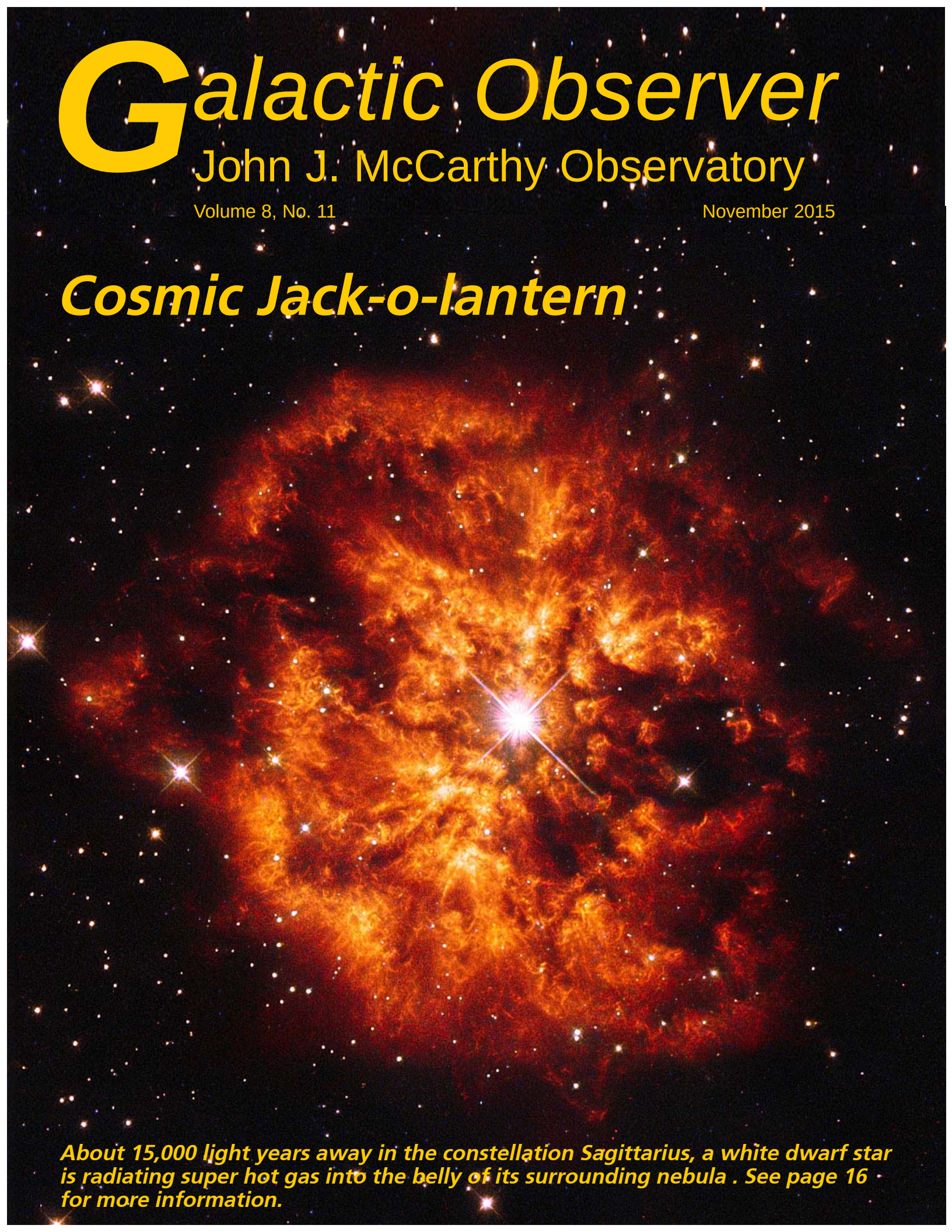
Galactic Observer

John J. McCarthy Observatory

Volume 8, No. 11 November 2015

Cosmic Jack-o-lantern



About 15,000 light years away in the constellation Sagittarius, a white dwarf star is radiating super hot gas into the belly of its surrounding nebula . *See page 16 for more information.*

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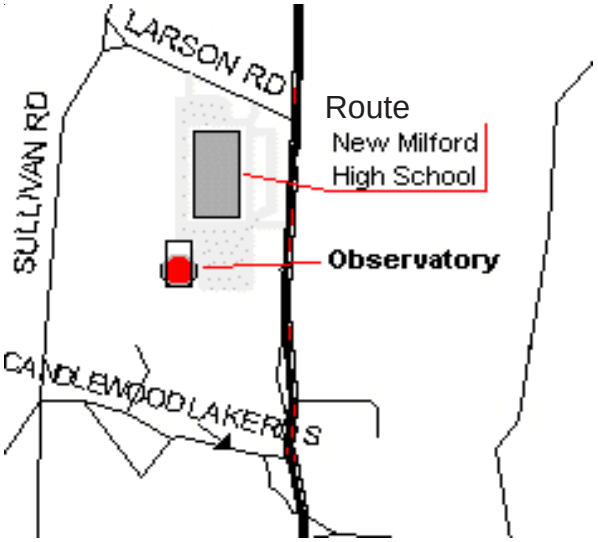

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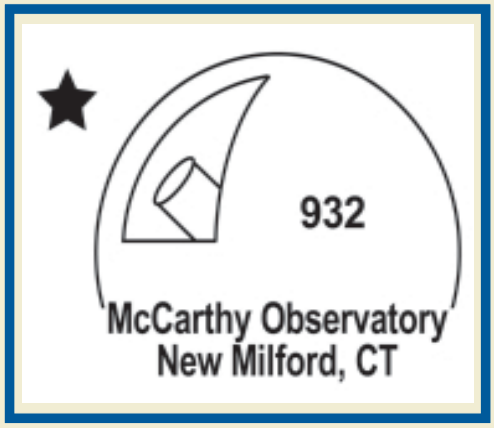
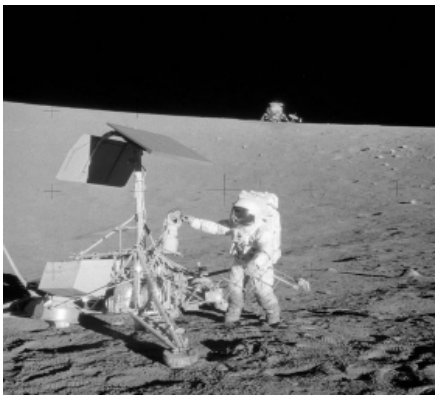


November Astronomy Calendar and Space Exploration Almanac

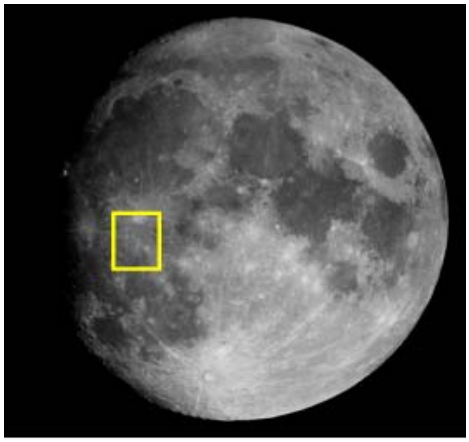
"Out the Window on Your Left"

IT'S BEEN OVER 40 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).



Astronaut Alan Bean inspects Surveyor 3 Credit: NASA

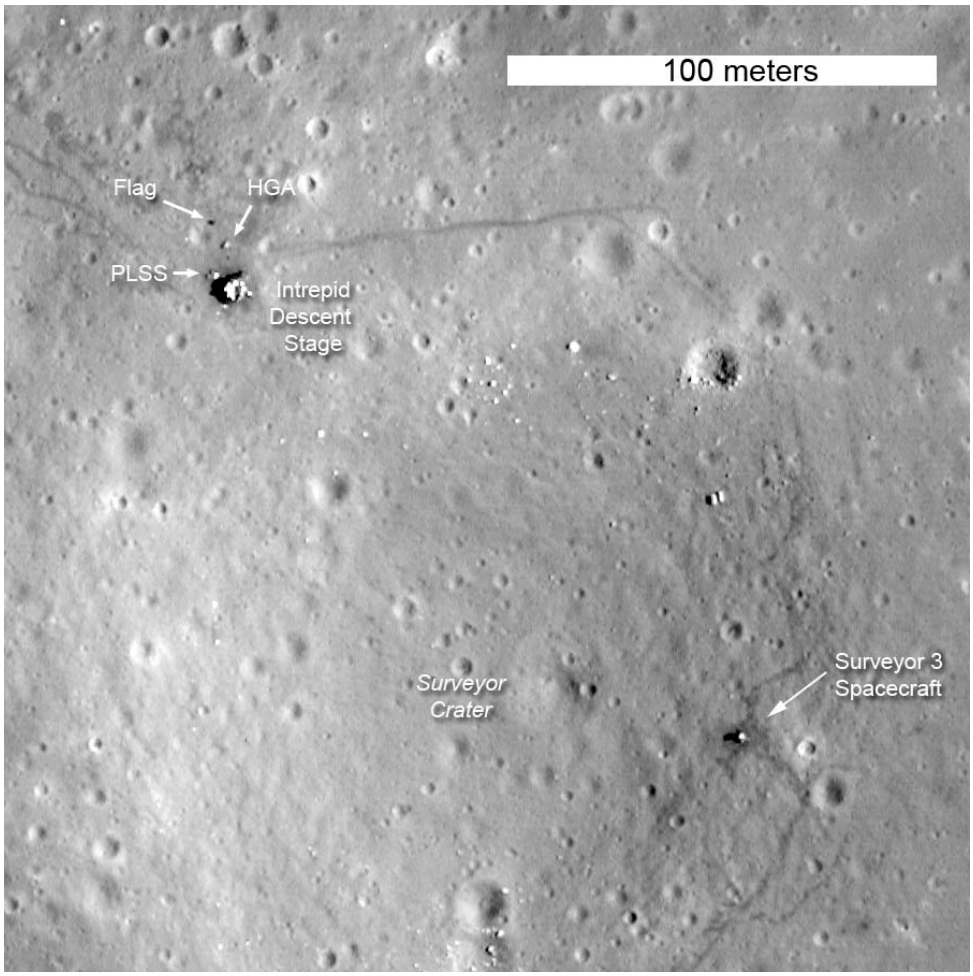
The landing site of Apollo 12 is visible in this month's image. The site for the second Moon landing was approximately 930 miles (1,500 km) west of the Apollo 11 site and similar in that it offered a relatively smooth landing area. The Apollo 12 site was selected for its proximity to Copernicus crater,



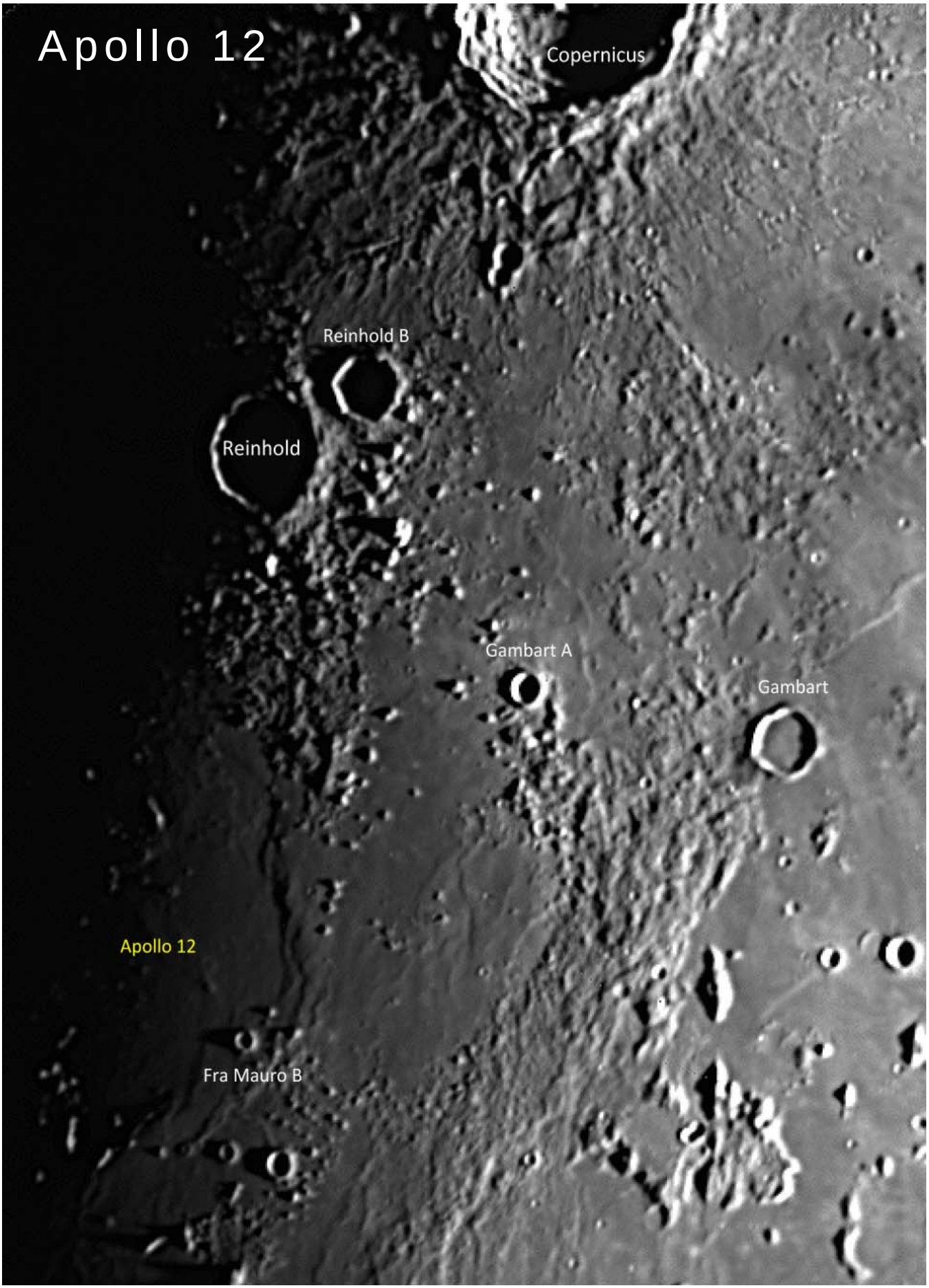
190 miles (300 km) to the north and the ejecta that was believed to have covered the site from the crater's formation. The location was also home to Surveyor 3, an unmanned spacecraft that landed on the Moon in April of 1967.

The crew of the Apollo 12 Lunar Module (Pete Conrad and Al Bean) executed a pinpoint landing on November 19, 1969, setting down 535 feet from the Surveyor spacecraft (to minimize the potential of contaminating Surveyor by the descent engine exhaust or dust kicked up by the engine required that the landing be at least 500 feet away from Surveyor). The Sun was only 6° above the horizon at touchdown, casting long shadows across the volcanic plains and adding sharp relief to the features at the landing site.

Conrad and Bean spent 7 hours and 45 minutes on the surface, in two separate excursions, collecting 75 pounds (34 kg) of rock and soil samples and setting up experiments. The astronauts were also able to venture into the crater in which Surveyor had landed and remove pieces (including the TV camera and soil scoop) for further study back on Earth.



The Apollo 12 landing site in Oceanus Procellarum imaged during the second LRO low-altitude campaign. Image width is 225 m, NAC Image M175428601R [NASA/GSFC/Arizona State University].


Apollo 12
Copernicus
Reinhold B
Reinhold
Gambart A
Gambart
Apollo 12
Fra Mauro B

The Real Martians

"The Martian" is a fictional yarn about an astronaut stranded on Mars. The novel is a bestseller and its movie adaptation has garnered enthusiastic reviews. While the public has been enjoying the exploits of fictional astronaut Mark Watney, there are two Earthlings actually working on the surface of Mars today - the robotic explorers Opportunity and Curiosity.

	Mars Exploration Rover Opportunity	Mars Science Laboratory Curiosity
Mission Design	Robotic Geologist	Mobile Laboratory
Landing Date (UT)	January 25, 2004	August 6, 2012
Landing Location	Meridian Planum	Gale Crater
Landing Method	Airbags	Powered Descent Vehicle/ Sky Crane
Primary Power Source	Solar Cells	Radioisotope Thermoelectric Generator
Weight (pounds)	384	1,982
Length (feet)	5.6	10
Width (feet)	5.9 (with solar panels deployed)	9
Height to Pancam Mast Assembly (feet)	4.9	7
Top Speed (mph)	0.16	3.35
Wheels (number)	6	6
Wheel Diameter (inches)	10	20
Instruments	5	10

Opportunity, the elder Martian, has been working on the Red Planet since January 2004. The diminutive rover landed in Eagle Crater, a small impact crater on Meridiani Planum, the westernmost portion of Terra Meridiani. The landing site, peppered with the occasional impact crater, is located just 2° south of Mars' equator. The location provided ample sunlight for Opportunity's solar panels throughout the Martian year.

Hematite, the mineral form of iron oxide, had been detected on Meridiani Planum by the orbiting Mars Global Surveyor. On Earth, hematite is often formed in hot springs or in standing pools of water. The shallow Eagle crater (approximately 74 feet across and 10 feet deep) was an auspicious start to the mission with an exposed rocky outcrop visible along its rim covered with small hematite concretions nicknamed "blueberries."

Eagle Crater was only the first, and smallest, crater explored by Opportunity. Seven and one-half years later, in August 2011, Opportunity reached its current location, the 14 mile diameter Endeavor Crater. After exploring the rim of the crater, Opportunity has moved into "Marathon Valley," a thousand foot long gash in the western rim of Endeavor. The valley's name comes from the rover's off-world driving record (exceeding the length of a marathon or 26 miles).

Marathon Valley had also been targeted from orbit as a site rich in clay minerals. Opportunity has been able to work through previous Martian winters; however, the dust currently coating the rover's solar panels is limiting the available power. Consequently, JPL's rover team is planning to restrict operations to the south side

of the valley to take advantage of the sun-facing slope (a technique that had been used for Opportunity's twin, Spirit, that operated at a more southern latitude).

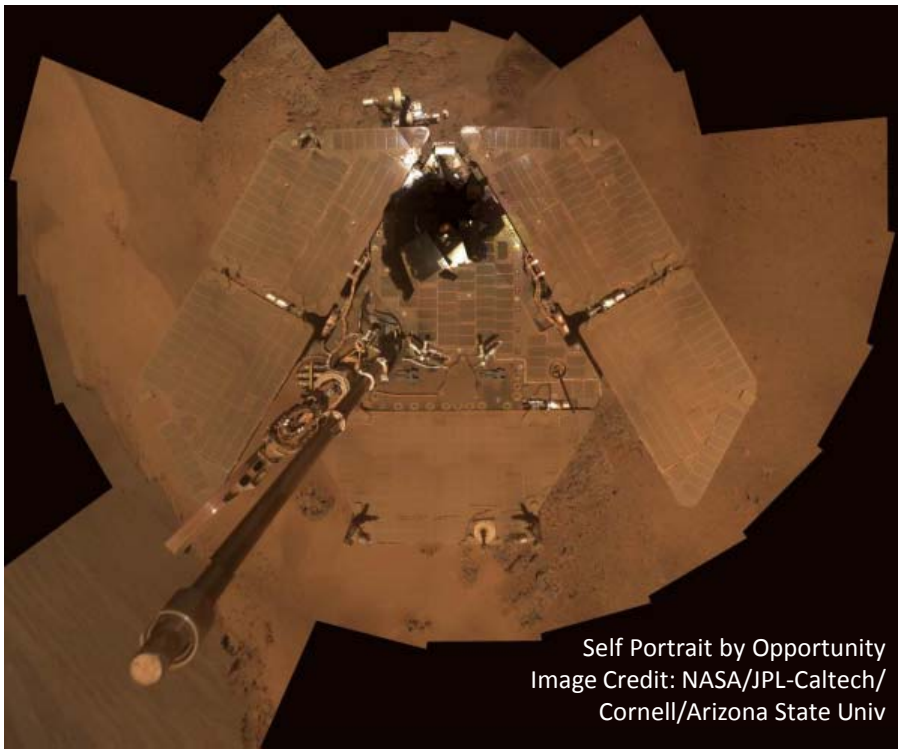
Opportunity will celebrate 12 Earth-years on Mars in January 2016, exceeding all expectations for a 90-day nominal mission.

Curiosity is more than five times heavier than Opportunity, and with its weight couldn't use the airbag landing system. The rover was set down in Gale Crater by a rocket powered descent vehicle. The 96 mile diameter crater is estimated to be about 3.5-3.8 billion years old. An 18,000 foot high mountain, Aeolis Mons (informally known as Mount Sharp), rises from its center.

Since landing in August 2012, Curiosity has been exploring the terrain surrounding Mount Sharp and, more recently, its foothills. The mountain appears to have been laid down in layers by water-borne sediment - layers that were later eroded away and shaped by the Martian winds. Exploration around the base of the mountain has uncovered clay minerals and ancient channels indicating fast moving water and evidence that the crater periodically filled with water. Sulfur and oxygen-bearing minerals appear in the overlying layers. Analysis of the local sediment suggests that a shallow lake may have been present for hundreds to thousands of years.

The possibility of standing water on the surface of Mars for long periods of time would suggest a thicker Martian atmosphere and conditions favorable for microbial life to evolve.

Curiosity celebrated 3 Earth-years on Mars in August as it continues to work its way up the mountain.

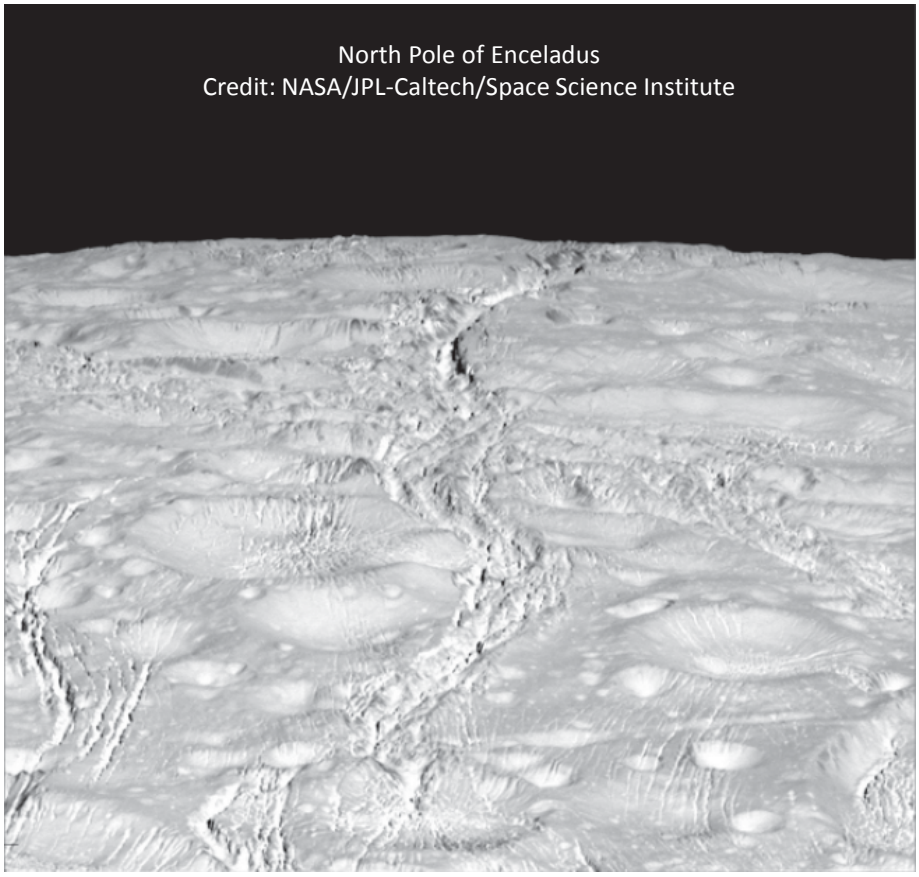


Self Portrait by Opportunity
Image Credit: NASA/JPL-Caltech/
Cornell/Arizona State Univ

Mars Science Laboratory
NASA/JPL-Caltech/MSSS

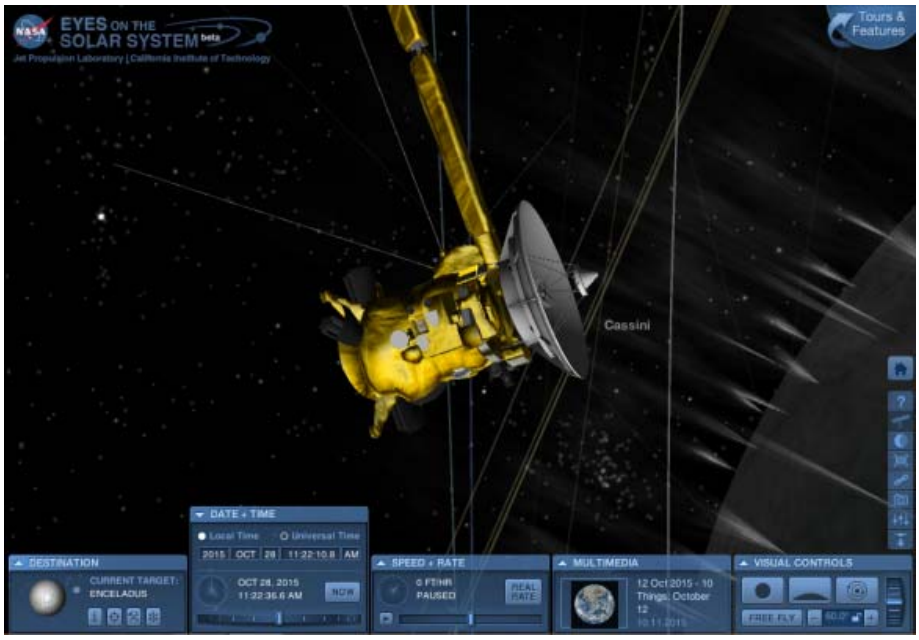
Tasting an Alien Ocean

The Cassini spacecraft flew by Saturn's icy moon Enceladus twice in October. The October 14th flyby took the spacecraft over the moon's north pole. The images returned from a distance of approximately 4,000 miles showed a heavily cratered landscape crisscrossed with fractures.



North Pole of Enceladus
Credit: NASA/JPL-Caltech/Space Science Institute

The month's second encounter, on the 28th, was a high speed pass (at approximately 19,000 mph) over the moon's active south pole, at an altitude of only 30 miles. As planned, Cassini passed through the moon's icy plumes, sampling the material spraying into space.



The spacecraft's Cosmic Dust Analyzer registered 173 impact events during the pass. The analyzer has the ability to directly measure the chemical composition of the particles. The calibration of the spectra will take some time, but the results might provide some additional clues as to chemistry of the subsurface ocean.

Cassini has been in orbit around Saturn since 2004. Its science mission will continue until 2017 when the spacecraft runs out of fuel. Cassini first imaged the plumes erupting from fissures near Enceladus' south pole in November 2005. Data returned from subsequent passes (the flyby on October 28th was the 21st of the mission) suggested a subsurface ocean as the source of the plumes. The ocean was initially thought to be confined to the moon's southern polar region, but scientists now believed that the subsurface ocean is global.

Scientists also believe that the ocean is in direct contact with the moon's rocky mantle. Water (possibly hot water) and rock can produce a chemistry favorable to simple forms of life.

Pluto and Kerberos

Recent data downloaded from the New Horizons spacecraft included the first images of Pluto's moon Kerberos. The images, captured approximately seven hours before the spacecraft's closest approach to Pluto, were taken from a distance of 245,600 miles from Kerberos. The moon appears to have two lobes, suggesting a merger of two smaller bodies (similar to the structure of comet 67P/Churyumov–Gerasimenko visited by the Rosetta spacecraft).

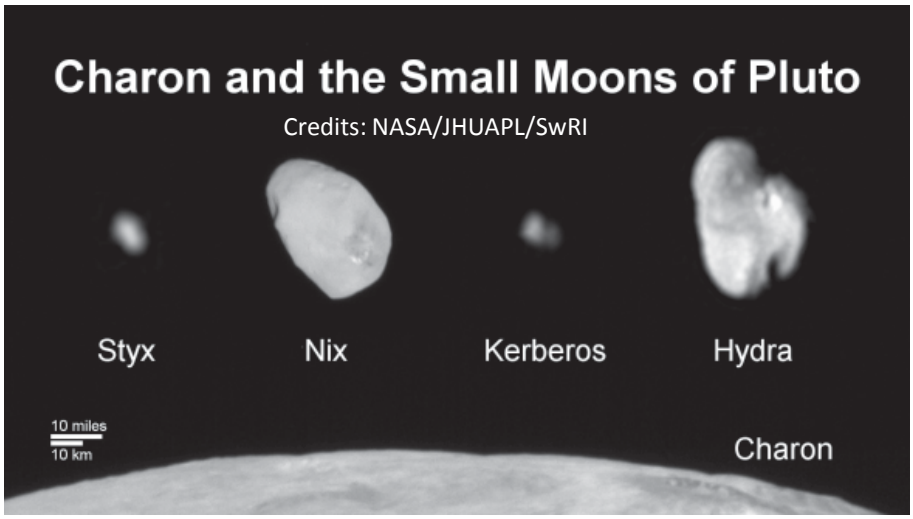
Kerberos is approximately 7.4 miles long. Its larger lobe is approximately 5 miles across with

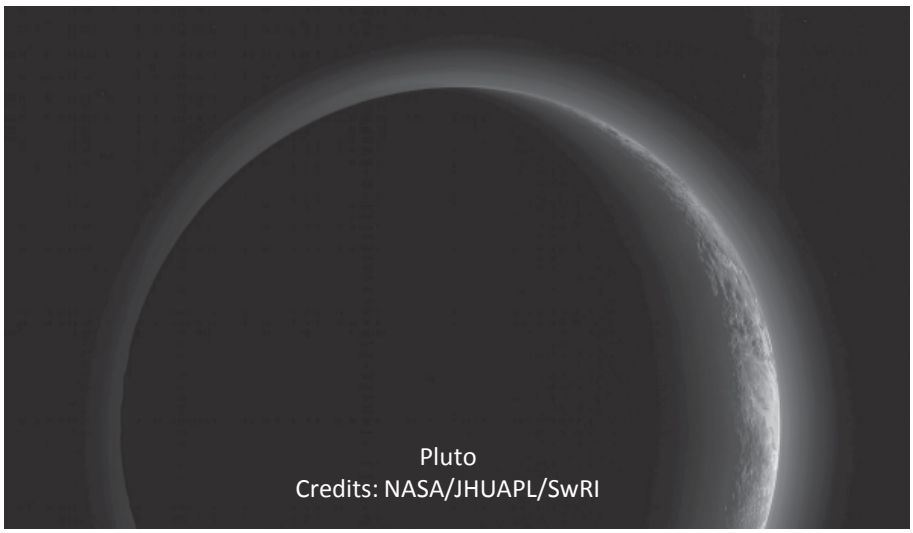
the smaller lobe approximately 3 miles across. Similar to Pluto's other small moons, Kerberos' surface is highly reflective, suggesting a coating of relatively pure water ice.

Puzzling scientists, the diminutive moon is smaller than expected based upon its gravitational influence on its companion moons. The image below shows the relative size of Pluto's five moons.

NASA also rereleased an image of Pluto taken 15 minutes after New Horizon's closest approach. The image, processed to bring out additional detail, shows the rugged little world sheathed in a haze and backlit by a distant Sun 3 billion miles away.

New Horizons was 11,000 miles from Pluto when the image was taken. The spacecraft continues to beam back the data from the encounter, a process not expected to be complete until later next year.





Leonid Meteor Shower

Almost everyone has seen a 'shooting star;' but not everyone knows what they are, where they come from and how best to view them. For those of you that remember that chilly November night in 2001 when the stars fell like rain, a meteor shower or meteor storm is truly unforgettable. As with that night, all you need are a comfortable chair and a warm blanket to enjoy the show.

Meteor showers occur when the Earth passes through a cloud of debris left behind by a comet. As a comet nears the Sun, the volatile gases warm and erupt along with trapped particles of rock and dust. Pushed away from the comet by the solar wind, this material forms the comet's tail. Each time a comet crosses the Earth's orbit it leaves behind a small cloud of debris. When the Earth passes through these clouds, the debris quickly heats up in the atmosphere, creating streaks of light across the night sky. The point in the sky

Leonid meteors seen from 39,000 feet aboard an aircraft during the 1999 Leonids Multi-Instrument Aircraft Campaign (Leonid-MAC). Credit: NASA/SAS/Shinsuke Abe and Hajime Yano

where the meteors appear to originate is called the radiant. Meteor showers are identified by the constellation in which the radiant appears. As such, if you trace the path of the meteors in the early morning of November 17, you will notice that most seem to originate from a point in the constellation Leo, hence the name Leonids.

Why does the same meteor shower excite one year and disappoint the next? While comets are responsible for seeding Earth's orbit with the makings of a meteor shower, most comets are not frequent visitors to the inner solar system. Comet Tempel-Tuttle (the source of the Leonid meteors) crosses Earth's orbit once every 33 years. The resulting cloud is about 10 Earth diameters across and continues to drift along the comet's path. Most years the Earth misses these clouds altogether. In those years the meteor shower is sparse. Other years, as in 2001, the Earth can interact with several debris clouds from Comet Tempel-Tuttle. If the debris cloud is dense (containing a lot of rock and dust) the show can be spectacular. However, as debris clouds age they stretch out and become less dense. The resulting encounter produces fewer and fewer meteors.

What can we expect this year? With a waxing crescent Moon setting before midnight, viewing conditions should be favorable. Expect to see an average of 15-20 meteors per hour during the peak period from a dark site (as long as the skies are clear).

Danger: Space Debris

MORE THAN A TON of meteoroids bombards the Earth and moon every day. Most disintegrate in the Earth's atmosphere. The moon is not so fortunate; the lunar surface is continually modified by the bombardment, as shown by the samples brought back from there by the Apollo astronauts. NASA is supporting projects that monitor the frequency of lunar impacts, anticipating that the information will be useful in designing more robust lunar structures and contingency plans for astronauts venturing out on the lunar surface.

NASA launched the Chandra X-ray Observatory in July 1999, placing it in an elliptical orbit that extends almost one-third the distance to the moon. In November 2003, the telescope's operators placed the telescope in a safe configuration during its passage through four meteor shower streams. Despite an extremely low probability (one in a million) that the telescope would be hit by a meteoroid, that's what apparently happened early on the morning of November 15th. Fortunately, there was no apparent damage to the more sensitive parts of the telescope.

In 2006, the right-hand payload bay door radiator of the space shuttle Atlantis was hit by space debris. The object blasted its way through the metal skin and aluminum honeycomb material inside before exiting the other side. The resulting hole missed the Freon coolant lines inside the panel and did not endanger the crew. (The radiators were only deployed once the shuttle is in space and were stored in the cargo bay during reentry.) However, the impact illustrates the danger presented by space debris to spacecraft and their human occupants.

Payload Bay Door Impact.
NASA Photo

The Hubble Space Telescope's Wide Field Planetary Camera 2 was returned to Earth as part of the telescope's servicing mission in 2009 (STS-125). Attached to the camera was a large radiator (2.2 m by 0.8 m). The radiator had been in space since the camera was installed in 1993, and its large flat surface provided an excellent measure for determining impact rates for orbital debris at the telescope's altitude (between 560 and 620 km). Initial analysis of the radiator found a total of 685 micrometeoroid and orbital debris impact features (larger than about 0.3 mm).

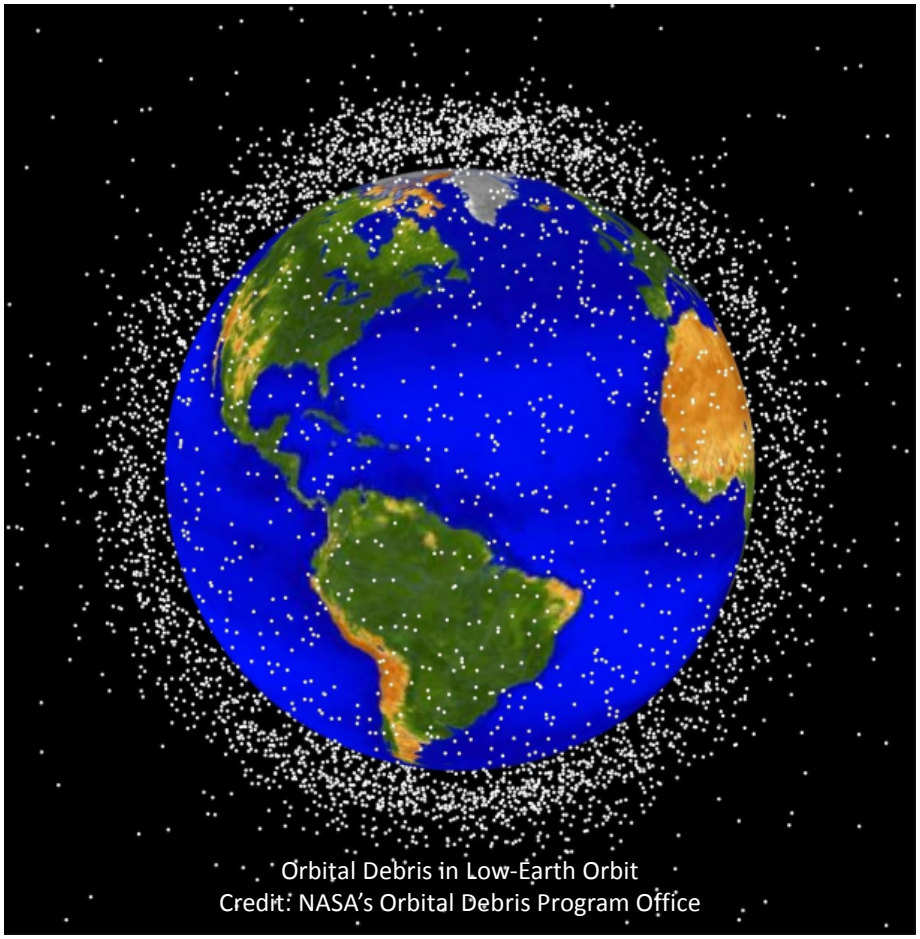
It is estimated that tens of millions of man-made objects also orbit the Earth, the vast majority smaller than 1 centimeter in size. The objects come from derelict spacecraft, exploding rocket boosters, discarded motors, deterioration of man-made structures including thermal blankets and solar panels, as well as from accidental and deliberate collisions. The objects orbit the Earth in many different directions, altitudes, and velocities, traveling up to 30,000 miles an hour or 20 times faster than a rifle bullet. At these speeds, it doesn't take a very large object to inflict considerable damage to another ob-

ject, including the International Space Station (ISS). The space shuttle windows were hit by small pieces of debris 32 times during an average mission. Micrometeorites are involved in approximately one-third of the collisions. The grains of sand are generally less dense than man-made debris, and therefore, relatively harmless. The remaining two-thirds do have some penetrating power and are primarily bits of aluminum, followed by paint, steel, and copper.

NASA currently tracks almost 17,000 objects; most are larger than 10 centimeters (4 inches). This is double the number of objects tracked ten years ago. (There may be 500,000 debris fragments greater than one centimeter in size and over a 100 million fragments smaller than a centimeter). While the United States and Russia are the largest contributors to the swarm of man-made objects, newer space faring nations, in particular China, have added to the problem (particularly after China's intentional destruction of its Fengyun 1C weather satellite, the single largest debris producing event). While debris in low-Earth orbit will eventually fall back to the surface, objects higher than 800 kilometers (480 miles) can continue to circle the planet for decades and even centuries.

The ISS was repositioned twice this year (2015) to avoid debris. The first maneuver, in April, was performed to avoid debris from an inactive satellite. The second maneuver, in June, was performed to avoid a collision with a discarded upper stage of a rocket. There was another close call in July with satellite debris. There wasn't enough time to reposition the IS, so the crew retreated into the Soyuz spacecraft docked to the station just in case the ISS was breached.

Until a solution can be found to cleaning up the debris (that is both technically feasible and economical), NASA has developed guidelines it hopes other nations will adopt to minimize the creation of even more debris. In the meantime, surveillance of the existing debris (only practical for the larger objects) will allow spacecraft to maneuver to avoid future collisions, and more importantly, the loss of life. For additional information, NASA publishes the "Orbital Debris Quarterly News," complete with a "satellite box score." The newsletter (past and present) is available at *http://orbitaldebris.jsc.nasa.gov/newsletter/newsletter.html*.

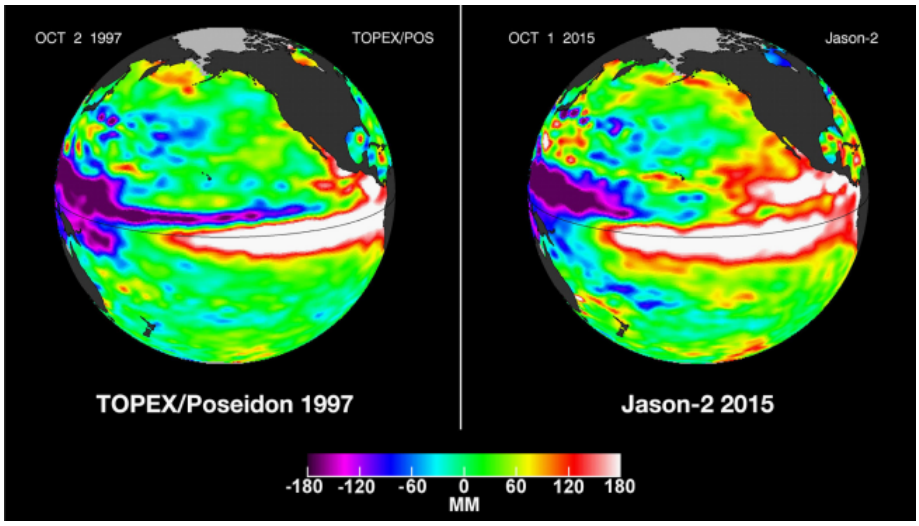


Orbital Debris in Low-Earth Orbit
Credit: NASA's Orbital Debris Program Office

Eyes on the Earth

A pool of unusually warm water develops in the eastern Pacific every two to seven years. The warm water (4° to 5° F above average) has a significant, short term effect on the Earth's climate. The phenomena, known as El Niño, is responsible for changes in the global circulation patterns and for extreme weather (droughts and floods).

As seen below, the conditions for an El Niño, are developing in 2015. The conditions are similar to what was seen in 1997-1998 based upon satellite data from the TOPEX/Poseidon and Jason-2 satellites. The 1997-1998 El Niño was the strongest on record with devastating effects on world-wide food supplies and other weather-dependent industries.



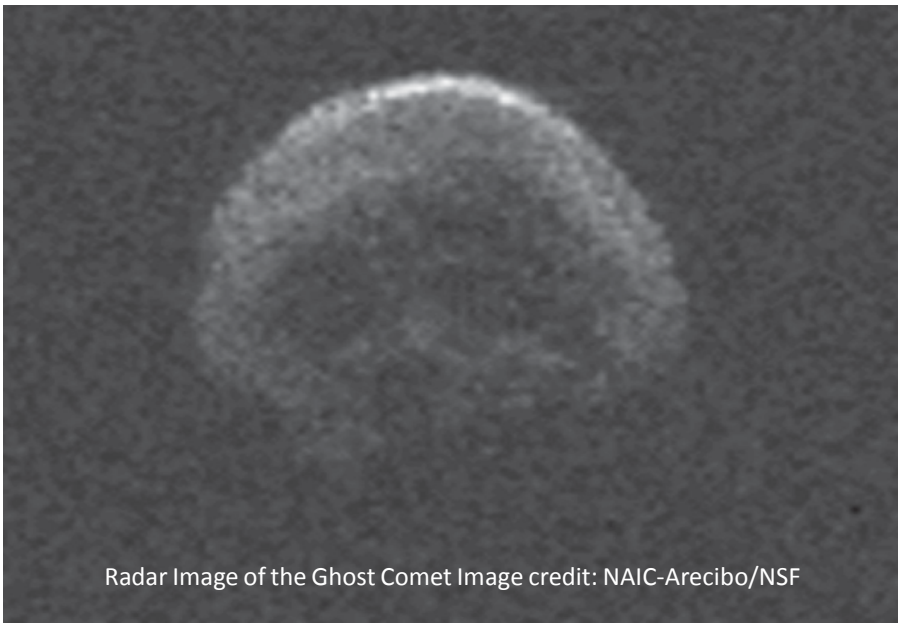
Sea Surface Height Anomalies in the Eastern Pacific
Image Credit: NASA/JPL-Caltech

Halloween Visitor

NASA had tracked an asteroid on course for a near-Earth flyby on Halloween. The asteroid (2015 TB145) was discovered on Oct. 10, 2015, by the University of Hawaii's Pan-STARRS-1 (Panoramic Survey Telescope and Rapid Response System) on Haleakala, Maui. The 1,300 foot wide asteroid safely passed by Earth, coming no closer than 300,000 miles (or just beyond the orbit of the Moon).

With its relatively large size and proximity, the object was targeted by a number of radio telescopes, including Goldstone in California, Green Bank in West Virginia and Arecibo in Puerto Rico. Radar imaging can provide data on the object's size, shape, rotation, and surface roughness.

Radar images of the "asteroid" suggest that it's actually a dead comet (not surprising given its relatively high velocity and inclination to the ecliptic). Infrared data, collected by NASA's Infrared Telescope Facility on Mauna Kea, Hawaii, may confirm its origin.



Radar Image of the Ghost Comet Image credit: NAIC-Arecibo/NSF

November History: Apollo 12

The second manned mission to the lunar surface was launched on November 14, 1969. The mission was almost lost before it started. The Saturn V rocket booster was hit by lighting as it rose from the launch pad. Fortunately, a young flight controller in mission control (John Aaron) remembered seeing the same dizzying display of warning lights and alarms in a practice run and was able to provide the crew directions on re-establishing power and control to the spacecraft.

After leaving Earth orbit, the command module extracts the lunar excursion module from the third stage. The trajectory (or path) of the third stage is then modified, so as not to interfere with the lunar landing (either by placing it into orbit around the Sun or deliberately crashing it into the Moon). In what would become of interest 33 years later, the engine on the third stage burned 300 seconds too long, sending the rocket booster into a semi-stable orbit around the Earth. Two years later, it finally entered into an orbit around the Sun (by passing through a region of space controlled by the Earth and Sun).

The Ocean of Storms was the designated landing site for Apollo 12, southeast of the large crater Lansberg (see page 4). Mission Commander Pete Conrad made a pinpoint landing 535 feet from the Surveyor 3 spacecraft which had landed two years earlier. The diminutive Conrad joked as he stepped out onto the lunar surface for the first time, "Whoopee! Man, that may have been one small one for Neil, but that's a long one for me."

In 2002, amateur astronomer Bill Yeung discovered a new object orbiting the Earth. Designated J002E3, the object was later determined to be artificial (from the analysis of reflected sunlight). After considerable study, it was concluded that J002E3 was most likely the third stage of Apollo 12. The object made six elongated orbits of the Earth before disappearing, presumably returning to its previous orbit around the Sun.

J002E3 was imaged from the McCarthy Observatory during three of its close approaches to Earth. Although the images are just snapshots, the tumbling motion of the booster is clearly seen as the sunlight alternately reflects off the white painted sides of the rocket and then the darkened ends.

November Nights

The late Harvard University astronomer Harlow Shapley was born in November 1885. One of his many accomplishments was accurately measuring the distance to globular star clusters and their position around the Milky Way Galaxy. While warm summer nights are usually reserved for hunting globulars, the autumnal sky contains several impressive clusters including M15 in Pegasus and M2 in Aquarius. M30 in Capricorn is also visible in the southwest sky in the evening.

On the eastern side of the Great Square of Pegasus is the constellation Andromeda. Within this constellation and visible to the unaided eye on a dark night is the Andromeda Galaxy (M31), a massive pinwheel of 500 billion suns. Larger than the Milky Way, the Andromeda Galaxy is currently rushing towards us at 75 miles per second. Fortunately, it is approximately 2½ million light years (14.7 million trillion miles) distant, so it will be some time before the two galaxies merge. Visible through a telescope are Andromeda's two companion galaxies, M32 and M110. While M32 can be mistaken for a bright star due to its close proximity to the core of the Andromeda Galaxy, M110 is a bit easier, being further away and larger than M32.

Located not far from M31 is the Triangulum or Pinwheel Galaxy (M33). Smaller and less massive than the Milky Way, this galaxy can be a challenge to see on less than ideal nights, due to its low surface brightness. However, through a large telescope on a dark, steady night, the view looking face-on at this giant pinwheel can be spectacular. The large spiral arms of M33 are filled with star-forming regions that almost appear to be gliding through space.

Sunrise and Sunset

Sun	Sunrise	Sunset
November 1st (EST)	07:25	17:49
November 15th	06:42	16:34
November 30th	06:59	16:25

Astronomical and Historical Events

1st End of Daylight Savings Time - set clocks back one hour at 2 a.m.
1st Kuiper Belt Object 2014 UM33 at Opposition (42.902 AU)
1st History: launch of the Wind spacecraft, designed to monitor the solar wind (1994)
2nd Plutino 144897 (2004 UX10) at Opposition (38.186 AU)
2nd History: flyby of Asteroid 5535 Annefrank by the Stardust spacecraft (2002)
2nd History: first light at the 100-inch telescope on Mount Wilson (1917)
3rd Last Quarter Moon
3rd Taurids Meteor Shower peak (associated with the comet Encke)
3rd Neptune Trojan 2006 RJ103 at Opposition (29.328 AU)
3rd History: launch of Mariner 10 to Venus and Mercury; first mission to use the gravitational pull of one planet (Venus) to reach another (Mercury) (1973)
3rd History: launch of Sputnik 2 and a dog named Laika (1957)
4th Centaur Object 54598 Bienor at Opposition (14.800 AU)

Astronomical and Historical Events (continued)

4th Kuiper Belt Object 55637 (2002 UX25) at Opposition (39.895 AU)
4th History: Deep Impact's closest approach to the nucleus of Comet 103P/Hartley 2 (2010)
4th History: launch of the Soviet Venus lander Venera 14 (1981)
5th Kuiper Belt Object 84522 (2002 TC302) at Opposition (44.110 AU)
5th History: Chinese spacecraft Chang'e 1 enters orbit around Moon (2007)
7th Moon at apogee (furthest distance from Earth)
7th History: launch of Mars Global Surveyor (1996)
7th History: launch of Surveyor 6 moon lander (landed two days later). On November 17th, the lander's small vernier engines were fired for 2½ seconds, lifting the lander off the lunar surface 10 to 12 feet and almost 8 feet sideways. This lunar "hop" was the first powered takeoff from the lunar surface. It also provided NASA a view of the original landing site and a baseline for acquiring stereoscopic images of its surroundings. (1967)
7th History: launch of Lunar Orbiter 2, Apollo landing site survey mission (1966)
8th History: launch of the ill-fated Phobos-Grunt spacecraft from the Baikonur Cosmodrome in Kazakhstan. Destined for the Martian moon Phobos, the spacecraft never left Earth orbit and eventually re-entered the atmosphere. (2011)
8th History: meteorite hits a house in Wethersfield, Connecticut (1982)
8th History: launch of Pioneer 9 into solar orbit (1968)
8th History: launch of Little Joe rocket, qualifying flight for the Mercury spacecraft (1960)
8th History: Edmund Halley born, English astronomer who calculated the orbit and predicted the return of the comet now called Comet Halley (1656)
9th History: launch of OFO-1 (Orbiting Frog Otolith) - two bullfrogs launched in an experiment to monitor the adaptability of the inner ear to sustained weightlessness (1970)
9th History: launch of the Venus Express spacecraft; ESA Venus orbiter (2005)
9th History: launch of the first Saturn V rocket, Apollo 4 (1967)
10th History: launch of Luna 17, Soviet Moon rover mission (1970)
10th History: launch of USSR spacecraft Zond 6; Moon orbit and return (1968)
10th History: Waseda Meteorite Fall; hits house in Japan (1823)
11th New Moon
11th Flyby of Saturn's moons *Calypso*, *Pan*, *Pandora* and *Tethys* by the Cassini spacecraft
11th History: launch of Gemini 12 with astronauts James Lovell and Edwin Aldrin (1966)
11th History: Tycho Brahe discovers a new star in the constellation Cassiopeia shining as bright as Jupiter; later determined to be a supernova - SN1572 (1572)
12th History: launch of STS-2, second flight of the Space Shuttle Columbia (1981)
12th History: flyby of Saturn by the Voyager 1 spacecraft (1980)
12th History: Seth Nicholson born, American astronomer who discovered four of Jupiter's moons, a Trojan asteroid, and computed orbits of several comets and of Pluto (1891)
13th Flyby of Saturn's largest moon *Titan* by the Cassini spacecraft
13th Neptune Trojan 2007 VL305 at Opposition (27.206 AU)
13th History: launch of HEAO-2, the second of NASA's three High Energy Astrophysical Observatories; renamed Einstein after launch, it was the first fully imaging X-ray space telescope (1978)
14th Second Saturday Stars - Open House at the McCarthy Observatory (7:00 pm)
14th Kuiper Belt Object 2012 VP113 at Opposition (82.352 AU)
14th History: discovery of the Great Comet of 1680 or Kirch's Comet by Gottfried Kirch (1680)
14th History: dedication of the New Milford Solar System Scale Model (2009)
14th History: Mariner 9 arrives at Mars; first spacecraft to orbit another planet (1971)
14th History: launch of Apollo 12, with astronauts Pete Conrad, Richard Gordon and Alan Bean to the moon's Ocean of Storms and near the robotic explorer Surveyor 3 (1969)
15th Plutino 2003 UZ413 at Opposition (42.529 AU)

Astronomical and Historical Events (continued)

- 15th History: ESA's spacecraft SMART-1 enters lunar orbit; first ESA Small Mission for Advanced Research in Technology; travelled to the Moon using solar-electric propulsion and carrying a battery of miniaturized instruments (2004)
- 15th History: the only orbital launch of the Russian space shuttle Buran; the unmanned shuttle orbited the Earth twice before landing (1988)
- 15th History: launch of Intasat, Spain's first satellite (1974)
- 16th Kuiper Belt Object 2010 VK201 at Opposition (47.050 AU)
- 16th History: launch of the third (and last) Skylab crew with astronauts Gerald Carr, William Pogue and Edward Gibson (1973)
- 16th History: launch of Venera 3, Soviet Venus lander (1965)
- 17th Leonids Meteor Shower peak (associated with the comet Tempel-Tuttle)
- 17th Plutino 84719 (2002 VR128) at Opposition (38.030 AU)
- 17th Scheduled return to launch of SpaceX's Falcon 9 rocket (SES 9 communication satellite)
- 17th History: launch of Soyuz 20, a 90 day, long duration mission that carried a biological payload (tortoises). The tortoises returned to Earth in good health (1975)
- 17th History: Soviet lunar lander Luna 17 deploys first rover - Lunokhod 1 (built by the Kharkov state bicycle plant); operated for 11 months, photographing and mapping the lunar surface and analyzing the regolith (1970)
- 18th Kuiper Belt Object 90377 Sedna at Opposition (84.850 AU)
- 18th History: Leonids Meteor Storm (2001)
- 18th History: launch of the COBE spacecraft; observed diffuse cosmic background radiation (1989)
- 19th First Quarter Moon
- 20th History: the Japan Aerospace Exploration Agency's Hayabusa spacecraft lands on Asteroid 25143 Itokawa for sample collection (2005)
- 20th History: launch of the Swift spacecraft; first-of-its-kind multi-wavelength observatory dedicated to the study of gamma-ray bursts (2004)
- 21st Scheduled launch of a Russian Progress cargo-carrying spacecraft from the Baikonur Cosmodrome, Kazakhstan to the International Space Station
- 23rd Moon at perigee (closest approach to Earth)
- 23rd Distant flyby of Saturn's moon Tethys by the Cassini spacecraft
- 23rd History: launch of the European Space Agency's first satellite, Meteosat 1 (1977)
- 23rd History: launch of Tiros II weather satellite (1960)
- 24th Distant flyby of Saturn's moons *Atlas*, *Daphins* and *Methone* by the Cassini spacecraft
- 25th Full Moon (Full Beaver or Full Frost Moon)
- 25th History: Albert Einstein publishes his General Theory of Relativity (1915)
- 25th History: William Dawes discovers Saturn's C Ring (1850)
- 26th Moon occults Aldebaran
- 26th Kuiper Belt Object 386723 (2009 YE7) at Opposition (49.829 AU)
- 26th History: launch of the Mars Science Laboratory (MSL) aboard an Atlas 5 rocket from the Cape Canaveral Air Force Station (2011)
- 26th History: discovery of Mars meteorites SAU 005 and SAU 008 (1999)
- 26th History: launch of France's first satellite, Asterix 1 (1965)
- 26th History: launch of Explorer 18; studied charged particles and magnetic fields in and around the Earth – Moon (1963)
- 26th History: discovery of the Orion Nebula by French astronomer Nicolas-Claude Fabri de Peiresc (1610)
- 27th Kuiper Belt Object 145453 (2005 RR43) at Opposition (38.361 AU)
- 27th History: Soviet spacecraft Mars 2 arrives at Mars; lander crashes, becoming first human artifact to impact the surface of Mars (1971)

Astronomical and Historical Events (continued)

28th History: launch of Algeria's first satellite, Alsat 1 (2002)
28th History: launch of Mariner 4; first spacecraft to obtain and transmit close range images of Mars (1964)
29th History: discovery of Y000593 Mars meteorite in Antarctica (2000)
29th History: launch of Australia's first satellite, Wresat 1 (1967)
29th History: launch of Mercury 5 with Enos the chimpanzee (1961)
30th Distant flyby of Saturn's largest moon, *Titan*, by the Cassini spacecraft
30th Kuiper Belt Object 229762 (2007 UK126) at Opposition (42.206 AU)

Commonly Used Terms

· Centaur: icy planetesimals with characteristics of both asteroids and comets
· Kuiper Belt: region of the solar system beyond the orbit of Neptune (30 AUs to 50 AUs) with a vast population of small bodies orbiting the Sun
· Opposition: celestial bodies on opposite sides of the sky, typically as viewed from Earth
· Plutino: an asteroid-sized body that orbits the Sun in a 2:3 resonance with Neptune
· Trojan: asteroids orbiting in the 4th and 5th Lagrange points (leading and trailing) of major planets in the Solar System

References on Distances

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

International Space Station/Space Shuttle/Iridium Satellites

Visit *www.heavens-above.com* for the times of visibility and detailed star charts for viewing the International Space Station, the Space Shuttle (when in orbit) and the bright flares from Iridium satellites.

Solar Activity

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

Image Credits

Front page design and graphic calendars: Allan Ostergren

Cover image: About 15,000 light years away in the belly of the constellation Sagitarius, a white dwarf star is radiating super hot gas into its surrounding nebula, M1-67. The star is known as Hen 2-427 in a catalogue of high-emission stars by NASA astronomer Karl Henize, and classified as a Wolf-Rayet star, from a compendium of super hot mass-ejecting stars by astronomers Charles Wolf and Georges Rayet.

Hen 2-427 is burning its hydrogen and helium and shedding these super hot gases into its nebula at a speed of 93,000 miles per hour (150,000 kph). The nebula, M1-67, is young - only 10,000 years old and about 15,000 light years away from Earth. Image credit: ESA/Hubble & NASA. Acknowledgement: Judy Schmidt (geckzilla.com).

Page 3 graphic: An image from the HiRISE camera on NASA's Mars Reconnaissance Orbiter of Acidalia Planitia, the landing site for the fictional Ares 3 mission (from the best-selling novel and Hollywood movie, *The Martian.*)

Second Saturday Stars poster: Marc Polansky

Second Saturday Stars

FREE EVENT

Every Month at the

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7:00 - 9:00 pm

Dawn @ Ceres

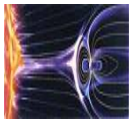
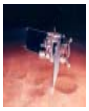
Refreshments
Family Entertainment
Handicapped Accessible
ASL Interpretation Available with Prior Notice
Rain or Shine

Map

art & design sean ross · rossgrafix13@aol.com

November 2015

Celestial Calendar

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
1  Launch of Wind spacecraft to study solar wind (1994)	**2** End of Daylight Savings Time   First light of Mt. Wilson 100-inch telescope - (1917) Harlow Shapley born, American astronomer, measured distances within our galaxy (1885) 	**3**  Taurids meteor showers peak  Launch of Mariner 10 to Venus and Mercury (1973) Launch of Sputnik 2, with dog Laika (1957) 	**4**  Chinese spacecraft Chang'e 1 enters orbit around Moon (2007)  Deep Impact closest approach to the nucleus of Comet 103/P Hartley 2 (2010)	**5**  Fred Lawrence Whipple born, American astronomer; first to theorize of comets as "dirty snowballs" (1906)	**6**  Lunar Orbiter 2 launch (1966) Charles Owen Hobaugh, NASA astronaught born (1961) 	Moon at apogee (farthest from Earth) **7**   Launch of Mars Global Surveyor (1996) Launch of Surveyor 6 Moon Lander, dry-run for later manned mission (1967) 
8  Launch of Little Joe rocket (1960) Meteorite hits house in Wethersfield CT (1982)   Edmund Halley born (1656)	**9**  Launch of 1st Saturn V rocket - Apollo 4 (1967)  Launch of Venus Express spacecraft; ESA Venus orbiter (2005)	**10**  Launch of Soviet spacecraft Zond 6 to Moon (1968) Launch of Luna 17, Soviet Moon Rover mission (1970)   Waseda meteor hits house in Japan (1823)	**11**  Tycho Brahe discovers supernova SN1572 (bright as Jupiter) (1572) Launch of Gemini 12, with astronauts Lovell and Aldrin (1966) 	**12**  Seth Nicholson born, American astronomer (1891) Space Shuttle Columbia safe re-launch, with commander Joe Engle and pilot Richard Truly (1981) 	**13**  Launch of HEAO-2 (Einstein), 1st fully-imaging x-ray telescope in space - 1978 Dawn spacecraft enters Asteroid Belt on way to Vesta and Ceres (2009) 	 **14** Launch of Apollo 12 Conrad, Gordon, Bean, 1969 Mariner 9 arrives at Mars, 1st spacecraft to orbit another planet, 1971   Dedication of the New Milford solar system scale model (2009) 2nd Saturday Stars Open House McCarthy Observatory 
15 Astronomer William Herschel born (1738)   ESA Smart-1 enters lunar orbit, using solar-electric propulsion 2004 Only orbital launch of Russian Buran space shuttle in unmanned mission (1988) 	**16**  Launch of Venera 3, Soviet Venus lander (1965)  Launch of 3rd and last Skylab crew - Carr, Pogue, Gibson (1973)	**17**  Soviet lunar lander, Luna 17 with 1st rover, Lunakhod 1 (1970) Leonids meteor shower peak 	**18** Leonids Meteor Storm (2001) Alan Shepard born, 1st American in space and 5th to walk on Moon - 1923 Launch of the COBE spacecraft; observed diffuse cosmic background radiation (1989)	**19** Apollo 12 astronauts Charles Conrad and Alan Bean made man's second landing on the moon (1969)	**20** Launch of the Swift spacecraft, multi-wavelength observatory to study gamma wave bursts (2004)	**21** India's space program begins with the launch of a Nike-Apache sounding rocket from coconut groves in Thumba, a small fishing village in Kerala state (1963)
22 Dr. Guion Stewart "Guy" Bluford, Jr. born - an engineer, NASA astronaut, and the first African American in space (1942)	Moon at Perigee (closest to Earth) **23** Launch of European Space Agency's 1st satellite, Meteosat (1977) launch of Tiros II weather satellite (1960) 	**24** Space-walking astronauts from shuttle Columbia catch a 1 1/2 -ton satellite, and the cockpit crew used the shuttle's robot arm to return it to the cargo bay (1997)	**25** Radio signals exchanged between Viking 1 Mars Lander and Earth are slowed by sun's gravity, confirming Einstein's general theory of relativity (1976)	**26** Launch of France's first satellite, Asterix 1 (1965) Launch of Explorer 18; studied charged particles and magnetic fields in and around the Earth - Moon (1963) Discovery of Mars meteorites AU 005 and SAU 008 (1999)	**27** Moon at Perigee (closest to Earth) Soviet spacecraft Mars 2, first human artifact to impact Martian surface (1971)	 **28** Launch of Algeria's 1st satellite, Alsat 1 (2002) Launch of Mariner 4, first spacecraft to send close range images of Mars (1964) Comet C/2012 S1 (ISON) Perihelion (0.012 AU)
 29 Launch of Australia's 1st satellite, Wresat 1 1967 Launch of Mercury 5, with Enos the chimp 1961 Discovery of Y000593 Mars meteorite in Antarctica (2000)	**30** Sylicauga meteorite fall strikes Alabama woman (1954)					

Phases of the Moon