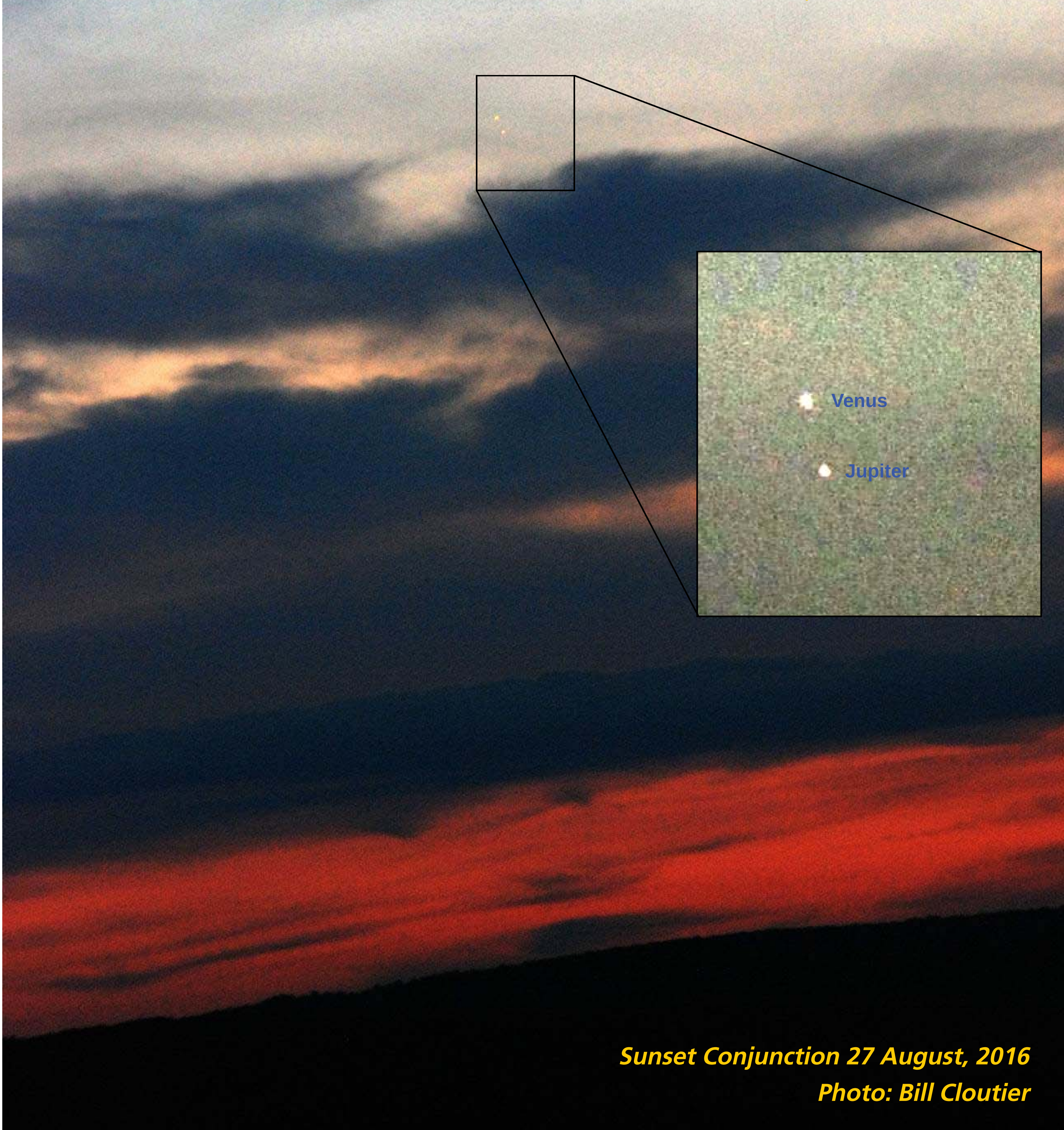
Galactic Observer

John J. McCarthy Observatory

Volume 9, No. 9 September 2016



Sunset Conjunction 27 August, 2016

Photo: Bill Cloutier

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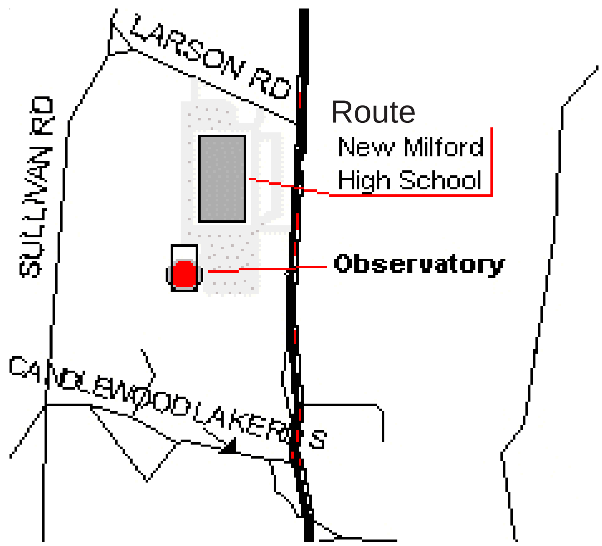
It is through their efforts that the McCarthy Observatory has established itself as a significant educational and recreational resource within the western Connecticut community.

Galactic Observer Editorial Committee



In This Issue

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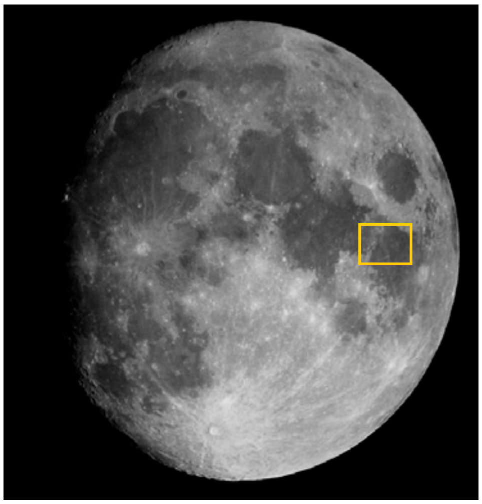
McCarthy Observatory
New Milford, CT

September Astronomy Calendar and Space Exploration Almanac

"Out the Window on Your Left"

IT'S BEEN ALMOST 45 years since we left the last footprint on the dusty lunar surface. Sadly, as a nation founded on exploration and the conquest of new frontiers, we appear to have lost our will to lead as a space-faring nation. But, what if the average citizen had the means to visit our only natural satellite; what would they see out the window of their spacecraft as they entered orbit around the Moon? This column may provide some thoughts to ponder when planning your visit (if only in your imagination).

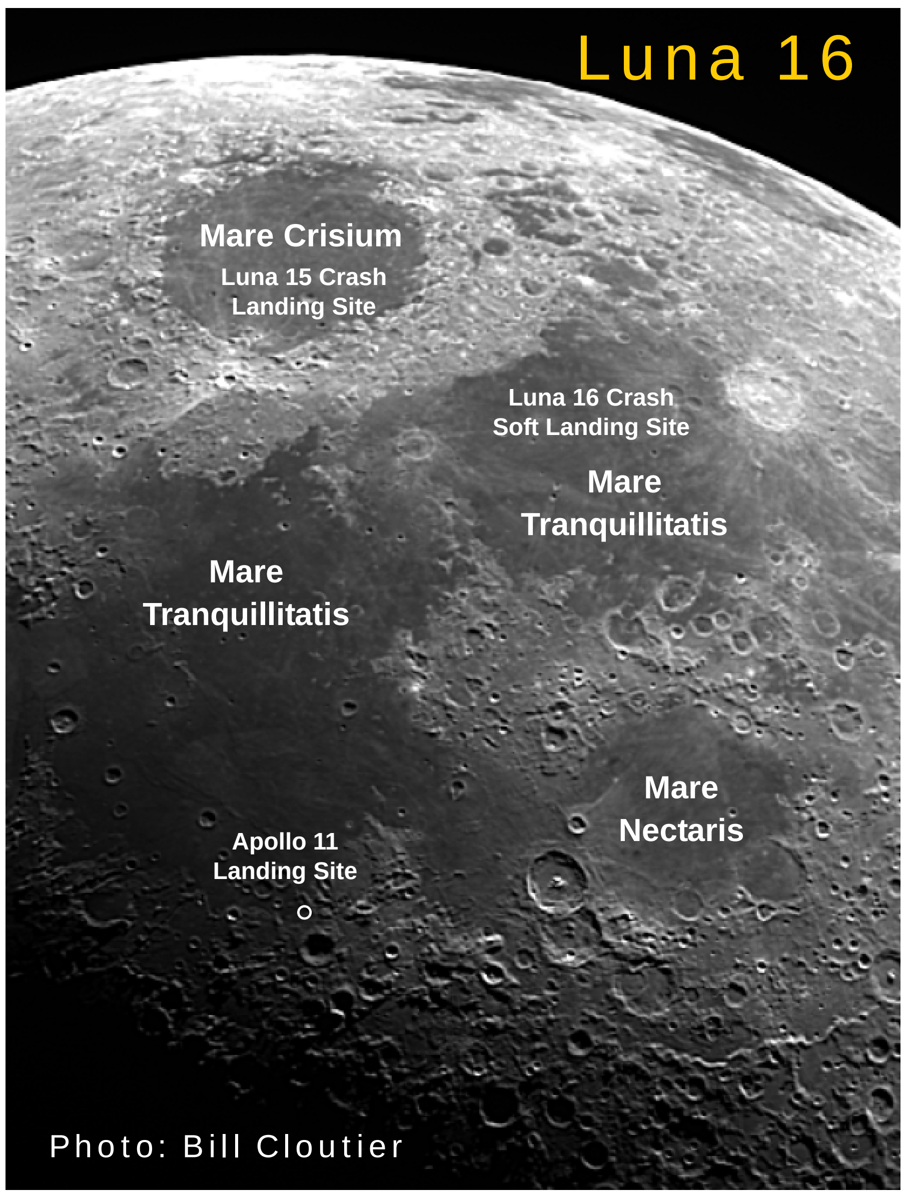


Lunar "seas" are expansive, low-lying plains formed by ancient lava flows

The twelve U.S. astronauts to walk upon the surface of the Moon collected approximately 2,200 samples of rock and dust from six different landing sites. In total, 842 pounds (382 kgs) of lunar material was returned to Earth for analysis by the Apollo missions. The Lunar Sample Laboratory at the Johnson Space Center is the main repository for the samples.

In addition to the samples returned by the Apollo missions, an additional 11 ounces (300 grams) of lunar regolith was collected and returned to Earth by three robotic Soviet spacecraft.

Luna 16 was the first successful Soviet sample-return mission. The spacecraft soft landed on Mare Fecunditatis (the Sea of Fertility) on September 20, 1970, after a four day journey and three days in lunar orbit. It was the first night landing on the Moon, the Sun having set 60 hours earlier. The spacecraft deployed a drill that was able to extract a 14 inch (35 cm) long core sample of approximately 3.6 ounces (101 grams). After 26.5 hours on the surface, the space-craft's ascent stage, containing the sample in a sealed container, was launched into an Earth-intercept trajectory. Three days later, the Luna 16 re-entry capsule successfully landed



in Kazakhstan by parachute. The descent stage continued to transmit temperature and radiation data from the Moon's surface.

The Luna 16 sample was similar in composition to other mare samples and comprised of fragments of basalt. The basalt was dated at 3.4 billion years and did have a higher concentration of aluminum than samples collected at the Apollo landing sites. In June 1971, a small portion of the Luna 16 material was provided to NASA (3 grams). In exchange, NASA presented their Soviet counterparts with 6 grams of material from the Apollo 11 and 12 landing sites.

Luna 16 fulfilled the mission objectives of the Luna 15 spacecraft which crash landed on Mare Crisium (Sea of Crises) on July 21, 1969 (while the Apollo 11 astronauts were still on the Moon). While NASA was initially concerned that Luna 15 operations might interfere with the first manned landing, the Apollo astronauts were never in any danger.

First Telescope on the Moon

Apollo 16 was the first and only mission to the lunar highlands. Astronauts John Young and Charles Duke spent three days on the Moon in April of 1972 exploring the Descartes region (approximately 236 miles or 380 km to the southwest of the Apollo 11 landing site on Mare Tranquillitatis).

Among the scientific instruments carried to the Moon by the Apollo 16 crew was the Far Ultraviolet Camera/Spectrograph. It used a 3-inch (7.5 cm) Schmidt telescope to capture images of the ultraviolet emissions of multiple celestial objects on a film cartridge for analysis back on Earth. The first telescope to make observations from the surface of the Moon captured 178 usable images across 10 difference regions of the lunar sky of various nebula and star clusters, as well as the Earth's upper atmosphere and aurora.

Apollo 16 astronaut John Young with telescope
Credit: Photo courtesy of NASA

The gold-plated camera/spectrograph was designed and built by Dr. George Carruthers, an astronomer at the Naval Research Laboratory. It was set up in the shadow of the Lunar Module (LM) and operated by the Apollo 16 astronauts. The instrument had to be relocated each day as the Sun moved higher in the sky. Since the LM blocked a significant part of the sky (and the launch had been delayed a month), several of the intended targets could not **be** observed. The astronauts removed the film cartridge when they completed their mission, leaving the telescope behind. A backup telescope is on display at Smithsonian's National Air and Space Museum.

Dr. George Carruthers (right) and William Conway (left) with the gold-plated ultraviolet camera/spectrograph.
Credit: U.S. Naval Research Laboratory

Mission Extensions

NASA's Science Mission Directorate conducts periodic reviews of its planetary exploration missions that have completed their prime missions. This year the Directorate reviewed nine missions: Curiosity, Dawn, Lunar Reconnaissance Orbiter, Mars Express, Mars Reconnaissance Orbiter, New Horizons, Odyssey, Opportunity, and the Mars Atmosphere and Volatile EvolutioN. The independent review panel recommended extended operations for all of the orbiters and rovers through fiscal years 2017 and 2018, based upon the mission's contributions to planetary science, future opportunities for ground-breaking discoveries and the return on investment. The Mars Reconnaissance Orbiter and New Horizons missions received the highest ratings by the review panel; the Dawn (Adeona option) mission, the lowest rating.

Subject to congressional funding, New Horizons is approved for a close flyby of a cold, classical Kuiper Belt Object known as 2014 MU69 in January 2019. In the extension of New Horizons' mission, the panel recognized an opportunity to explore an uncharted region of the solar system and visit a relic from its formation.

The review panel also recommended that Dawn remain in orbit around Ceres. A proposal had been presented that would have had the spacecraft leaving Ceres and visiting 145 Adeona, a main belt, 93 mile (150 km) Ch-class asteroid, in May 2019. Panel members agreed that having Dawn remain at Ceres was a more valuable option, citing the desire to improve the hydrogen mapping (an indicator of water ice) on the dwarf planet. The Dawn spacecraft is currently orbiting Ceres at an altitude of 240 miles (385 km), completing an orbit in less than 5.5 hours.

OSIRIS-REx

On September 8th, a United Launch Alliance Atlas 5 rocket is scheduled for launch from the Cape Canaveral Air Force Station in Florida. Contained within its payload fairing is the Origins, Spectral Interpretation, Resource Identification, Security, Regolith Explorer (OSIRIS-REx) spacecraft. The solar-powered spacecraft has a wingspan of 20.25 feet (6.2 meters) with its panels deployed and a mass (including fuel) of 4,650 pounds (2,110 kg). Its five instruments are designed to scan the surface of an asteroid, identifying and mapping the distribution of minerals and organic material.

Assembled spacecraft readied for environmental testing
Credit: Lockheed Martin Corporation

OSIRIS-REx is a sample return mission. Destined for the near-Earth asteroid Bennu in 2018, the spacecraft will return a sample (at least 2.1 ounces or 60 grams) from the surface of the asteroid to the Earth in 2023. During the Earth intercept phase, the sample container will separate from the spacecraft and enter the Earth's atmosphere. Shedding velocity with its heat shield, the container will land in the Utah desert under parachute. The spacecraft will be maneuvered into a stable orbit around the Sun.

Bennu was discovered in 1999 by the Lincoln Laboratory Near Earth Research (LINEAR) survey telescope in New Mexico. Based upon optical, infrared and radar imaging, Bennu is roughly spheroidal, with a diameter between 1,500 and 2,000 feet (450-600 meters). It has a rotational period of approximately 4 hours. Bennu is a B-type carbonaceous asteroid and classified as a potentially hazardous object with its Earth-crossing orbital period of 1.2 years, its size, and its minimum distance to Earth as the two orbits intersect (Bennu makes a close pass to Earth every six years). This type of asteroid is rich in volatiles and may have been a key contributor in early planetary formation and the delivery of water to the inner planets.

Juno Update

The Juno spacecraft successfully entered into orbit around Jupiter on July 4th after a five year voyage (1.74 million miles or 2.8 million km traveled) that included a 2013 flyby of Earth for a gravity assist. The spacecraft is currently executing two 53.5-day long capture orbits of Jupiter before it restarts its engine to reshape its orbital path and begin its 14-day long science orbits. Science operations (comprising 33 orbits) will continue through February 2018 at which time the spacecraft will be deorbited into the atmosphere of the Jupiter.

Juno reached its most distant point in its capture orbit (apojove) on July 31st, 5 million miles or 8.1 million km from Jupiter. On August 27th, at its closest (perijove), the spacecraft passed within 2,600 miles (4,200 km) of Jupiter's cloud tops. During the science orbits, perijove will be a nominal 3,100 miles (5,000 km) above the planet's cloud tops. The spacecraft's polar orbit allows complete coverage of the planet by the science instruments, keeps the spacecraft's solar panels in sunlight and avoids the most intense levels of radiation within the planet's equatorial radiation belts.

Juno's suite of instruments were powered up for the first time during the August 27th close encounter. The image (right) was taken when Juno was still 437,000 miles (703,000 km) from Jupiter and traveling at 130,000 mph (208,000 kph) with respect to the gas giant. The planet's north pole is visible at the top of the image with its Great Red Spot in the southern hemisphere. The Great Red Spot is an anticyclone and larger in diameter than the Earth. It was first observed in the 1600s, most likely by Giovanni Cassini).

NASA will be releasing highly detailed images from the encounter later in the coming weeks.

High Definition

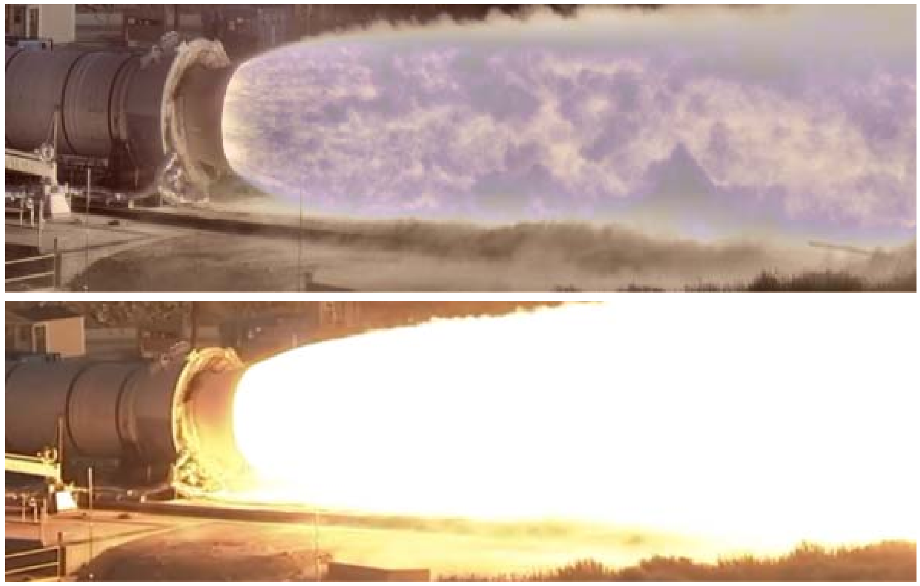
NASA's new Space Launch System (SLS) vehicle is being developed for deep space exploration. The launch vehicle's core, powered by four liquid-fuel RS-25 engines (upgraded space shuttle engines), is supplemented by two five-segment solid rocket boosters.

Images of the solid rocket motor test with traditional video (above) and with the HiDyRS-X camera (below). Credit: NASA

The manufacturer of the solid rockets, Orbital ATK, has conducted two, full-scale test firings of the 177 foot long solid rocket at its test facility in Promontory, Utah, in support of the qualification of the launch vehicle and its anticipated 2018 test flight. The solid rockets are expected to provide 75% of the SLS's total thrust at liftoff.

Slow motion video recordings of the rocket motor tests are used to supplement the data collected by the heavily instrumented rocket and test stand. However, extracting details of the motor's performance with the extremely bright plume has been challenging. The second test firing provided NASA an opportunity to assess its high dynamic range video camera. The HiDyRS-X camera can record video in multiple exposures that can then be combined to optimize views of the motor's subcomponents, as well as exhaust plume phenomenology, during the two minute test (when 1,385,000 pounds of propellant are burned).

The propellant had been prechilled to 40°F for the test firing (the lower portion of its range of operations). The rocket motor, operating at a temperature of nearly 6,000°F, was, by all indications, a success. Engineers are currently disassembling the solid rocket for a detailed inspection of each segment.

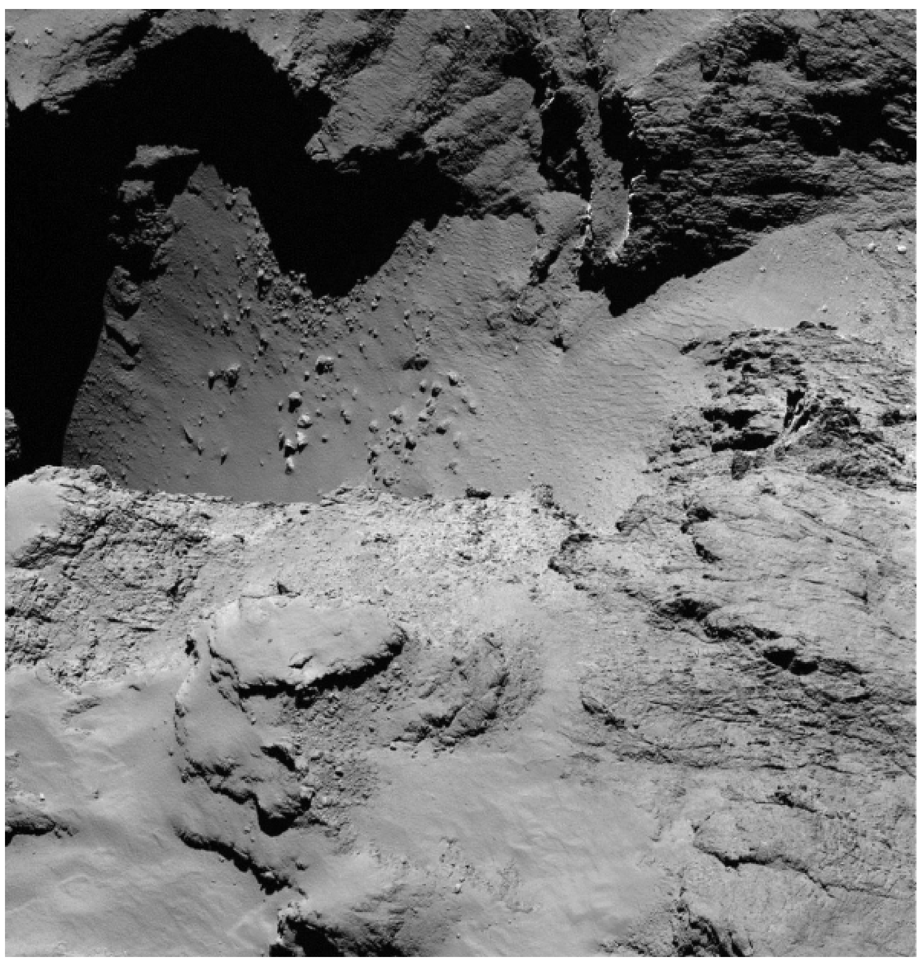


Images of the solid rocket motor test with traditional video (above) and with the HiDyRS-X camera (below). Credit: NASA

Mission Complete

On September 30th, the European Space Agency (ESA) will deorbit the Rosetta spacecraft, terminating its mission. Launched in 2004, Rosetta intercepted comet 67P/Churyumov-Gerasimenko ten years later. In 2015, the spacecraft monitored the surface activity of the two-lobed comet as the icy world made its closest approach to the Sun (perihelion) in its 6.45 year orbital period. Since then, as its distance from the Sun continues to increase (the comet's orbit extends out beyond the orbit of Jupiter), the sunlight available to power Rosetta has lessened, adversely impacting spacecraft operations (exacerbated by the dusty environment). ESA has therefore decided to terminate the mission by setting the spacecraft down on the comet's surface.

The image (below) exemplifies the varied terrain of the comet over a relatively small area (image measures 0.8 miles or 1.3 km across).



Credit: ESA/Rosetta/MPS for OSIRIS Team MPS/UPD/LAM/IAA/SSO/INTA/UPM/DASP/IDA

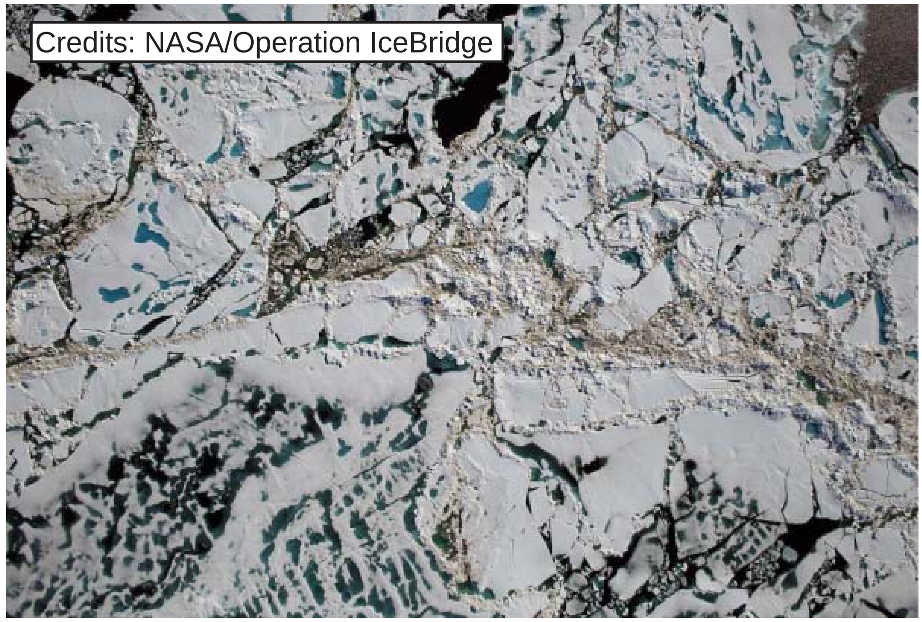
Operation IceBridge

NASA's Operation IceBridge is an annual airborne survey of the polar and Greenland ice sheets. Arctic sea ice retreats during the northern hemisphere's summer months, reaching its lowest area of coverage in September. That minimum area of coverage has been steadily declining, with sea ice today covering 40% less area than it did in the 1970s and 1980s.

The photo (below) shows a field of broken sea ice in the Chukchi Sea (an area just north of the Bering Strait and bounded by the East Siberian and Beaufort seas). The darker areas are open water and the lighter blue patches, melt water ponds. The melt water ponds, formed from surface melt, accelerate the melting process as their darker color absorbs more sunlight.

The first half of 2016 was the warmest (globally) on modern record (since 1880). While the warmer waters of the tropical Pacific contributed to the temperature rise last winter, global temperatures continued to increase as the effects of the El Niño event waned. Polar sea ice coverage set new records (smallest coverage) in five of the first six months of 2016 (since satellite coverage monitoring in 1979).

If the warming trends continue, ice could disappear from the summer Arctic Ocean before the middle of the century. Sea ice plays an important role in the polar ecosystem, regulating regional and global temperatures, affecting ocean salinity and circulation patterns, providing a habitat for animals, as well as, protecting coastlines from erosion (by mitigating wave action). The disappearance of sea ice won't raise the sea level by itself (since it already floats on top of the water), but its disappearance may trigger other changes in the climate that will.

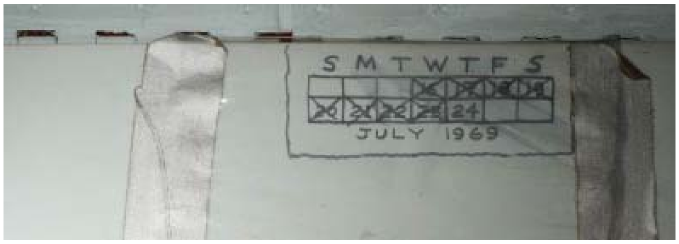


Virtual Apollo Reality

The Apollo 11 Command Module is on display just inside the main entrance to the Smithsonian's National Air and Space Museum in Washington, D.C. Shrouded in protective plexiglass and often surrounded by inquisitive visitors, it is difficult to view the capsule's congested interior and truly appreciate the complexity of the machine that carried three astronauts to the Moon and returned them safely back to Earth.

Main console with one of the Flight Director/Attitude Indicators (8-ball) and the Guidance Computer's Display and Keyboard.

For this year's 47th anniversary of the historic mission, the Smithsonian has completed a high-resolution, 3-D scan of the command module's interior and exterior. It is now possible to view areas of the interior that may have not been seen, in some instances, since the original mission ended. Additional details can be found on the website: https://3d.si.edu/apollo11cm/. Files are also available to download and print certain components (designed for a 3-D printer).



Mission calendar written on wall of the Command Module (above) and kept by the Apollo 11 crew with dates crossed off, with the exception of splashdown on July 24th. Interior view of the capsule (below) with Lunar Module Pilot's hand controller visible lower, center. Credit: Smithsonian Institution

Mesage left behind by Apollo 11 Command Module Pilot Michael Collins on the Space Sextant Aperture and Telescope panel: "Spacecraft 107 - alias Apollo 11, alias "Columbia, The Best Ship to Come Down the Line, God Bless Her"
Credit: Smithsonian Institution

The Carrington Event

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

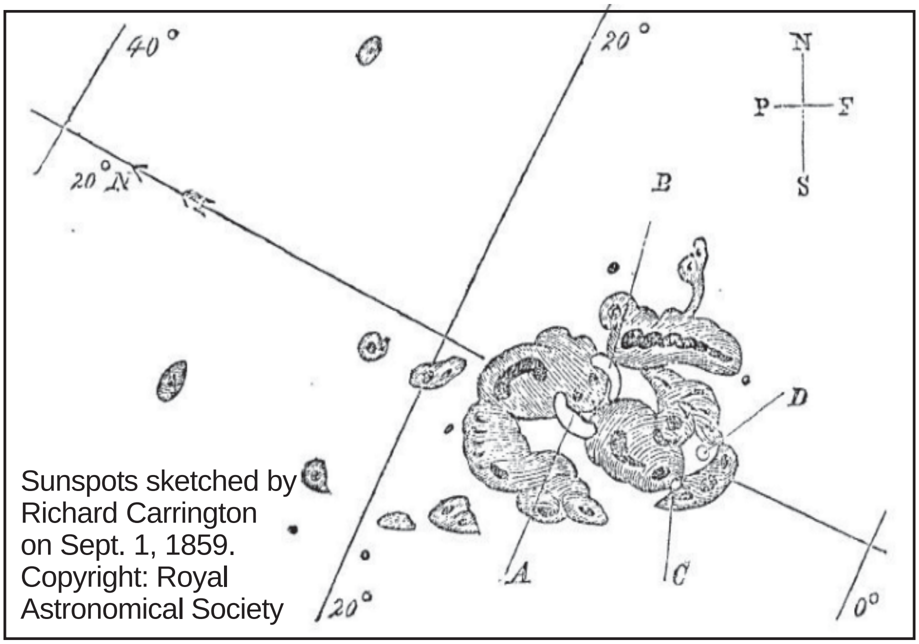
The following morning, the sky as far south as Hawaii and the Caribbean erupted in filaments of color as aurora bright enough to easily read a newspaper were visible. Sailors reported compass needles swinging wildly, making it impossible to navigate, and power surges in telegraph wires damaged equipment,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

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

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

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

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



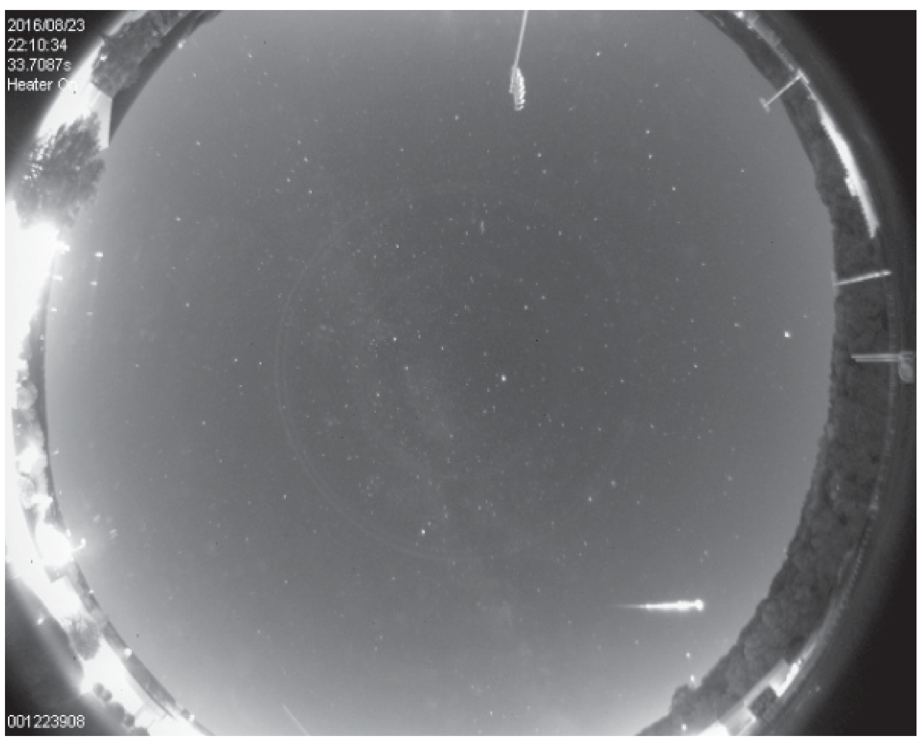
Sunspots sketched by Richard Carrington on Sept. 1, 1859. Copyright: Royal Astronomical Society

Watcher of the Void

Did you know that while you are sleeping, the McCarthy Observatory is monitoring Earth's timeless trek through a cosmic shooting gallery.

Each day, approximately 100 metric tons (1,000 kg or 2,205 pounds) of cosmic dust enters Earth's atmosphere. While the bombardment generally goes unnoticed, larger pieces appear as meteors or "shooting stars" on a moonless night. Several thousand meteors (the light-emitting phase of a meteoroid as it travels through the atmosphere) fall each night, the vast majority over uninhabited areas. A fireball is a meteor brighter than the planet Venus (generally brighter than magnitude -4).

The American Meteor Society (AMS) solicits reports of bright meteors and maintains a log of the sightings (*http://www.amsmeteors.org/*). The McCarthy Observatory has contributed to the AMS fireball log and to NASA's All Sky Fireball Network (*http://fireballs.ndc.nasa.gov/*).



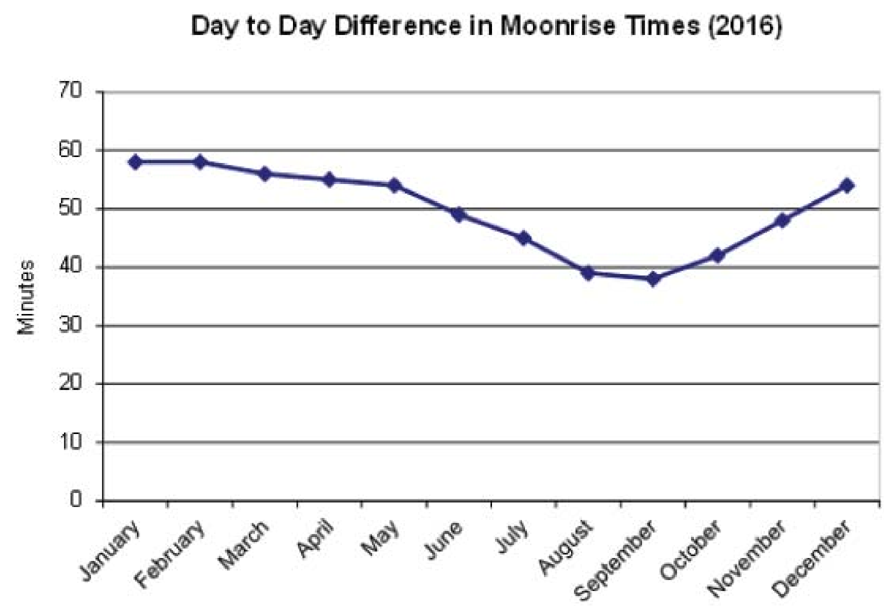
The image (above) is a frame from the video captured by the Observatory's all-sky camera from the night of August 23rd. The fragmented fireball (circled in yellow) was spotted by two Observatory volunteers driving through the West Hartford/Farmington area of I-84. With the approximate time of the sighting, the fireball was easily found on the Observatory's video archive. The AMS received 70 reports of this particular fireball from observers along the east coast.

Harvest Moon

The Full Moon that occurs closest to the Autumnal Equinox is known as the Harvest Moon. This year the Full Moon occurs on September 16th. The Harvest Moon traditionally appears around the time when farmers in the northern hemisphere are working long days to bring in their crops. The full moon provides a bit more light, longer into the evening. However, what is really special at this time of the year is the appearance of the Moon in the days just before and after it reaches its full phase.

Throughout the year the Moon rises, on average, 50 minutes later each day. The difference can be more than an hour in the spring and closer to 30 minutes in the fall. On the following graph, the average difference in the time of moonrise on the three days preceding and following the full moon are plotted. In September, the difference is as little as 37 minutes (from one night to the next). The effect is that an almost fully illuminated moon is in the evening sky earlier each evening, benefiting farmers still out in the field (and children playing after school).

For example, the Moon rises at 7:08 pm on September 16th, the night of the full Moon. On each of the next three nights the Moon rises about 40 minutes later. As such, on September 19th, (three days after full) a bright moon is back in the sky two hours after sunset (9:02 pm).



Autumnal Equinox

The Sun crosses the celestial equator at 10:21 am (EDT) on the morning of September 22rd, marking the beginning of the fall season in the northern hemisphere.

Sunrise and Sunset

Sun	Sunrise	Sunset
September 1st (EDT)	06:20	19:26
September 15th	06:34	19:02
September 30th	06:50	18:36

Aurora and the Equinoxes:

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

September Nights

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

Present and Future Pole Stars

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

Astronomical and Historical Events

1st New Moon
1st Apollo Asteroid 357024 (1999 YR14) near-Earth flyby (0.056 AU)
1st Apollo Asteroid 2201 Oljato closest approach to Earth (2.611 AU)
1st History: flyby of Saturn by the Pioneer 11 spacecraft (1979)
2nd Apollo Asteroid 25143 Itokawa closest approach to Earth (1.101 AU)
2nd History: discovery of asteroid *3 Juno* by Karl Harding (1804)
3rd Neptune at Opposition (rising with the setting Sun and visible all night)
3rd History: controlled impact of the SMART-1 spacecraft on the lunar surface at the conclusion of a successful mission; precursor of NASA's LCROSS mission (2006)
3rd History: Viking 2 spacecraft lands on the Martian surface (1976)
4th Kuiper Belt Object 145452 (2005 RN43) at Opposition (39.628 AU)
5th Apollo Asteroid 2009 ES near-Earth flyby (0.048 AU)
5th History: launch of Voyager 1 to the planets Jupiter and Saturn (1977); at almost 12 billion miles (19.3 billion km) from Earth, Voyager 1 has entered the interstellar space
6th Moon at apogee (furthest distance from the Earth)
6th Kuiper Belt Object 2010 RF43 at Opposition (52.371 AU)
7th Apollo Asteroid 250458 (2004 BO41) near-Earth flyby (0.100 AU)
8th International Observe the Moon Night (http://www.lpi.usra.edu/observe_the_moon_night/)
8th Scheduled launch of OSIRIS-REx (asteroid sample return mission)
8th History: sample return canister from the Genesis spacecraft crashes back to Earth when drogue parachute fails to deploy. Spacecraft was returning to Earth from Lagrange Point 1 with its collec tion of solar wind particles (2004)
8th History: launch of the Surveyor 5 spacecraft (lunar science mission); landed on Mare Tranquillitatis three days later (1967)
8th History: first Star Trek episode airs on television (1966)
8th History: discovery of Comet Ikeya-Seki by Kaoru Ikeya and Tsutomu Seki (1965)
8th History: Marshall Space Flight Center's dedication by President Eisenhower (1960)
9th First Quarter Moon
9th History: launch of Conestoga I, first private rocket (1982)
9th History: launch of Soviet spacecraft Venera 11 (Venus lander) to the planet Venus (1978)
9th History: discovery of Jupiter's moon *Amalthea* by Edward Barnard (1892)
10th Second Saturday Stars – Open House at the McCarthy Observatory
10th Aten Asteroid 2015 KE near-Earth flyby (0.038 AU)
10th History: launch of the GRAIL spacecraft aboard a Delta 2 rocket from the Canaveral Air Force Station; lunar gravity mapping mission (2011)
10th History: debut flight of the Japanese H-2 Transfer Vehicle (or HTV) to the International Space Station (2009)
11th Apollo Asteroid 2009 BK2 near-Earth flyby (0.076 AU)
11th History: Mars Global Surveyor enters orbit around Mars (1997)
11th History: flyby of Comet Giacobini-Zinner by the International Cometary Explorer (ICE), first space craft to visit a comet (1985)
12th Apollo Asteroid 2016 LX48 near-Earth flyby (0.046 AU)
12th Apollo Asteroid 161989 *Cacus* closest approach to Earth (0.243 AU)
12th History: launch of Soviet Luna 16; first robotic probe to land on the Moon and return a coring sample (101 grams) of lunar regolith to Earth (1970)
12th History: launch of Gemini XI with astronauts Charles Conrad and Richard Gordon (1966)
12th History: launch of the Soviet spacecraft Luna 2, first to impact the Moon's surface (1959)
13th History: launch of the Japanese Moon orbiter "Kaguya" (Selene 1) (2007)
14th History: launch of Soviet spacecraft Venera 12 (Venus lander) to the planet Venus (1978)

Astronomical and Historical Events (continued)

14th History: discovery of Jupiter's moon *Leda* by Charles Kowal (1974)
14th History: John Dobson born, architect of the Dobsonian alt-azimuth mounted Newtonian telescope (1915)
15th Apollo Asteroid 2011 BT15 near-Earth flyby (0.051 AU)
15th Atira Asteroid 434326 (2004 JG6) closest approach to Earth (0.692 AU)
16th Full Moon (Full Harvest Moon)
16th Centaur Object 2015 KJ153 at Opposition (2.981 AU)
17th History: Konstantin Tsiolkovsky born in Izhevskoye, Russia; one of the fathers of rocketry and cosmonautics, along with Goddard and Oberth (1857)
17th History: discovery of Saturn's moon *Mimas* by William Herschel (1789)
18th Moon at perigee (closest distance to Earth)
18th Atira Asteroid 2015 ME131 closest approach to Earth (1.604 AU)
18th History: launch of Vanguard 3, designed to measure solar X-rays, the Earth's magnetic field, and micrometeoroids (1959)
19th History: NASA unveiled plans to return humans to the moon (2005)
19th History: first launch of the Wernher von Braun-designed Jupiter C rocket from Cape Canaveral (1956)
19th History: discovery of Saturn's moon *Hyperion* by William and George Bond and William Lassell (1848)
20th Apollo Asteroid 5786 *Talos* closest approach to Earth (0.939 AU)
21st Apollo Asteroid 2016 HO3 closest approach to Earth (0.160 AU)
21st History: MAVEN (Mars Atmosphere and Volatile Evolution) spacecraft enters orbit around Mars (2014)
21st History: second flyby of Mercury by the Mariner 10 spacecraft (1974)
21st History: Gustav Holst born, composer of the symphony "The Planets" (1874)
21st History: Soviet spacecraft Zond 5 returns after circumnavigating the Moon (1968)
21st History: Galileo spacecraft impacts Jupiter after completing its mission (2003)
22nd Autumnal Equinox at 10:21 am (EDT)
22nd Apollo Asteroid 2015 DS53 near-Earth flyby (0.050 AU)
22nd Kuiper Belt Object 2010 RE64 at opposition (51.635 AU)
22nd History: Deep Space 1 spacecraft passes within 1,400 miles (2,200 km) of the 5 mile long potato-shaped nucleus of Comet Borrelly (2001)
23rd Last Quarter Moon
23rd Scheduled launch of a Russian Soyuz spacecraft from the Baikonur Cosmodrome, Kazakhstan, to the International Space Station with the next expedition crew
23rd Kuiper Belt Object 308933 (2006 SQ372) at Opposition (26.253 AU)
23rd Kuiper Belt Object 120347 *Salacia* at Opposition (43.735 AU)
23rd History: Johann Galle discovers the planet Neptune (1846)
24th History: India's MOM (Mars Orbiter Mission) spacecraft enters orbit around Mars (2014)
24th Distant flyby of Saturn's moon *Polydeuces* by the Cassini spacecraft
24th History: John Young born (1930), first person to fly in space six times, including Gemini 3 (1965), Gemini 10 (1966), Apollo 10 (1969), Apollo 16 (1972), STS-1, the first flight of the Space Shuttle (1981), and STS-9 (1983)
25th Apollo Asteroid 363831 (2005 PY16) near-Earth flyby (0.075 AU)
25th Atira Asteroid 164294 (2004 XZ130) closest approach to Earth (1.139 AU)
26th History: Cosmonauts V. Titov and Strekalov escape moments before Soyuz T-10-1 explodes on the pad (1983)
27th Scheduled flyby of Saturn's largest moon *Titan* by the Cassini spacecraft
27th Plutino 2001 QF298 at Opposition (42.401 AU)
27th History: launch (2007) of the Dawn spacecraft to Vesta (2011) and Ceres (2015)
27th History: launch of SMART-1, the first European lunar probe (2003)
28th Mercury at its Greatest Western Elongation (18°) – apparent separation from the Sun in the morning sky
28th Apollo Asteroid 6239 *Minos* closest approach to Earth (0.946 AU)

Astronomical and Historical Events (continued)

28th History: launch of Soviet lunar orbiter Luna 19; studied lunar gravitational fields and mascons (mass concentrations), radiation environment, and the solar wind (1971)
28th History: launch of Alouette, Canada's first satellite (1962)
28th History: discovery of Jupiter's moon Ananke by Seth Nicholson (1951)
29th Asteroid 11 *Parthenope* at Opposition (8.9 Magnitude)
29th Apollo Asteroid 3200 *Phaethon* closest approach to Earth (0.402 AU)
29th Apollo Asteroid 4183 *Cuno* closest approach to Earth (2.144 AU)
29th History: launch of Salyut 6, first of a second generation of Soviet orbital space station designs (1977)
30th New Moon
30th Scheduled controlled descent of the Rosetta spacecraft to the surface of Comet 67P/Churyumov-Gerasimenko (mission complete)
30th Connecticut Star Party, Ashford, CT, http://www.asnh.org/ (through October 2nd)
30th Aten Asteroid 2009 UG near-Earth flyby (0.019 AU)
30th Apollo Asteroid 2015 SO2 near-Earth flyby (0.044 AU)
30th Kuiper Belt Object 2015 RR245 at Opposition (62.966 AU)
30th History: all instruments deployed on the Moon by the Apollo missions are shut off (1977)
30th History: discovery of Jupiter's moon *Themisto* by Charles Kowal (1975)

Commonly Used Terms

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

References on Distances

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

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

International Space Station/Iridium Satellites

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

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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. Image by Bill Cloutier.

Second Saturday Stars poster: Marc Polansky.

Second Saturday Stars

FREE EVENT

Every Month at the

John J. McCarthy Observatory

Behind the New Milford High School

860.946.0312

www.mccarthyobservatory.org

September 10th

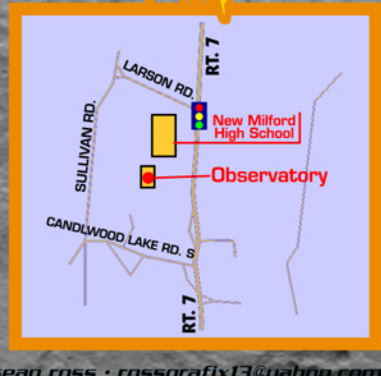
8:00 - 10:00 pm

Dawn @ Ceres

Part II

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

Map



art & design · sean ross · rossgrafix13@yahoo.com

September 2016

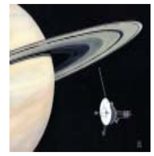
Celestial Calendar

Sunday | Monday | Tuesday | Wednesday | Thursday | Friday | Saturday

Phases of the Moon

Sep 1 Sep 9 Sep 16 Sep 23 Sep 30

1



Flyby of Saturn by Pioneer spacecraft (1979)

2

Discovery of asteroid 3 Juno by Karl Harding (1804)

3

Viking 2 lands on Mars (1976)

SMART-1 spacecraft controlled impact on Moon (2006)

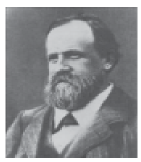
4

Oscar E. Monnig born, American amateur astronomer, contributed to the study of Meteoritics - a science that deals with meteorites and other extraterrestrial materials (1902)

5

Launch of Voyager 1 to Jupiter and Saturn (1977)

6



John Henry Dallmeyer born - Anglo-German optician, who developed the rapid rectilinear lens that is symmetrical about its stop to reduce radial distortion

7

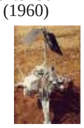
James Alfred van Allen born, an American space scientist whose proposal to use geiger counters on Explorer missions to detect charged particles gave his name to the van Allen Belt (1914)

8

Comet Ikeya-Seki (1965)

Marshall Space Center born (1960)

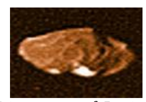
launch of the Surveyor 5 spacecraft to Mars (1967)



first Star Trek episode airs on television (1966)

9

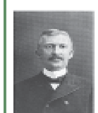
Launch of Conestoga 1, first private rocket 1982



Discovery of Jupiter's moon Analthea by Edward Barnard (1892)

10

GRAIL spacecraft launch to study Moon's gravity (2011)



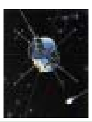
James Edward Keeler, American astronomer, discovered gap in Saturn's rings; later gave name to Keeler Gap, discovered by Voyager (1857)

2nd Saturday Stars Open House McCarthy Observatory

11

Mars Global Surveyor enters orbit around Mars (1997)

Flyby of Comet Giacobini-Zinner by the ICE spacecraft, first to visit a comet (1985)



12

Launch of Luna 2, 1st to impact Moon's surface (1959) and Luna 16, 1st robotic probe to return a sample to Earth (1970)

Launch of Gemini XI with astronauts Charles Conrad and Richard Gordon (1966)

13

Trans-Neptunian dwarf planet, 2003 UB313, is officially named "Eris", after Greek goddess of strife and conflict; estimated to be 27% more massive than pluto (2006)

14

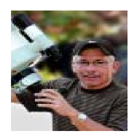
John Dobson born, father of dobsonian telescope (1915)

Discovery of Jupiter's moon Leda by Charles Kowal (1974)

15

Jean-Sylvain Bailly, French astronomer, mathematician, and political revolutionary leader; predicted return of Halley's Comet and researched the satellites of Jupiter; died on guillotine (born 1736)

16

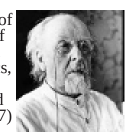


Robert Jay GaBany born, American amateur astronomer and astrophotographer, developed use of smaller telescopes and CCD cameras to produce long-exposure high resolution images of distant galaxies (1954)

17

Discovery of Saturn's Moon Mimas by William Herschel - 1789

Konstantin Tsiolkovsky born in Izhevskoye, Russia; one of the fathers of rocketry and cosmonautics, along with Goddard and Oberth (1857)



18

Launch of Vanguard 3, designed to measure solar x-rays, the Earth's magnetic field and micrometeoroids (1959)

19

Launch of von Braun-designed Jupiter-C rocket from Cape Canaveral (1956)

Discovery of Saturn's Moon Hyperion by William and George Bond and William Lassell (1848)

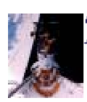
International Observe the Moon Night

InOMN

20

Surveyor 2 lunar lander launched, loses mission control, tumbles and crashes onto surface of Moon two days later (1966)

21



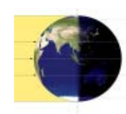
Jupiter impact ends successful Galileo mission (2003)

Gustav Holst born, composer of The Planets (1874)

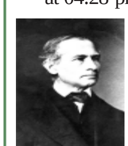
22

Flyby of comet Borrelly by Deep Space 1 (2001)

23



Autumnal Equinox at 04:28`pm EDT)



Johann Gottfried Galle discovers planet Neptune (1846)

24

John Young born - first to fly six times in space (1930)

Soviet spacecraft Luna 16 returns 101 grams of lunar soil to Earth

25

Launch of NASA Mars Observer spacecraft, also known as the Mars Geoscience/Climatology Orbiter, a robotic space probe; communication with the spacecraft was lost on August 21, 1993, 3 days prior to orbital insertion. (1992)

26

Cosmonauts V. Titov and Strelkov escape moments before Soyuz T-10-1 explodes on pad (1983)

27

Total Lunar Eclipse

Launch of SMART-1, 1st European lunar probe - 2003

Launch of Dawn spacecraft to Vesta and Ceres (2007)

28

Discovery of Jupiter's moon Ananke by Seth Nicholson (1951)

Launch of Alouette, Canada's first satellite (1962)

29

SpaceshipOne X1 achieves altitude of 102.9 kilometers, first of two flights to win X Prize competition (2004)

Launch of Salyut 6, first of a second generation of Soviet orbital space station designs (1977)

30

Discovery of Jupiter's moon Themisto by Charles T. Kowal (1975)