet spacecraft Venera 13 lands on Venus and records first color panoramic views of the surface (1982)

1st History: discovery of Saturn's moon *Helene* by Pierre Laques and Jean Lecacheux from the Pic du Midi Observatory in the French Pyrenees; named after Helen of Troy (1980)

1st History: Soviet spacecraft Venera 3 lands (crashes) on Venus, becoming first spacecraft to impact the surface of another planet (1966)

2nd History: launch of the Rosetta spacecraft (2004); rendezvoused with Comet 67 P/Churyumov-Gerasimenko in May 2014, sending a lander to its surface in November 2014

2nd History: launch of Pioneer 10, a Jupiter flyby mission (1972)

3rd History: Chinese National Space Agency announces the Chang'e lunar exploration program (2003)

3rd History: launch of Apollo 9 with astronauts James McDivitt, David Scott and Russell Schweikart in the first manned flight test of the lunar module (1969)

Astronomical and Historical Events (continued)

3rd History: launch of the Pioneer 4 spacecraft towards the Moon; first U.S. spacecraft to escape the Earth's gravity (1959)
4th Amor Asteroid 2018 AF4 near-Earth flyby (0.088 AU)
4th Asteroid 3530 *Hammel* closest approach to Earth (1.951 AU)
4th Kuiper Belt Object 2013 FZ27 at Opposition (47.370 AU)
5th Apollo Asteroid 38086 *Beowolf* closest approach to Earth (1.555 AU)
5th History: Soviet spacecraft Venera 14 lands on Venus and uses a screw drill to obtain a surface sample that was determined to be similar to oceanic basalts on Earth (1982)
5th History: flyby of Jupiter by the Voyager 1 spacecraft (1979)
6th History: Valentina Tereshkova's birthday (1937), Soviet cosmonaut became the first woman to fly to space in 1963
6th History: the Dawn spacecraft enters orbit around the dwarf planet *Ceres* (2015)
6th History: launch of the Kepler telescope from Cape Canaveral Air Force Station aboard a Delta II rocket (2009); designed to survey nearby stars for Earth-size and smaller planets; as of mid-February 2016 JPL's Planet Quest reports 1,941 confirmed exoplanets orbiting 1,209 stars
6th History: flyby of Comet Halley by Vega 1, a Soviet spacecraft (1986)
7th Apollo Asteroid 2017 VR12 near-Earth flyby (0.010 AU)
7th Aten Asteroid 2003 EM1 near-Earth flyby (0.043 AU)
7th Apollo Asteroid 11500 *Tomaiyowit* closest approach to Earth (0.327 AU)
7th Kuiper Belt Object 2013 FY27 at Opposition (79.120 AU)
7th History: John Herschel born, first astronomer to survey the southern hemisphere (1792)
8th Apollo Asteroid 2015 FM34 near-Earth flyby (0.058 AU)
8th History: maiden voyage of Europe's first unmanned cargo ship to the International Space Station; the Jules Verne was launched from Kourou, French Guiana aboard an Ariane 5 rocket; in addition to delivering supplies to the ISS, the cargo ship contained a manuscript by the 19th century French author and science fiction pioneer with computations of distances from Earth to several astronomical destinations, as well as to the center of the planet (2008)
8th History: flyby of Comet Halley by Susei, a Japanese spacecraft (1986)
8th History: discovery of rings around Uranus by NASA's airborne observatory (1977)
9th Last Quarter Moon
9th Aten Asteroid 2013 ND15 (Venus Trojan) closest approach to Earth (0.650 AU)
9th History: Space Shuttle Discovery (STS-133) makes its final landing (2011)
9th History: flyby of Comet Halley by Vega 2, a Soviet spacecraft (1986)
9th History: launch of the Soviet spacecraft Sputnik 9, with dog Chernushka (1961)
9th History: Yuri Gagarin born; first person to orbit the Earth in 1961 (1934)
10th **Second Saturday Stars - Open House at McCarthy Observatory**
10th Apollo Asteroid 2015 DK200 near-Earth flyby (0.018 AU)
10th Apollo Asteroid 2003 DY15 near-Earth flyby (0.058 AU)
10th Aten Asteroid 2007 CM26 near-Earth flyby (0.070 AU)
10th History: Mars Reconnaissance Orbiter arrives at Mars (2006)
10th History: flyby of Comet Halley by Sakigake, a Japanese spacecraft (1986)
10th History: Uranus' rings discovered by astronomers James Elliot, Edward Dunham, and Jessica Mink using the Kuiper Airborne Observatory while observing a stellar occultation (1977)
11th Moon at apogee (furthest distance from Earth)
11th Daylight Saving - Set Clock Ahead 1 Hour (United States)
11th Apollo Asteroid 2102 *Tantalus* closest approach to Earth (2.032 AU)
11th History: launch of Pioneer 5 into solar orbit between the Earth and Venus; confirmed the existence of interplanetary magnetic fields (1965)
11th History: Urbain Leverrier born, mathematician and astronomer, predicted existence of Neptune (1811)
12th Apollo Asteroid 2013 RZ73 near-Earth flyby (0.055 AU)

Astronomical and Historical Events (continued)

12th Aten Asteroid 398188 *Agni* closest approach to Earth (0.292 AU)
12th Atira Asteroid 2014 FO47 closest approach to Earth (0.346 AU)
12th Apollo Asteroid 1866 *Sisyphus* closest approach to Earth (2.206 AU)
13th History: flyby of Comet Halley by Giotto, a European Space Agency spacecraft (1986)
13th History: discovery of Saturn's moon *Calypso* by Dan Pascu, P.K. Seidelmann, William Baum and D. Currie (1980)
13th History: Percival Lowell born, established observatory in Flagstaff, AZ to observe Schiaparelli's Martian "canali" and look for other signs of life (1855)
13th History: William Herschel discovers the planet Uranus; originally named Georgium Sidus by Herschel in honor of his patron, King George III of England (1781)
13th History: Galileo Galilei publishes "Sidereus Nuncius" (Starry Messenger), the first scientific treatise based on observations made through a telescope; it described Galileo's early observations of the Moon, the stars, and the moons of Jupiter (1610)
14th Pi Day
14th Apollo Asteroid 2017 RY15 near-Earth flyby (0.073 AU)
14th Aten Asteroid 367943 *Duende* closest approach to Earth (1.202 AU)
14th History: launch of ESA's ExoMars Trace Gas Orbiter and Schiaparelli lander aboard a Russian Proton rocket from the Baikonur Cosmodrome in Kazakhstan (2016)
14th History: Stardust passes within 112 miles (181 km) of the nucleus of Comet Tempel 1 (2011)
14th History: John J. McCarthy Observatory issued Observatory Code Number 932 by the Minor Planet Center of the International Astronomical Union (2001)
14th History: first European launch of a liquid-fueled rocket by Johannes Winkler (1931)
14th History: Albert Einstein born, developed theories of mass to energy conversion and the curvature of space and time in large gravitational fields (1879)
14th History: Giovanni Schiaparelli born, director of the Milan Observatory and first to describe faint features on Mars as "canali" (1835)
15th Mercury at its Greatest Eastern Elongation (18°), visible in the western sky shortly after sunset
15th Atira Asteroid 2013 JX28 closest approach to Earth (1.254 AU)
15th History: Alan Bean born; astronaut, moonwalker and artist (1932)
16th History: third and final flyby of Mercury by the Mariner 10 spacecraft (the last of the Mariner probes); Mariner 10 was also the first spacecraft to use solar radiation pressure on its solar panels and the antenna for attitude control during flight (1975)
16th History: launch of Gemini 8 with astronauts Neil Armstrong and David Scott; first docking with another space vehicle, an unmanned Agena stage (1966)
16th History: launch of the first Titan II Intercontinental Ballistic Missile, also used as the launch vehicle for the manned Gemini spacecraft in the early 1960's (1962)
16th History: Robert Goddard launches first liquid-fuel rocket in Auburn, MA (1926)
16th History: Caroline Herschel born (1750)
17th New Moon
17th History: discovery of Asteroid 16 *Psyche* by Annibale de Gasparis (1852)
17th History: launch of the Gravity Recovery And Climate Experiment (GRACE) spacecraft (2002)
17th History: launch of Vanguard 1, 4th artificial satellite and oldest still orbiting Earth (1958)
18th History: MESSENGER enters orbit around Mercury (2011)
18th History: New Horizons spacecraft (on its way to Pluto) crosses the orbit of Uranus (2011)
18th History: explosion during launch of a Vostok rocket carrying a military spy satellite kills 48 members of the Soviet Missile Troop; likely cause of explosion was an oxygen peroxide leak caused by the poor quality of the rocket's fuel filters (1980)
18th History: Alexei Leonov performs first spacewalk from Soviet Voskhod spacecraft (1965)
19th 49th Lunar and Planetary Science Conference, Woodlands, Texas

Astronomical and Historical Events (continued)

19th History: Tenham meteorite fall; fragments of a large meteor rain down on a remote area of western Queensland, Australia (1879)
19th History: Moon flyby by the Hiten spacecraft; Japan's first lunar flyby, orbiter and surface impactor (1990)
20th Vernal Equinox (beginning of the Spring season in the northern hemisphere) at 12:15 pm EDT (16:15 UT)
20th Aten Asteroid 326290 *Akhenaten* closest approach to Earth (1.188 AU)
21st A Russian government Soyuz rocket will launch the crewed Soyuz spacecraft to the International Space Station with members of the next Expedition crew. The capsule will remain at the station for about six months, providing an escape pod for the residents
21st Apollo Asteroid 1981 *Midas* near-Earth flyby (0.090 AU)
21st Amor Asteroid 3908 *Nyx* closest approach to Earth (1.964 AU)
21st History: launch of Ranger 9, Moon impact mission; transmitted the highest resolution imagery obtained to that date before impacting the floor of Alphonsus crater on the 24th (1965)
22nd Aten Asteroid 2011 GP44 near-Earth flyby (0.056 AU)
22nd History: launch of space shuttle Atlantis (STS-76), third mission to Russian space station Mir and transfer of the first American woman, Shannon Lucid, to the station (1996)
23rd Apollo Asteroid 267940 (2004 EM20) near-Earth flyby (0.096 AU)
23rd History: launch of Gemini 3 with astronauts Virgil Grissom and John Young, first manned Gemini flight (1965)
23rd History: Wernher von Braun born, German rocket scientist and leader of the U.S. moon program (1912)
24th First Quarter Moon
24th History: discovery of Comet Shoemaker-Levy 9 (1993)
25th Aten Asteroid 2017 FZ2 near-Earth flyby (0.071 AU)
25th Neptune Trojan 316179 (2010 EN65) at Opposition (25.260 AU)
25th Dwarf Planet 136472 *Makemake* at Opposition (51.640 AU)
25th History: launch of the IMAGE spacecraft, first mission dedicated to mapping the Earth's magnetosphere (2000)
25th History: close approach of Comet Hyakutake (0.10 AU) to Earth (1996)
25th History: launch of Soviet spacecraft Sputnik 10 with dog Zvezdochka (1961)
25th History: Christiaan Huygens discovers *Titan*, Saturn's largest moon (1655)
26th Moon at perigee (closest distance from Earth)
26th History: American astronomer J.W. Draper takes first photograph of the Moon (1840)
27th Apollo Asteroid 2004 EU22 near-Earth flyby (0.084 AU)
27th History: U.S. astronaut Scott Kelly and Russian cosmonaut Mikhail Kornienko arrive at the International Space Station for a year-long mission (2015)
27th History: launch of the Soviet atmospheric probe and lander Venera 8 to Venus (1972)
27th History: launch of Mariner 7, Mars flyby mission (1969)
27th History: President Eisenhower approves the military lunar program to be managed by the Advanced Research Projects Agency (1958)
28th Apollo Asteroid 2016 SR2 near-Earth flyby (0.048 AU)
28th Apollo Asteroid 2013 QM48 near-Earth flyby (0.087 AU)
28th Aten Asteroid 2003 FY6 near-Earth flyby (0.095 AU)
28th Centaur Object 31824 *Elatus* at Opposition (15.297 AU)
28th History: flyby of Comet Halley by the ICE spacecraft (1986)
28th History: Heinrich Olbers discovers the asteroid 2 *Pallas* (1802)
29th History: First flyby of Mercury by the Mariner 10 spacecraft (1974)
29th History: Heinrich Olbers discovers the asteroid 4 *Vesta* (1807)
30th Apollo Asteroid 37655 *Illapa* closest approach to Earth (0.283 AU)
31st Full Moon (Full Worm Moon)

Astronomical and Historical Events (continued)

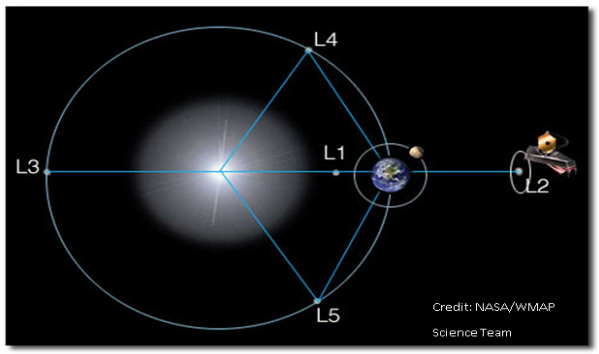
31st Aten Asteroid 2010 GD35 near-Earth flyby (0.040 AU)
31st Apollo Asteroid 2001 FA58 near-Earth flyby (0.097 AU)
31st History: launch of Soviet spacecraft Luna 10, first man-made object to go into orbit around another planetary body; detected evidence of mass concentrations on the Moon called "mascons" (1966)

Commonly Used Terms

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

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).



References on Distances

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

Solar Activity

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

International Space Station and Iridium 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.

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

On January 21, 2014, a bright flash broke the darkness in the constellation Ursa Major, alerting observers in the United Kingdom to a type 1a supernova that had occurred about 11-12 million years earlier. A week after the sighting, volunteers at the McCarthy Observatory assembled a composite image of the event, taken by the camera on the Observatory's Meade 16 inch telescope (see below).

Although this image, and others taken at the same time, clearly reveal a supernova event, they only provide an optical view of the phenomenon. The image on page 1 is a composite of data derived from three of NASA's eyes in space-X-ray images from the Chandra observatory (blue), infrared from the Spitzer space telescope (red), and from the Hubble telescope (yellow-green). Together, they reveal the glowing embers of a galactic firestorm.

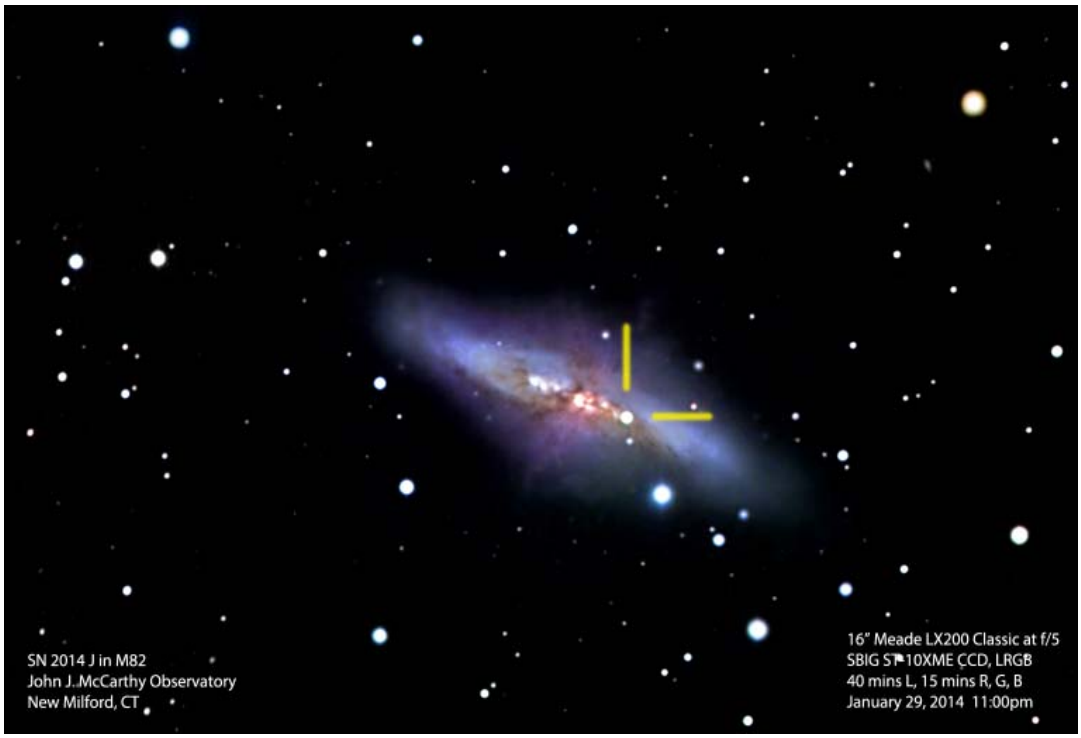
The supernova originated in *Messier 82*, characterized as a starburst galaxy for its bright luminescence and robust rate of star formation. These are typically small galaxies which exhibit a frenetic growth rate, quickly exhaust their surplus of gas, and then burn out, reigniting the creation process. They are also a leading source of supernovae. The impetus for this activity is often from the gravitational affects of a nearby galaxy, which in this case is the companion galaxy, M81.

M82 has even more surprises—Britain's Jodrell Bank Observatory has estimated that a supernova explosion occurs in M82 every 20-30 years. In April, 2010, Jodrell reported a possible micro-quasar lurking near the center of the galaxy.

In a few hundred million years, the galaxy will have exhausted its surplus of gas and its frenetic growth will subside. Eventually, the twin galaxies will pull together and merge their celestial populations.

(Image Credit: X-ray: NASA/CXC/JHU/D.Strickland; Optical: NASA/ESA/STScI/AURA/The Hubble Heritage Team; IR: NASA/JPL-Caltech/Univ. of AZ/C. Engelbracht.

Source: *http://chandra.harvard.edu/photo/2006/m82/* ; http://www.jb.man.ac.uk/news/2010/M82mystery/.



Above: a luminance, red, green, blue composite taken at McCarthy Observatory on January 29th, 2014 with the ST-10XME camera on the Meade 16" with the 0.5x focal reducer. Total exposure time was roughly an hour and a half between the 4 filters, with over an hour of it being luminance. Image taken by Marc Polansky and the JJMO imaging team.

Second Saturday Stars

FREE EVENT

Every Month at the

John J. McCarthy Observatory

Behind the New Milford High School

860.946.0312

www.mccarthyobservatory.org

March 10th

7:00 - 9:00 pm

TRAPPIST-1

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

Image Credit: ESA/Hubble

Map

March 2018

Celestial Calendar

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
Phases of the Moon  Mar 1 Mar 9 Mar 17  Mar 20 Mar 27				**1**  Soviet spacecraft Venera 3 crashes on Venus (1966) Venera 13 makes successful landing (1982) Saturn's moon Helene discovered by Pierre Laques and Jean Lecheux (1980) 	**2** Launch of Pioneer 10 Jupiter flyby mission (1972)   Launch of Rosetta spacecraft to comet 67 P/ Churyumov-Gerasimenko (2004)	**3**  Launch of Apollo 9; first test of lunar module (1969) ESA's Mars Express spacecraft close flyby of Martian moon Phobos (2010) 
4  Giovanni Schiaparelli, born, first to describe Martian "canali" (1835)	**5**  Soviet spacecraft Venera 14 lands on Venus (1982) launch of the Air Force's second robotic space plane (X-37B) from the Cape Canaveral Air Force Station   Voyager 1 flyby of Jupiter (1979)	**6**  Flyby of comet Halley by Soviet Vega 1 spacecraft (1986) Launch of Kepler telescope, to search for exoplanets (2009)   Dawn spacecraft arrives at the dwarf planet Ceres	**7**  John Herschel born, first astronomer to survey southern hemisphere (1792)	**8**  Flyby of Comet Halley by Japanese Suisei spacecraft (1986) Discovery of Uranus' rings by NASA Airborne Observatory (1977)   Maiden voyage of the Jules Verne, Europe's first unmanned cargo ship to International Space station (2008)	**9** Flyby of comet Halley by Vega 2, Soviet spacecraft (1986)   Sputnik 9, with dog Chernushka (1961) Yuri Gagarin born - first to orbit Earth (1934) 	**10**  Flyby of Comet Halley by Japanese Sakigake spacecraft (1986) Mars Reconnaissance Orbiter arrives at Mars (2006)   2nd Saturday Stars Open House McCarthy Observatory
11  Moon at apogee (farthest from Earth) Urbain Leverrier born - Predicted existence of Neptune (1811)   Launch of Pioneer 5 into solar orbit to study interplanetary magnetic fields (1965)	**12**  Simon Newcomb born - Canadian-American astronomer, studied planetary motion (1855)	**13**  Daylight Saving Time Percival Lowell born (1855)   Discovery of Uranus by William Herschel (1781) Flyby of Comet Halley by ESA spacecraft, Giotto (1986) 	**14**  Happy Pie Day! Albert Einstein born (1879)   Giovanni Schiaparelli born, first to observe Martian "canali" (1835) JJMO earns Observatory Code 932 from IAU's Minor Planet Center for tracking of asteroid Geographos (2001) 	**15**  Abbé Nicolas Louis de Lacaille born, French astronomer, catalogued southern hemisphere stars and constellations (1713) San Juan Capistrano Meteorite Fall (1973) 	**16**  Robert Goddard First liquid fuel rocket (1926) First Titan 2 ICBM (1962) Caroline Herschel born. first woman astronomer (1750)	**17** Vanguard 1 artificial satellite (1958) Publication of *Sidereus Nuncius* on Galileo's astronomical observations (later taken on 2008 Hubble repair mission) (1610)
18 Alexei Leonov First Spacewalk (1965) Soviet Vostok rocket explodes during launch, killing 48 (1980)	**19** Moon flyby by Japan's Hiten orbiter and impactor (1990)	**20** Vernal Equinox 12:15 PM EDT (16.15 UT)	**21** Launch of Ranger 9 Moon impact mission (1965)	**22** Shannon Lucid, first American woman on Russian Space Station (1996)	**23** Launch of Gemini 3 (Grissom, Young) (1965) Wernher von Braun born (1912) First photo of Moon by J.W. Draper (1840)	**24** Planet Pluto (now *dwarf* planet) officially named by Lowell Observatory, on suggestion of Oxford schoolgirl, Venetia Burney (1930)
25 Launch of IMAGE spacecraft, first to study Earth's magnetosphere (2000) Comet Hyakutake 1996 Christiaan Huygens, discovers Saturn's moonTitan (1655) 	**26** Moon at perigee (closest distance to Earth) John Draper takes first photograph of the Moon (1840) French mathematician and discoverer of Neptune, Urban Jean Joseph Le Verrier, proposes existence of a new planet Vulcan within orbit of Mercury (1859)	**27** Eisenhower approves military lunar program (1958) Launch of Mariner 7 Mars flyby mission (1969)	**28** Flyby of Halley's Comet by ICE spacecraft (1986)	**29** First flyby of Mercury by the Mariner 10 spacecraft (1974) Heinrich Olbers discovers the asteroid 4 Vesta (1807) 	**30** Bernhard Voldemar Schmidt born - German astronomer and inventor of the Schmidt telescope, known for its high definition and wide field of view (1879)	**31** Launch of Soviet spacecraft Luna 10, first to orbit Moon (1966)