Galactic Observer

John J. McCarthy Observatory

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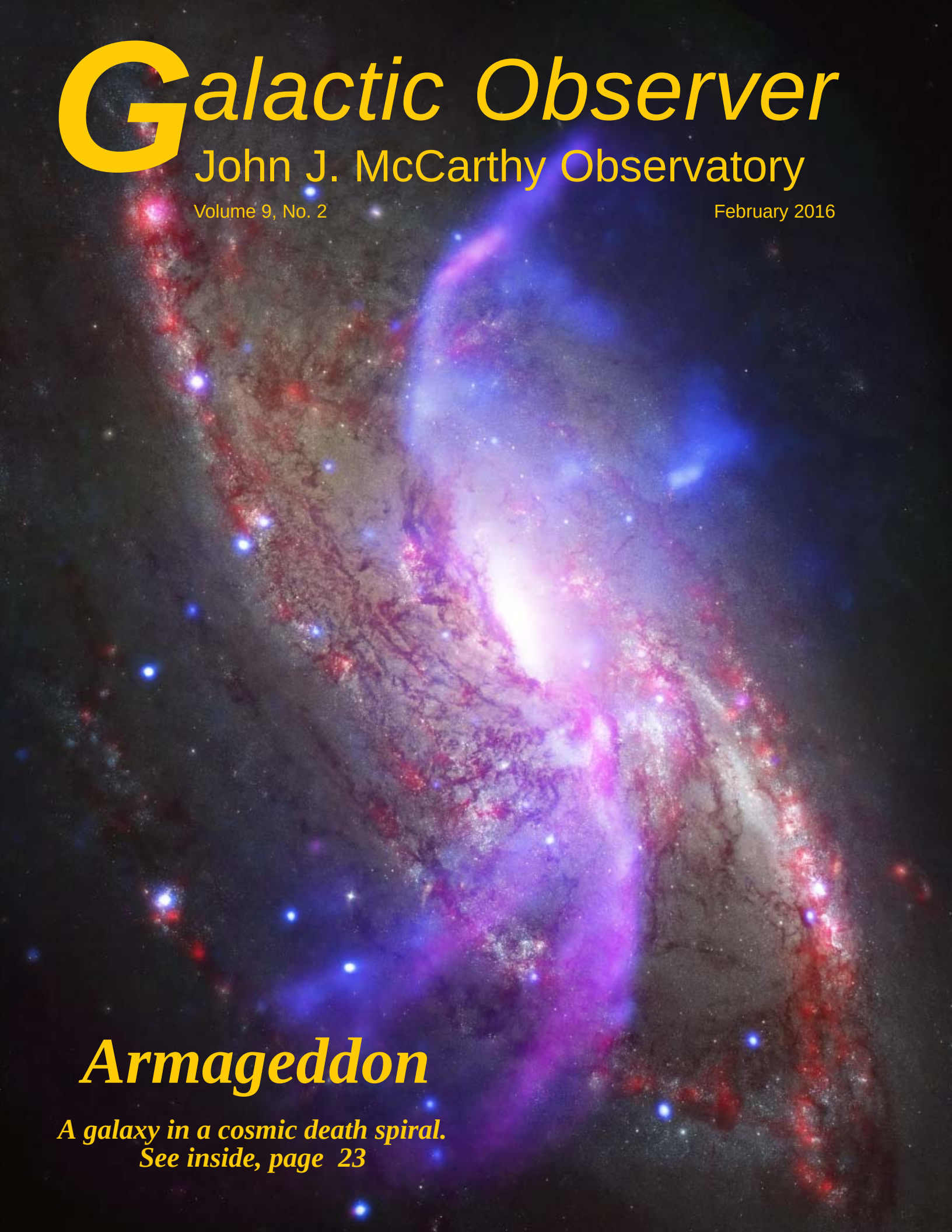

Armageddon

A galaxy in a cosmic death spiral.

See inside, page 23

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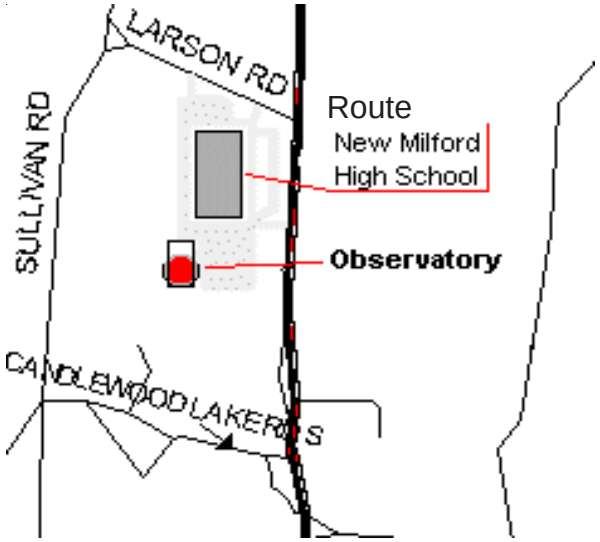

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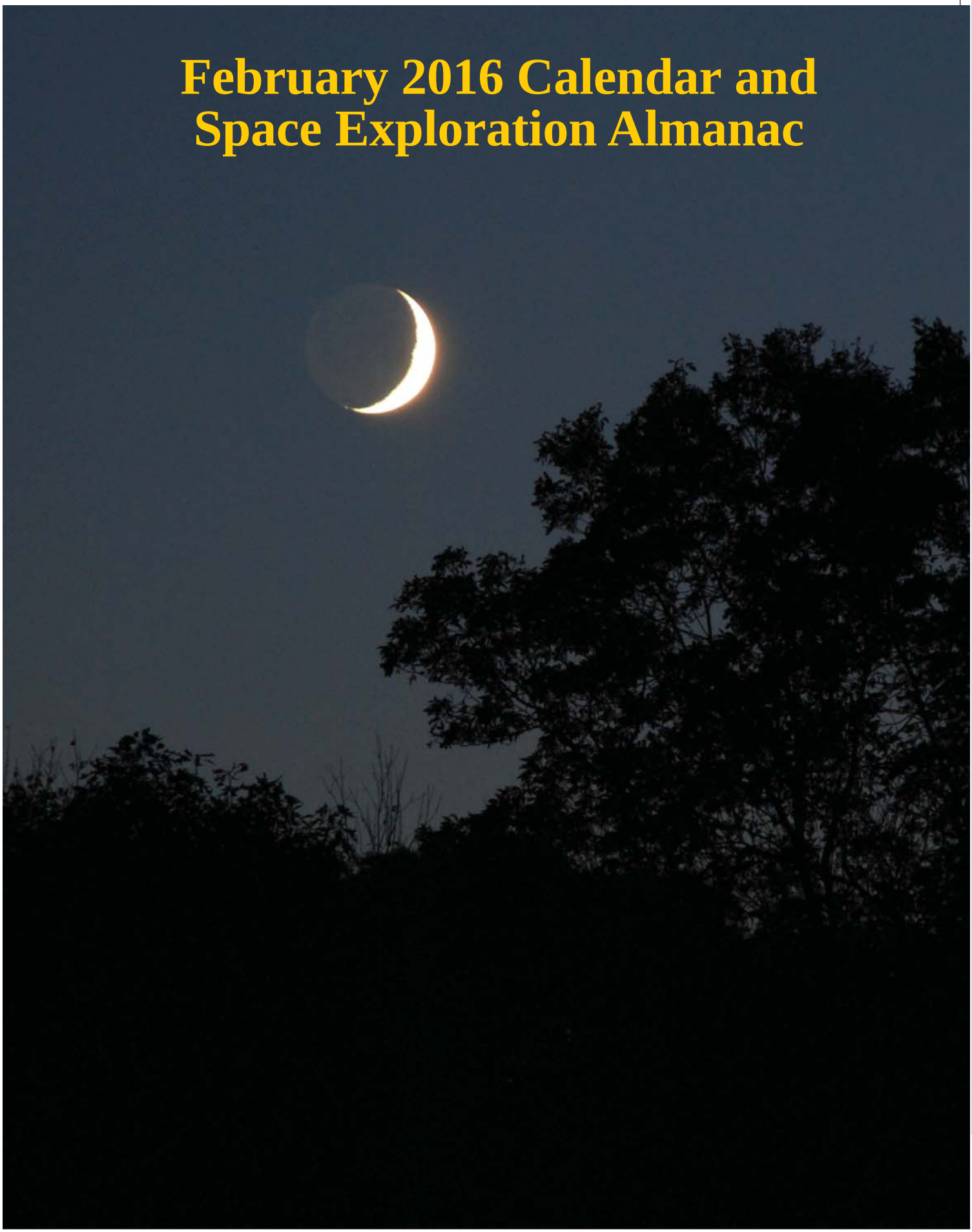
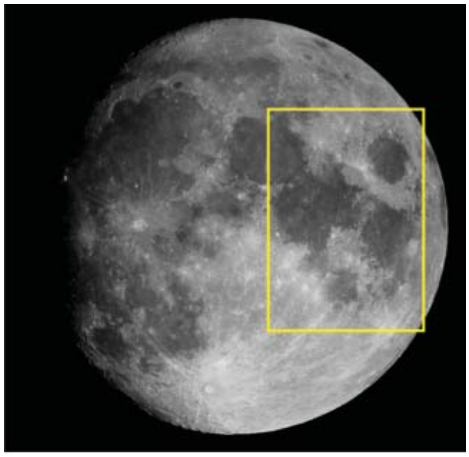


"Out the Window on Your Left"

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 actually expansive low-lying plains formed by ancient lava flows

The Moon's eastern hemisphere was the focus of considerable activity in the first decade of exploration.

The Ranger program launched an armada of robotic probes to the Moon, taking close-up images of the lunar surface in the last few minutes before impact. The images were used to evaluate and select potential landing sites for the Apollo program. Ranger 8 was the second successful Ranger mission. The spacecraft transmitted 7,137 photographs from its six television cameras before impacting on the plains of Mare Tranquillitatis (Sea of Tranquility) on February 20, 1965, north of crater Sabine E (which would later be renamed for Neil Armstrong). The final image taken before impact had a resolution of 5 feet (1.5 meters).

Surveyor 5 landed 9 miles (15 km) to the west-northwest of crater Sabine D (which would later be renamed for Michael Collins). The Surveyor program was intended to validate the technology for soft landing on the Moon, assess landing site conditions and perform an in-situ analysis of the lunar regolith. Surveyor 5 was the third successful Surveyor mission. Following its landing on September 10, 1967, Surveyor returned a total of 19,118 pictures during its three (Earth) months of operation (four lunar days).

Surveyor 5 was also the most successful of the Surveyor landers, beginning with a precision landing on the slope of a small, rimless crater. It was the first to chemically analyze the lunar regolith. Data returned from the lander's instruments established the volcanic origin of Moon's surface. It also confirmed the stability of the soil for future landings.

Launched 3 days before, and arriving in lunar orbit 2 days prior to Apollo 11, the Luna 15 robotic spacecraft was the Soviets' second attempt at a sample return mission. On July 20th, both Luna 15 and Apollo 11 were in lunar orbit. Luna 15 remained in orbit during Apollo 11's successful landing before beginning its descent approximately 2 hours before astronauts Neil Armstrong and Buzz Aldrin were ready to leave the lunar surface. According to archived records from the Jodrell Bank Observatory, which monitored both missions with its radio telescope located in northwest England, Luna 15 descended too fast, crashing into Mare Crisium (Sea of Crises) on July 21, 1969. (NASA had requested, and received, assurance from the Soviet Union that Luna 15's trajectory, and the communications with the spacecraft, would not interfere with the Apollo 11 mission.)

Apollo 11 accomplished a national goal set forth by President Kennedy before a special joint session of Congress on May 25, 1961 ("… this nation should commit itself to achieving the goal, before this decade is out, of landing a man on the moon and returning him safely to earth."). Astronauts Armstrong and Aldrin spent less than 24 hours on the lunar surface and only a little more than 2½ hours outside of the Lunar Excursion Module (LM) exploring the landing area. In that short time, they set up scientific experiments, including a Laser Ranging Retroreflector, and collected almost 50 pounds (22 kg) of material, including rocks, regolith and two core tubes (the first geologic samples from the Moon).

Luna 16 was the Soviet Union's first successful sample return mission. The spacecraft soft-landed on Mare Fecunditatis (the Sea of Fertility) on September 20, 1970, after the Sun had set (first night landing). The lander's drilling rig collected 3½ ounces (101 grams) of lunar regolith which were placed in a hermetically sealed container. The spacecraft's ascent stage carried the container back to Earth where it made a ballistic entry before landing under parachute in Kazakhstan.

NASA and the Soviet Academy of Sciences exchanged lunar samples in 1971. The Soviet Union provided 3 grams of the material collected by Luna 16 to NASA scientists and NASA provided 6 grams of material from the Apollo 11 and 12 missions to Soviet scientists.

The Soviets attempted another sample return mission a year later with Luna 18 (Luna 17 had suc-

cessfully delivered a rover to Mare Imbrium). The spacecraft landed in the rugged terrain northeast of Mare Fecunditatis. Communications were lost upon landing. Luna 20 also targeted the Appolonius Highlands in February 1972, successfully setting down less than 3 miles (1.8 km) northeast of the Luna 18 crash landing site. Less than 2 ounces (50 grams) were returned to Earth in this second of three successful sample return missions by the Soviets. NASA was provided approximately 2 grams of the Luna 20 core in exchange for 1 gram from the Apollo 15 landing site.

Apollo 16 was NASA's first and only mission to the lunar highlands and the second equipped with a battery-powered lunar rover. Astronauts John Young and Charlie Duke set their LM down in an old crater on the Cayley Plains, not far from the Descartes crater. The landing site was targeted by scientists who believed that the Caley and Descartes formations were of volcanic origin. This turned out not to be true; almost every rock collected by the astronauts were breccias (rocks composed of fragments of other, older rocks). Breccias are typically found at impact sites or where impact debris is present. Based upon the age of the Apollo 16 samples, it is believe that the older breccias were associated with the formation of the Nectaris basin to the east, while the slightly younger breccias were likely from the Imbrium basin to the northwest. The few fragments of basalt that were found (and dated at 3.79 billion years) are thought to have come from the Nectaris mare. They were likely transported to the Apollo 16 site by a large impact, for example, the impact that created the 62 mile (100 km) diameter crater Theophilus, located 155 miles (250 km) to the east.

The Apollo 16 astronauts brought back some of the oldest rocks collected by the Apollo missions, including one that formed between 4.44 and 4.51 billion years ago, shortly after the formation of the Moon.

Astronauts Young and Duke collected 731 rock and soil samples in their 71 hours on the Moon, returning 212 pounds (96 kg) back to Earth for analysis.

Apollo 17 was NASA's last manned mission. A narrow valley in the Taurus Mountains on the shore of Mare Serenitatis (Sea of Serenity) was selected for exploration by astronauts Gene Cernan and Jack Schmitt (LM pilot Schmitt was the first and last scientist/geologist on the Moon). It was NASA's longest stay on the Moon (approximately 75 hours). The crew covered a cumulative driving distance of 22.4 miles (36 km) in their lunar rover, venturing as far as 4.7 miles (7.6 km) from the LM. One of the highlights of the second of three excursions out onto the surface was the discovery of "orange soil" on the rim of Shorty crater. The "soil" was comprised of volcanic glass from an ancient lava fire fountain. Cernan and Schmitt brought back a total of 245 pounds (111 kg) of samples from the landing site.

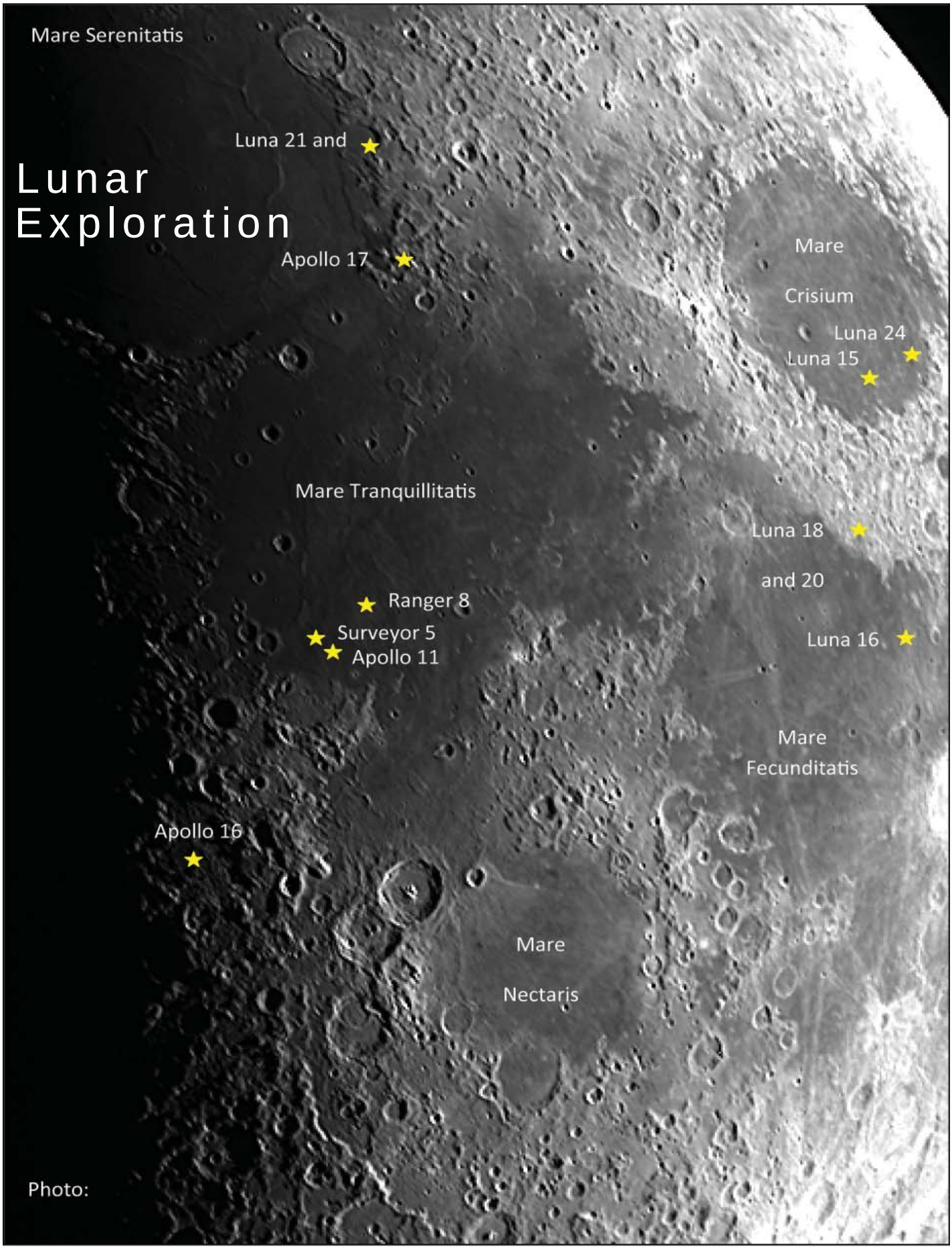
Tycho crater (53 miles or 85 km in diameter) is located in the lunar highlands, approximately 1,200 miles (2,000 km) to the southwest of the Apollo 17 landing site. The crater's unblemished features, brightness and smooth radiating blanket of ejecta, or ray field, suggest a relatively recent impact. Tycho's rays (radial streaks of fine ejecta) extend halfway across the Moon's surface including one that appears to cross the Apollo 17 landing site. Some of the samples collected by the Apollo 17 astronauts show evidence of an impact about 100 million years ago that may also date the Tycho impact.

Apollo 17 was also the second mission to be "saved" by duct tape (Apollo 13 being the first). During the first excursion, one of the lunar rover's rear fenders was damaged. The plume of dust kicked up by the unshielded wheel threatened to shower the rover and the astronauts with abrasive grit, clog delicate machinery and cause equipment (and space suits) to overheat. The fender was eventually repaired by clamping laminated maps to it that had been duct taped together.

Commander Gene Cernan, took man's last steps on the Moon (so far) around 12:40 a.m. on December 14, 1972.

The Soviets landed their second rover (Lunokhod 2) with the Luna 21 spacecraft in Le Monnier crater in January 1973. The crater is located on the eastern rim of Mare Serenitatis. The Lunokhods were almost circular in shape with 8 wheels and a remotely operated lid. The lid was opened during the lunar day exposing a solar panel for power. At night the lid was closed to keep the rover warm (along with a nuclear-powered heater). The rover operated for approximately 4 months, exploring the crater's rim and floor, covering a total distance of 23 miles (37 km). It is believed that the rover stopped working when lunar regolith got inside the vehicle and covered its radiator, causing the rover to overheat.

The last of the Luna series, Luna 24, set down on Mare Crisium in August of 1976, approximately a mile from Luna 23 which had been damaged in landing. It was the third and last sample retrieval mission. The lander's sample arm and drill successfully collected 170.1 grams of rock and dust which were returned to Earth several days later.


Lunar Exploration
Mare Serenitatis
Luna 21 and
Apollo 17
Mare
Crisium
Luna 24
Luna 15
Mare Tranquillitatis
Luna 18
and 20
Ranger 8
Surveyor 5
Apollo 11
Luna 16
Mare
Fecunditatis
Apollo 16
Mare
Nectaris
Photo:

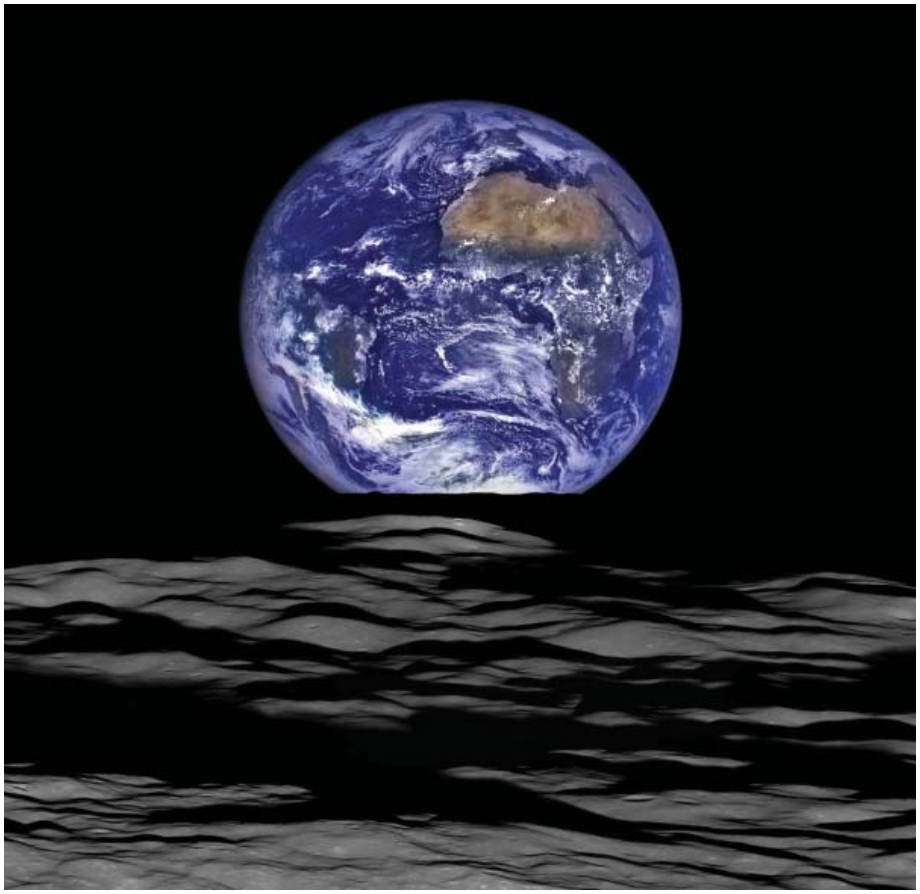
LRO Earthrise

Astronauts on the near-side (or Earth facing) surface of the Moon never see the Earth rise or set; it remains relatively stationary in the ink black sky, ever changing its appearance as clouds, oceans and continents rotate in and out of view. In orbit, however, the Earth does disappear and reappear as the spacecraft passes behind and reemerges from the Moon's far side.

Occasionally, cameras on orbiting spacecraft capture the breathtaking view of the Earth appearing to rise over the lunar surface. The composite image, shown below, was created from a series of takes captured by the Lunar Reconnaissance Orbiter (LRO). At the time of the photo opportunity, the spacecraft was passing over Compton crater at an altitude of 83 miles or 134 km. Compton is located east of the Mare Humboldtianum in the northern hemisphere of the far side. To capture the imagery, the spacecraft was rolled over onto its side with its cameras pointed towards the terminator.

Black and white images of the scene were captured by LRO's Narrow Angle Camera. The Earth was sharpened and colorized with multiple images through narrow band filters from the spacecraft's Wide Angle Camera, all while traveling at more than 3,580 mph (1600 m/s).

It was just a few days prior to a New Moon when the Earthrise image was captured. Mountains on the near side, still in darkness, are silhouetted against the bright terrestrial globe on the limb. The large dark mare on the far side, below LRO's track, is Mare Moscoviense (the "Sea of Moscow"). LRO's vantage point can be recreated with NASA's "Eyes on the Solar System" simulator, available for download at http://eyes.nasa.gov/download.html (as shown at right).



Neutrinos

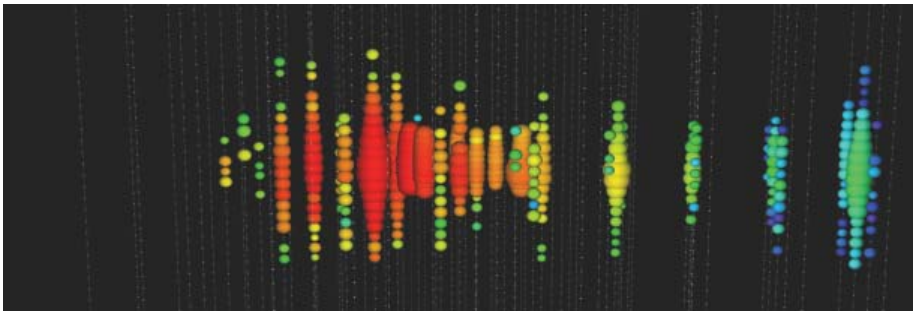
Trillions of neutrinos pass through the Earth (including you and I) every second. While the majority originate deep within our Sun's core, neutrinos have been detected from sources outside our galaxy, for example, from a supernova (cataclysmic star collapse) in the Large Magellanic Cloud. These elementary particles have no charge, are unaffected by magnetic fields and rarely interact with matter. Originally, physicists believed that neutrinos, like photons, did not have mass. However, recent evidence suggests that neutrinos do

have mass, although it is at least a million times less than the mass of an electron.

The IceCube Neutrino Observatory is the world's largest neutrino detector. It was built to search for cataclysmic and high-energy sources (for example, neutrinos emerge promptly from the collapse of a star's core while visible light (photons) may take hours, days or never emerge from the stellar envelope). Located at the South Pole, the detector encompasses a quarter of a cubic mile (1 cubic km) of ice. The detector is comprised of 86 instrument strings embedded in the ice. Each string contains 60 basketball-sized digital optical modules (extremely sensitive light detectors) positioned along the instrument string to a depth of approximately 8,000 feet (2,450 meters). When by chance a neutrino interacts with a proton or neutron within an atom (for example, the nuclei of the oxygen atoms in the ice), secondary particles are produced such as muons. Moving at faster than the speed of light in ice (but slower than the speed of light in a vacuum), the muon's shockwave produces a faint, blue light (called Cherenkov radiation) that can be detected by IceCube's optical modules.

Muons are abundant at sea level, raining down on Earth as a by-product of collisions between cosmic rays and molecules in the upper atmosphere. To sort out these "domestic" muons from the sporadic one produced by neutrino interactions, scientist use the Earth (7,900 miles or 12,720 km of rock) as a filter. By looking for muons coming from beneath the detector (from neutrinos that have passed through the Earth) they can eliminate atmospheric sources.

A very high energy neutrino detected in the IceCube. The colors show when the light arrived, with reds being the earliest, succeeded by yellows, greens and blues. The size of the circle indicates the number of photons observed. Image: IceCube Lab



Europa Clipper

The "Consolidated Appropriations Act, 2016" (Public Law No: 114-113) appropriated $175 million "for an orbiter with a lander to meet the science goals for the Jupiter Europa mission as outlined in the most recent planetary science decadal survey…" The Act also called for a launch no later than 2022.

In concept, the spacecraft would spend three years on orbit around Jupiter, executing 45 flybys of the icy moon at altitudes varying from 16 to 1,700 miles (25 km to 2,700 km). Objectives include scouting potential landing sites and locating deposits from the subsurface ocean. Nine instruments for the concept mission have been selected for the science payload, including ice penetrating radar for determining the thickness of Europa's icy shell. Other instruments will determine the depth and salinity of the underlying ocean and search the surface for signs of recent eruptions. The inclusion of a lander is a recent development and could add $700 million or more to the mission. One scenario would park the lander outside Jupiter's intense radiation field while the primary spacecraft assesses potential landing sites (for example, near a surface fracture where there may be active vents of the subsurface ocean).

Since Europa is tidally locked (with only one hemisphere facing Jupiter) and Jupiter's rotating magnetosphere bombards Europa's trailing hemisphere, landing sites on the leading hemisphere would be preferred (the lower radiation levels pose less of a risk to the spacecraft's electronics).

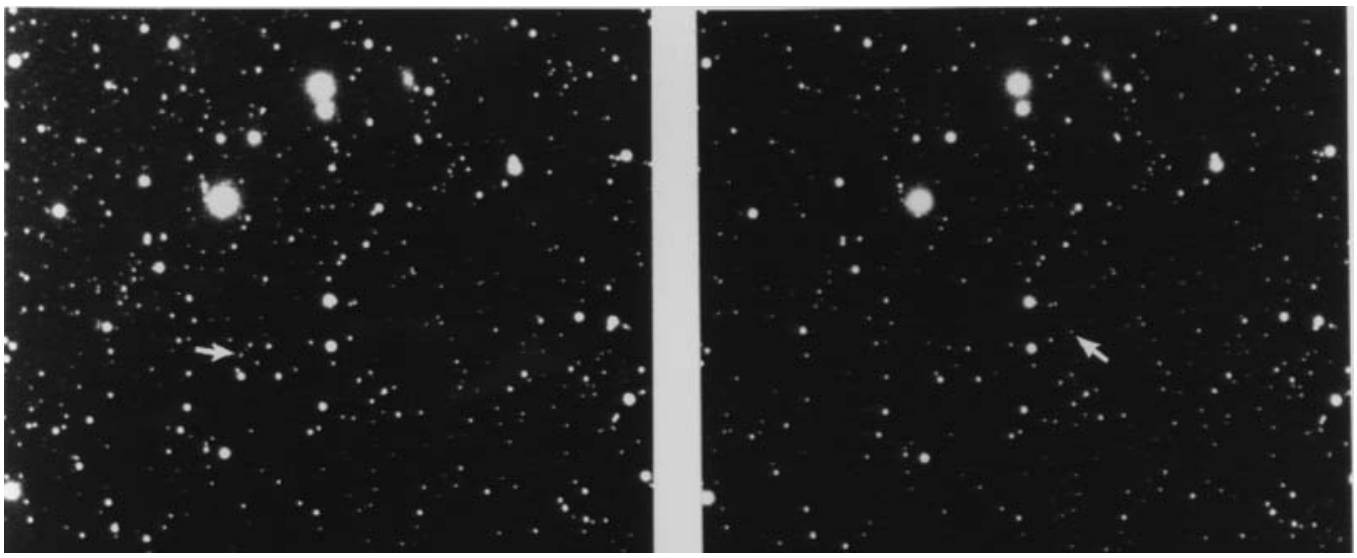
Pluto and Charon

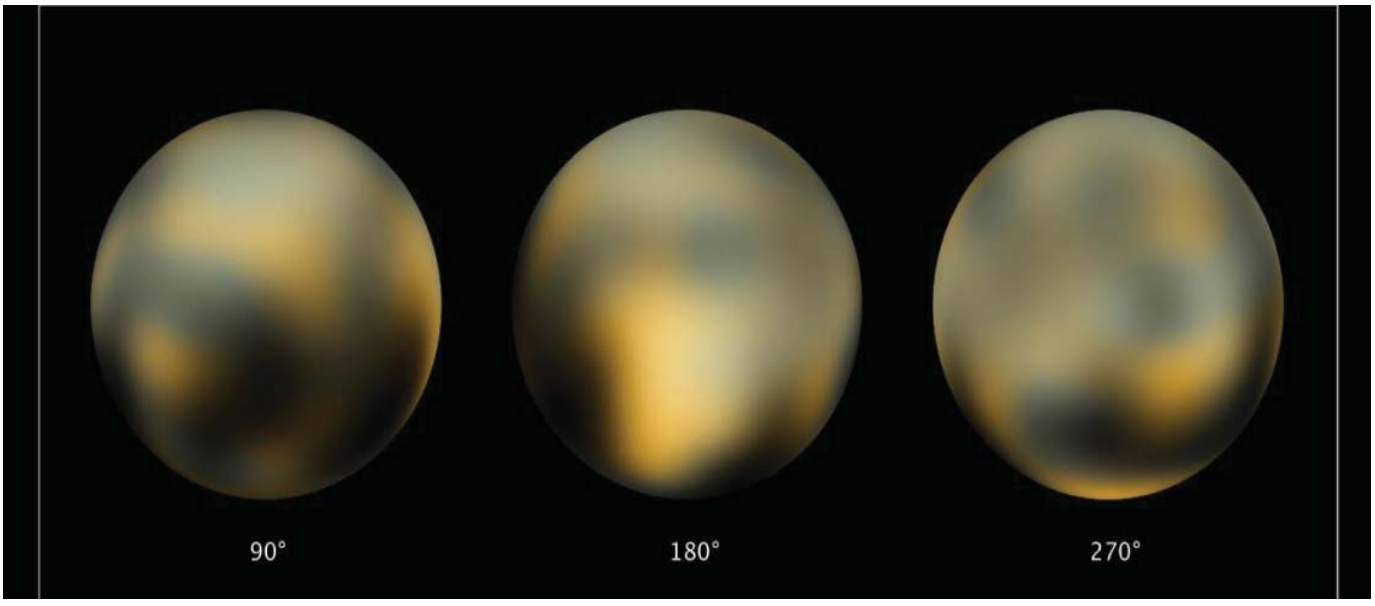
The images on the following pages provide a pictorial history of Pluto and its largest moon, Charon since their discovery. Pluto was discovered by Clyde Tombaugh, an amateur astronomer hired in 1929 by the Lowell Observatory to systematically image the sky in a search for "Planet X," a hypothetical planet beyond the orbit of Neptune. In the images taken in January of 1930 (on January 23rd and 29th), approximately a year after the search began, Tombaugh identified an object that was at the predicted distance for the hypothetic planet. The Observatory waited until March 13th to announce the discovery. The date was selected to coincide with Percival Lowell's birthday (the Observatory's founder and advocate for the Planet X search) and the 149th anniversary of William Herschel's discovery of Uranus.

In 2002 and 2003, a global view of Pluto was constructed from multiple images acquired by the Hubble Space Telescope. It was the most detailed view available of the dwarf planet at that time. The images suggested that Pluto was a dynamic world, with seasonal changes, despite its vast distance from the Sun.

In 1978, James Christy, an astronomer at the U.S. Naval Observatory, was imaging Pluto in an effort to better define the planet's orbit. In several images, Christy noticed the planet was elongated, with the position of the elongation changing over time with respect to the background stars. After eliminating other potential explanations, the discovery of a moon (called Charon) was announced on July 7th. Identifying a moon around Pluto allowed astronomers to better determine the planet's mass (using Kepler's third law of planetary motion and the orbital period of the moon).

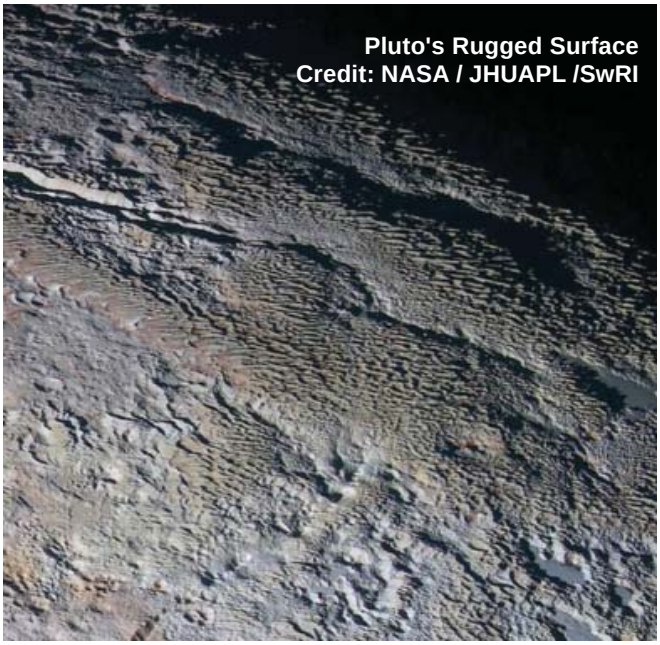
Pluto





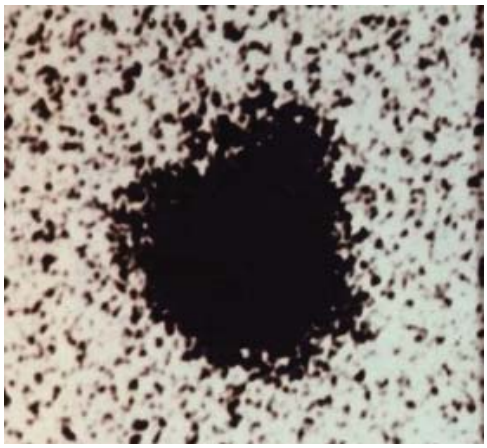
The latest images of Pluto and Charon were captured by the New Horizon's spacecraft during its July 14, 2015 flyby. After almost 10 years and three billion miles, the spacecraft passed within 7,750 miles (12,473 km) of Pluto's surface while traveling at 30,800 miles per hour (49,600 km per hour). Data from the flyby is still being downloaded from the spacecraft to ground stations.

Pluto

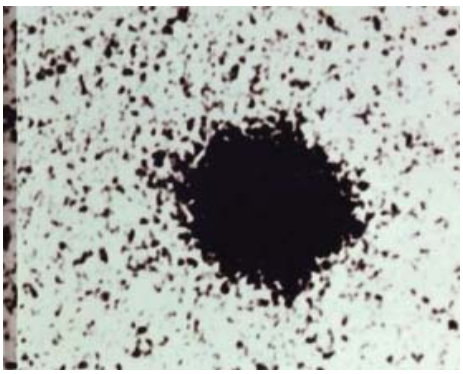


Pluto's Rugged Surface
Credit: NASA / JHUAPL /SwRI

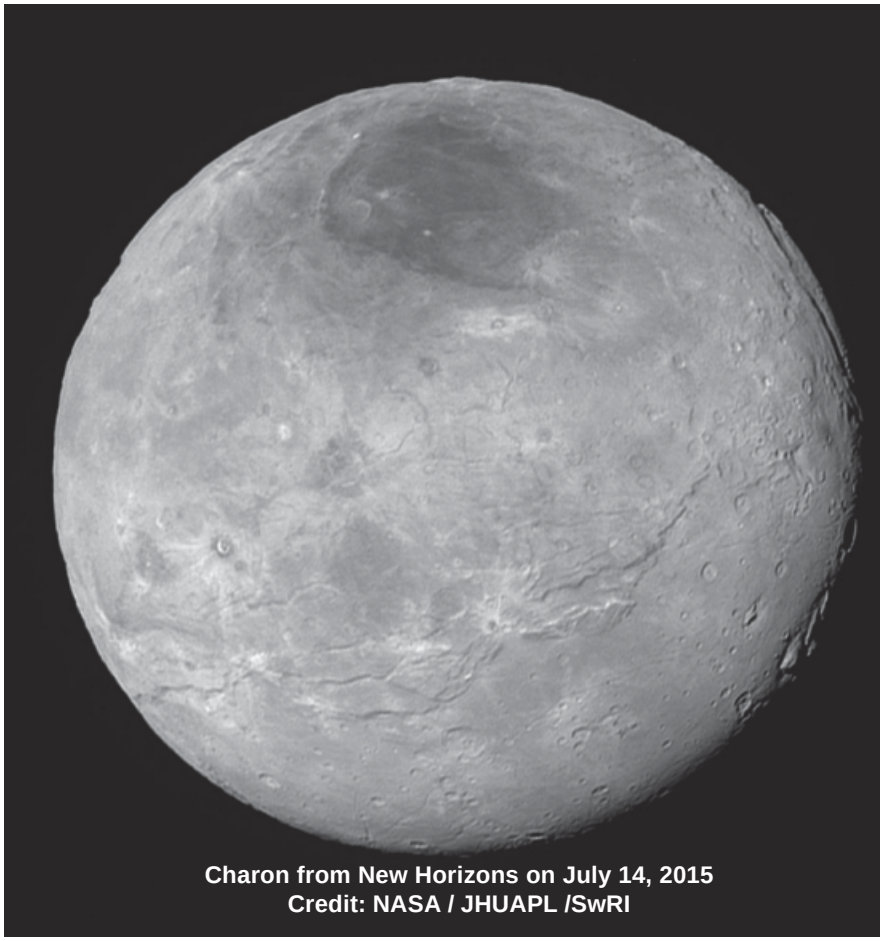
Charon



Charon Discovery Image, July 7, 1978
Credit: U.S. Naval Observatory



Pluto
Credit: U.S. Naval Observatory



Charon from New Horizons on July 14, 2015
Credit: NASA / JHUAPL /SwRI

Measuring Sea Surface Heights

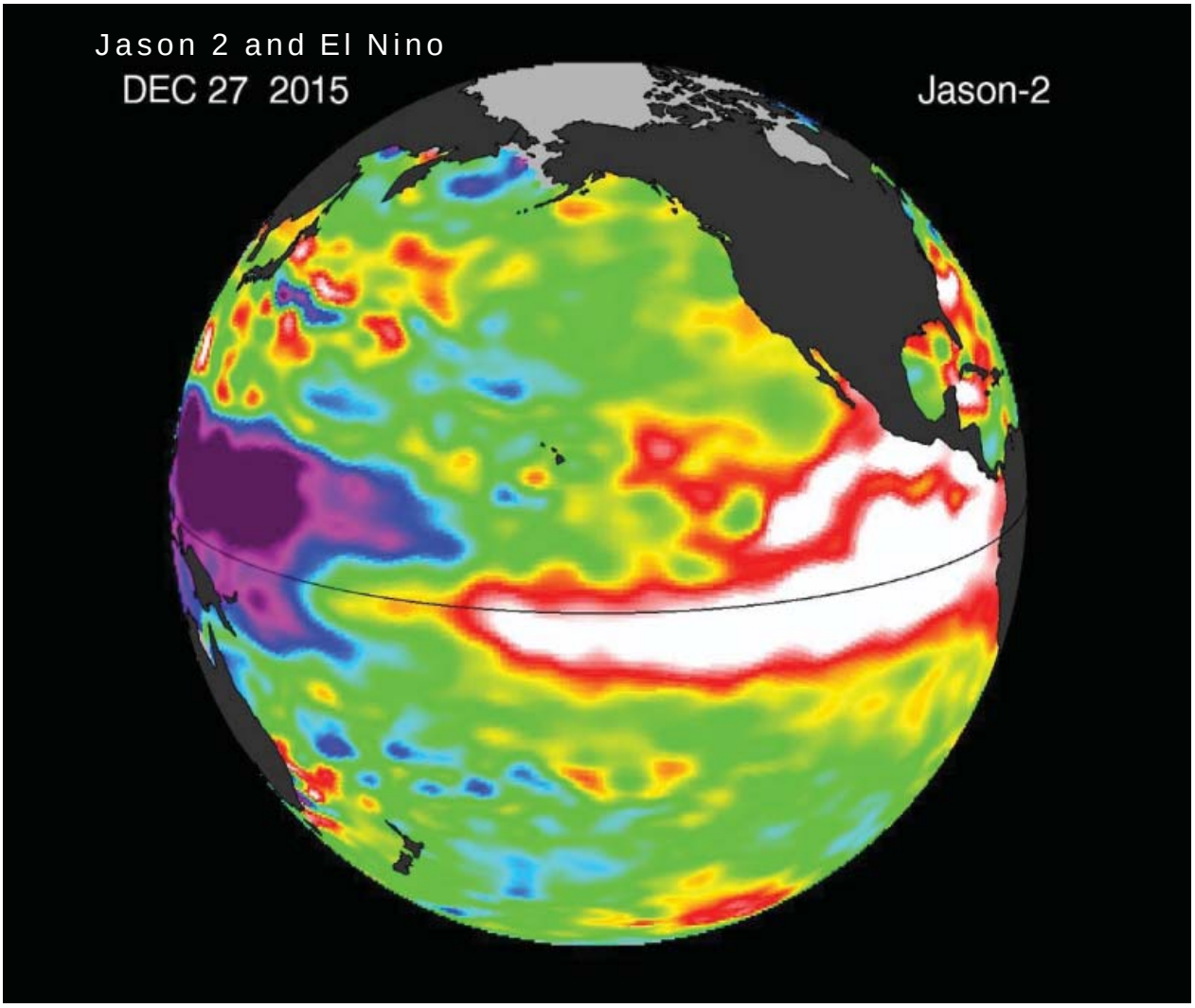
BEGINNING with the joint NASA/Centre National d'Etudes Spatiales (CNES) Topex/Poseidon mission in 1992, satellites have been continuously monitoring the global sea level. The observations have provided information on variations in the sea surface height, speed and direction of currents and the amount of heat stored in the ocean (seawater expands when heated). The diagrams, on the previous page, were generated from data collected by the Jason 2 satellite launched in 2008. They show an "El Niño" condition late in 2015 where a sea level rise of warm water occurs off the coast of South America (in a normal year, trade winds blow westward and warm water builds near Australia). During an El Niño, the heavy rains associated with the warm water move from Southeast Asia and Australia to the central and eastern Pacific, causing droughts in the west and flooding in the east.

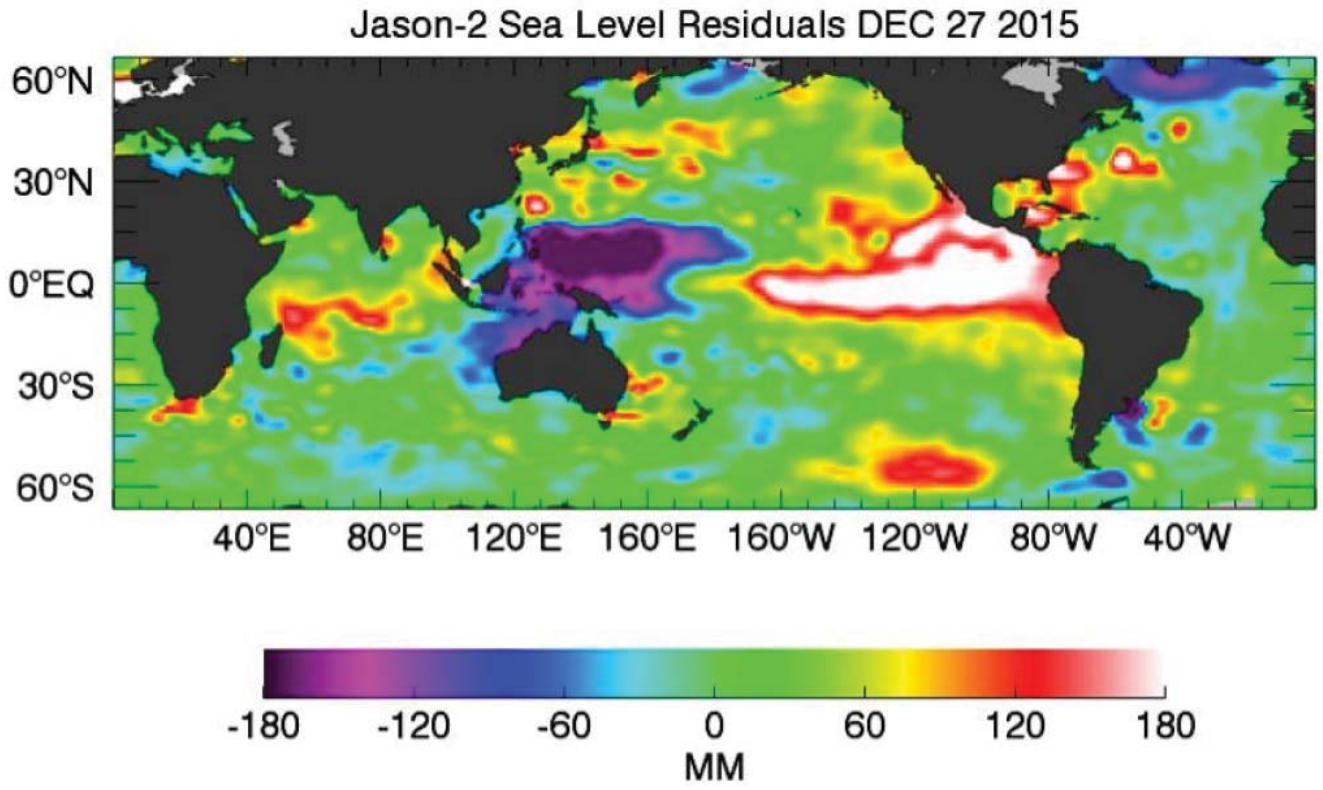
On January 17, 2015, NASA and CNES (in collaboration with the National Oceanic and Atmospheric Administration and the European Organization for the Exploitation of Meteorological Satellites) added another satellite to the ocean monitoring fleet with the launch of Jason 3. The satellite was launched from the Vandenberg Air Force Base in California aboard a SpaceX Falcon 9 rocket. Jason 3 was initially placed into an orbit just below Jason 2. The spacecraft's orbit will be gradually raised so that Jason 3 will fly the same orbital track as Jason 2. Separated by only minutes, the two spacecraft will fly in formation from an altitude of 830 miles (1,336 km) with an orbit inclination of 66 degrees. Over a ten day period, the surface height of world's oceans will be measured to a precision of approximately 1.3 inches or 3.3 centimeters (the spacecraft will also measure wave height and ocean surface wind speeds).

Jason 3 on the pad at the Vandenberg Air Force Base. Credit: SpaceX

Jason 3 is designed for a 3 year mission, with expectations that it will be extended to five years. In the future, satellites with a longer design life (e.g., seven years) are being considered (the proposed Sentinel-6/Jason-CS missions).

In a study recently published in Nature Climate Change, researchers reported that the oceans are absorbing heat at twice the rate as they did 18 years ago. They also found that, based upon historical records that date back to the HMS Challenger's expedition, half the heat absorbed by the oceans in the past 150 years has occurred in the past 18 years. The capacity of the oceans to act as a heat sink and temper global warming remains unknown.


Jason 2 and El Nino
DEC 27 2015
Jason-2


Jason-2 Sea Level Residuals DEC 27 2015
60°N
30°N
0°EQ
30°S
60°S
40°E
80°E
120°E
160°E
160°W
120°W
80°W
40°W
-180
-120
-60
0
60
120
180
MM

Dawn Up-Close

What a difference a year makes. A year ago, the Dawn spacecraft was on final approach to the dwarf planet Ceres, having previously visited the asteroid Vesta. The image below was captured on January 13, 2015 from a distance of 238,000 miles (383,000 km), the approximate distance from the Earth to the Moon.

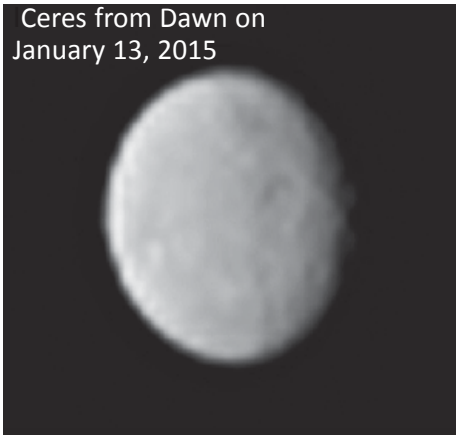
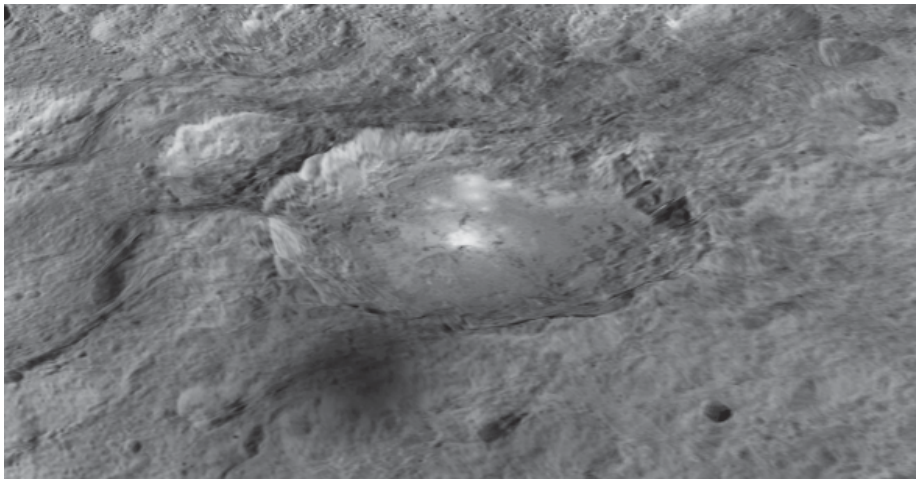


Image Credit: NASA/JPL-Caltech/ UCLA/MPS/DLR/IDAI

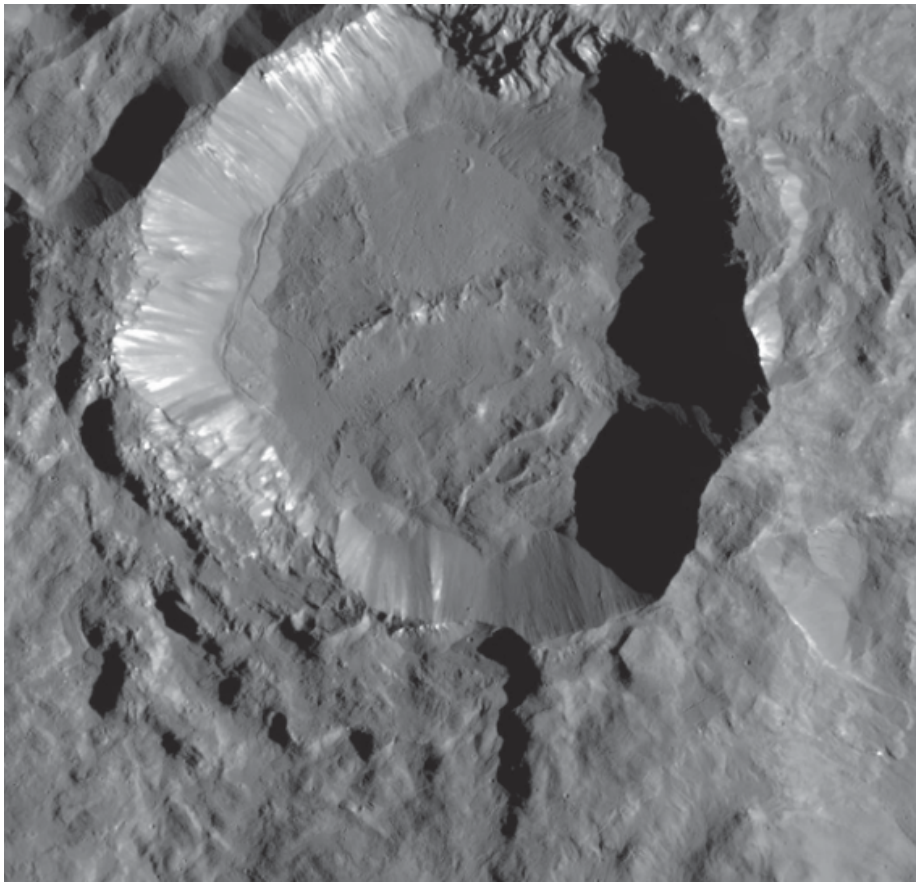
Dawn was launched in September of 2007. With an assist (gravity assist) from Mars, the spacecraft arrived at the asteroid Vesta in July of 2011. After a year of detailed study, Dawn restarted its ion engines, left orbit and began a 2½ year journey to Ceres. The spacecraft was captured by Ceres' gravity in early March (2015).

Since capture, Dawn has been studying Ceres from a near-polar orbit. The spacecraft started its science mission from an altitude of 8,400 miles (13,500 km). It has then used its ion engine to spiral down to progressively closer orbits (at three different altitudes). Dawn is currently in its closest, low-altitude mapping orbit, at a distance of 230 miles (or 375 km) above the surface where it will remain for the duration of its mission.

Dawn's low orbit is providing scientists a detailed look at Cere's surface, including craters, fissures, and "bright spots." The image of Kupalo Crater, one of the youngest craters on Ceres, was taken in December of 2015. Measuring 16 miles (26 km) across, Kupalo's flat floor, like many large lunar craters, is likely comprised of impact melt and other debris. The bright material on the crater's rim may be salt and related to the bright spots in Occator Crater.



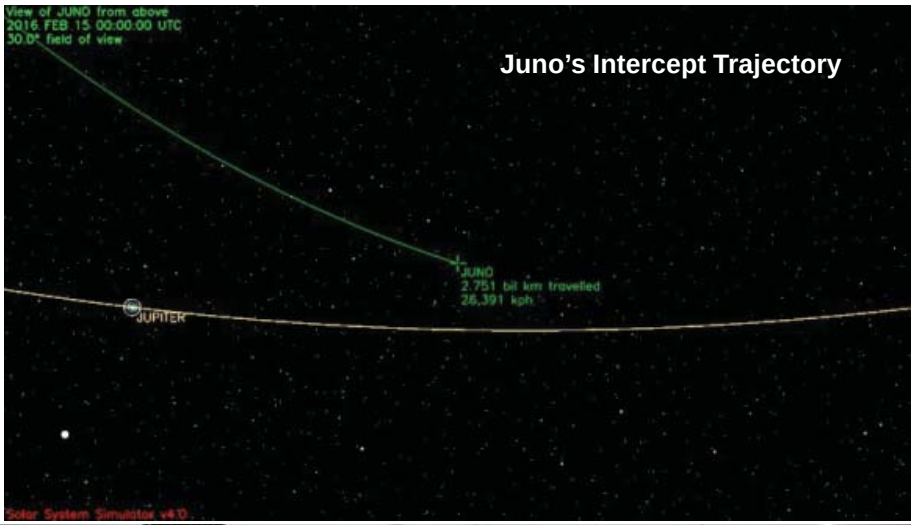
Ceres distinctive briaght spots are seen in crater Occator. Vertical relief is enhanced to provide increased definition. Image credit: NASA/JPL-Caltech/UCLA/MPS/DLR/IDA/LPI



Kupalo Crater - December 2015
Credits: NASA/JPL-Caltech/UCLA/MPS/DLR/IDA

Final Approach

Juno was launched in August 2011 and is scheduled to arrive at Jupiter on July 4, 2016. The diagram produced by the Jet Propulsion Laboratory's Solar System Simulator (*http://pace.jpl.nasa.gov/*) for February 15th shows the position of the Juno spacecraft (in green).



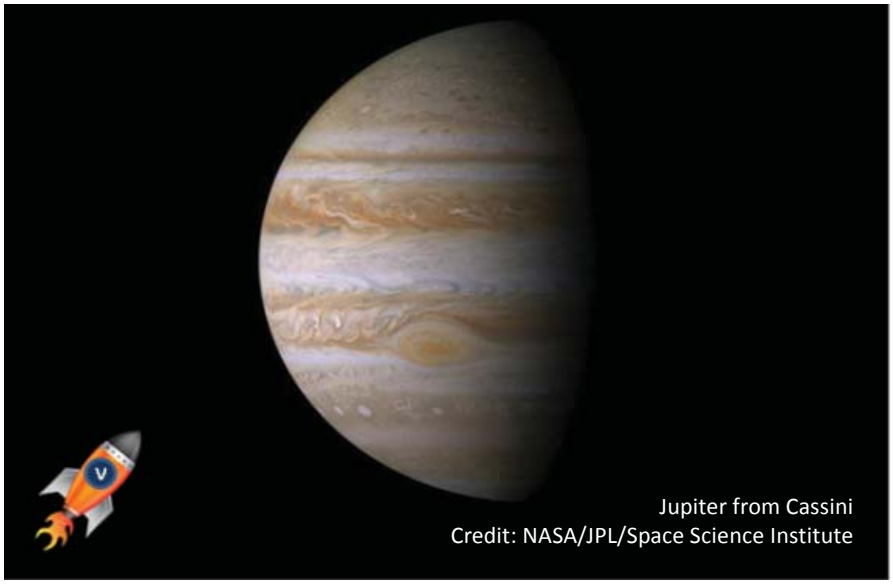
On January 13th, Juno set a new record for the most distant solar-powered spacecraft (493 million miles or 793 million km). During its 20 month (and 37 orbits) Jupiter encounter that distance from the Sun will increase to 517 million miles (832 million km). To power the spacecraft's instruments at such a great distance, Juno is equipped with three 30-foot long (9 meter) solar panels to capture the Sun's feeble light.

Stowing Juno's Solar Arrays. Image credit: NASA/JPL-Caltech/KSC

Journey to the Center of Jupiter

We are currently in the observing season of Jupiter. While the gas giant is closest to Earth in early March, it is now well placed in the early evening sky. The four Galilean moons are clearly visible as companion stars as they travel in synchronous orbits around Jupiter. Prominent on the planet's disk are alternating bands of bright dark clouds within the gaseous atmosphere.

Cassini was the last spacecraft to visit Jupiter (15 years ago on its way to Saturn), and it will be another 5 months before the Juno



Jupiter from Cassini
Credit: NASA/JPL/Space Science Institute

spacecraft arrives in July 2016. While robotic spacecraft may one day explore Jupiter's moons, exploring the gas giant is more challenging (the Galileo atmospheric probe was destroyed by Jupiter's crushing atmospheric pressure less than 100 miles below the cloud tops).

But if you could explore the depths of the gas giant, what would you experience? For this imaginary journey, we will travel with a neutrino (˜), a fundamental particle without charge that rarely interacts with matter.

At more than 11 times the diameter of the Earth, Jupiter will command our attention well before our "neutrino transfer vehicle" or NTV arrives. Jupiter's presence is first detected at a distance of almost 2 million miles, with a steady increase in radiation levels. Jupiter's magnetic field has an intrinsic strength 20,000 times greater than Earth's and is saturated with a sea of charged particles. The Sun facing side of the field is shaped and compressed by the solar wind, while the far side extends out past the orbit of Saturn.

Inside the magnetosphere, our NTV encounters several small and irregular moons possible remnants from ancient collisions or captured debris left over from the solar system's formation, before crossing the orbits of the four large, Galilean moons. Visible on the Jupiter facing side of the outer moon Callisto are a series of large concentric ridges surrounding Valhalla, an ancient impact basin. Ganymede is the next moon encountered. Larger than the planet Mercury, its icy surface is masked by large dark regions, impact craters and intersecting ridges and grooves. Closer to Jupiter is the enigmatic world, Europa. Its relatively smooth surface is crisscrossed with a network of cracks in its icy shell. Its youthful appearance and lack of impact craters suggests that the surface has been periodically renewed, possibly by a subsurface ocean that might extend more than 60 miles in depth. The possibility of a vast ocean beneath Europa's surface makes it one of the most likely candidates for extraterrestrial life and, therefore, targets for future missions, such as the Europa Clipper.

Before reaching Jupiter's cloud tops, we pass by Io, the closest of the Galilean moons and the most active. Densest of the four moons, Io's surface is mottled in colors of red, yellow and orange from recent eruptions of its active volcanoes. Io's geological activity is a result of its proximity to Jupiter and Jupiter's tidal forces.

Thirty thousand miles above the outer layers of Jupiter's atmosphere is a faint ring that encircles the planet at its equator. Unlike Saturn's bright ice ring that is easily visible from Earth, Jupiter's dark, dusty ring is more difficult to see and was first detected by the Voyager 1 spacecraft during its flyby of the planet in 1979. Embedded within the ring are two small moons, Adrastea and Metis, which may be the source of the ring's dust.

Inside the ring, the churning, banded atmosphere takes center stage. Jupiter rotates once every 10 hours, causing the clouds and embedded cyclonic storms to rush by our probe. Wind speed at the equator averages 200 miles an hour (mph), although it can reach as high as 400 mph. The cloud layer extends to a depth of 50 to 60 miles (100 km) from the top of the troposphere and is comprised of three different layers with distinct types of clouds. Below the high haze are wispy white clouds of ammonia. Several miles beneath, we find a layer of ammonium hydrosulfide ice and other elemental compounds, exhibiting colors of yellows, reds and browns. At the lowest level, clouds are comprised of water ice and bluish in color. At this point in our journey, the pressure is almost 10 times that on Earth (at sea level).

The temperature and pressure continues to increase the deeper we descend. Hydrogen and helium comprise over 99 percent of Jupiter's atmosphere (with hydrogen being the most abundant) and with the increasing pressure, the gases slowly transition to liquid. Illumination, if any, at this depth is provided by lightning in the layers above.

At a depth of 10,000 miles, the pressure is 3 million times the atmospheric pressure on Earth. Under these conditions the molecular hydrogen ocean begins its transition to a metallic state. A liquid metal ocean extends all the way down to a rocky core, almost 40,000 miles below the cloud tops.

The conditions at the core of Jupiter are extreme, with a pressure 50 million times, or more, than the atmospheric pressure on Earth and a temperature between 60,000 to 70,000° F. With internal heat generated by gravitational energy, Jupiter radiates almost twice as much heat as it receives from the Sun.

As our probe reaches the center of the core, we begin our journey back out through the dark and lifeless oceans of hydrogen, through the overlying layers of clouds and back into the void beyond.

John Glenn and the Flight of Freedom 7

On the morning of February 20, 1962, John Glenn became the first American to orbit the Earth aboard a Mercury space capsule that Glenn named Friendship 7. Originally scheduled for the previous December, the launch was delayed by several technical and mechanical issues, including a fuel leak, and by weather.

Glenn's capsule was placed into orbit by an Atlas rocket, a rocket originally developed as an Intercontinental Ballistic Missile. While the advantages of a multi-stage rocket were well known in the 1950s (dropping off spent stages reduces the fuel required to place the payload into orbit), starting engines in mid-flight had not been perfected. As such, vehicle weight was reduced during flight of the Atlas by dropping off the two outer engines while its center engine continued to burn until orbit was achieved. The Atlas was also unique in that it relied upon a "balloon" design to minimize its weight. This required pressurization of the fuel tanks so that the booster wouldn't collapse in upon itself.

While no longer a balloon design, the Atlas rocket remains an active expendable launcher today, carrying payloads for NASA, the Air Force and other customers.

John Glenn served with the Marine Corps prior to being selected by NASA in the first group of seven astronauts (the Mercury Seven). As a fighter pilot, he flew 59 combat missions in the South Pacific during World War II. Following service in the Korean War (baseball Hall of Fame legend Ted Williams was one of his wingmen), he set a speed record for a transcontinental flight on July 16, 1957 when he flew a Vought F8U Crusader from California non-stop to New York in 3 hours 23 minutes in a test of a new Pratt & Whitney engine (it did require 3 mid-air refuelings).

Glenn's trip around the Earth lasted 4 hours and 55 minutes and 23 seconds, completing 3 orbits before splashing down in the Atlantic Ocean southeast of Bermuda. While a public relations success, the flight was not without problems, the most serious of which was an indication that the capsule's heat shield had come loose and its landing bag deployed. Not knowing whether it was a faulty indicator, mission control asked Glenn to leave the retro-pack on during reentry. (The retro-pack consisted of three small rockets that were used to slow the spacecraft down. It was attached to the spacecraft by three straps that extended over the heat shield.) Fortunately, the indicator was faulty and the flaming debris that Glenn saw streaming by his window during reentry was from the retro-pack and not the heat shield.

John Glenn would not return to space for another 36 years. In 1998, at the age of 77, Glenn joined the crew of the space shuttle Discovery for a nine day mission.

Astronaut John Glenn entering the Mercury capsule. Credit: NASA

February History

Eighty-six years ago on February 18th, a young American astronomer named Clyde Tombaugh discovered the solar system's ninth planet while working at the Lowell Observatory in Flagstaff, Arizona.

Clyde Tombaugh was born on an Illinois farm in February 1906, the eldest of six children. His family moved to a wheat farm in Kansas in 1922. At age 22, with only a high school diploma, Clyde spent most of his time working the family farm. In his spare time he would grind and test telescope mirrors in the farm's underground cellar. In 1928, Clyde sent several of his drawings of Mars and Jupiter from images seen through his homemade telescope to the Lowell Observatory. By chance, the observatory had just acquired a 13-inch telescope and was looking for a

dedicated amateur to conduct photographic surveys of the night sky. With only enough money for a one-way ticket, Clyde left Kansas for Arizona in January of 1929. Thirteen months later, and after photographing millions of stars, he would discover Planet X (its designation before being officially named).

Clyde Tombaugh died in 1997. His wife and his family attended the launch of New Horizons. Making the journey to Pluto along with the spacecraft are the ashes of the astronomer.

Venetia Phair, an 11 year old girl from England, suggested the name Pluto for the newly discovered planet. Her grandfather, who was the head librarian at Oxford University, passed the suggestion along to the American astronomers. Venetia, a retired school teacher, passed away in 2009 at the age of 90, but remains the only woman in the world to have named a planet (even if it's only a Dwarf Planet today). Venetia wasn't the only family member to have named a celestial object; her great uncle named the moons of Mars (Phobos and Deimos).

Compared to the size of the parent planet, Pluto has the largest moon in the solar system (the pair is sometimes referred to as a "double planet"). Charon was discovered in 1978 by the American astronomer James Christy and named for the boatman who ferried dead souls across the river Styx to Hades (Pluto's domain). Charon is more than half the size of Pluto. It is also only 12,000 miles from Pluto (compared to 238,000 miles for Earth's moon). As such, in the dark and frozen sky at the edge of our solar system, Charon would appear more than 7½ times larger in Pluto's sky than our moon appears in the Earth's sky.

Supernovas

A supernova is an explosion produced when a massive star exhausts its fuel and collapses. These collapsing stars are typically red supergiants at least 8 times more massive than our Sun. If the original star is less than 20 solar masses, the supernova leaves behind a neutron star, approximately 10 to 17 kilometers (6-10 miles) across, a teaspoon of which weighs 200-400 million tons. (More massive stars can collapse into black holes.) One of the more famous remnants of a supernova is the Crab Nebula, visible with a moderate telescope in the winter sky in the constellation Taurus.

Hubble Heritage Team
(NASA/STScI/AURA)

Many of the supernovas that occur in the Milky Way Galaxy are obscured from our view by gas and dust. On average, one supernova is detected in our galaxy every century (undetected supernovas may occur every 25 to 50 years, based upon our observations of other galaxies). Supernovas can become so bright that they overwhelm their host galaxies for weeks. In the last thousand years, there were four supernovas in the Milky Way that were well documented: a star in the constellation Lupus in the year 1006, one in the constellation Taurus in 1054 (described by Chinese astronomers), one in Cassiopeia in 1572 (observed by Tycho Brahe), and another in Ophiuchus in 1604 (studied by Johannes Kepler).

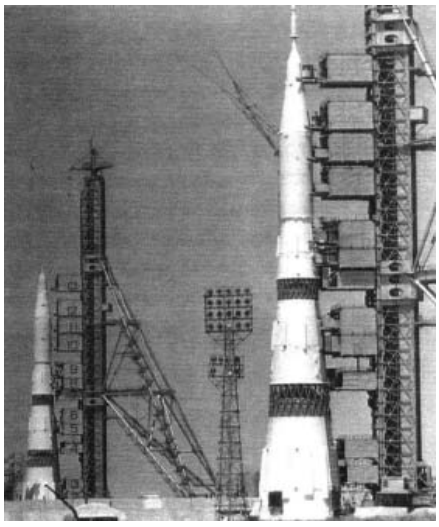
One of the most scrutinized supernovas occurred within the Large Magellanic Cloud, a satellite galaxy to the Milky Way. In February 1987, a star exploded near the Tarantula nebula some 169,000 light years away. It was the first time that astronomers had detailed observations, not only of the supernova, but of the star before it exploded. The most unusual feature of Supernova 1987A is the circumstellar rings of material seen expanding from the dying star. Since the rings are only moving at a speed of 70,000 to 100,000 miles per hour (much slower than the material ejected in the supernova explosion), scientists theorize that the material was expelled before the supernova when the star was still a red giant.

As Dr. Carl Sagan reminded us: "We are star-stuff." Almost all of the elements in our universe were created inside stellar factories (nucleosynthesis). However, elements heavier than iron are only created in the final moments of the collapse of a massive star and detonation of the core. So the next time that you admire your gold jewelry, remember that though it may have come from your favorite jeweler, those gold atoms were created by a nearby supernova.

Soviet Moon Program

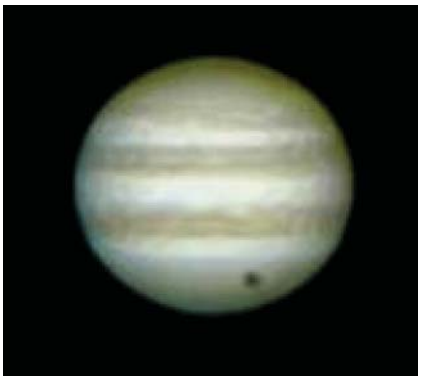
February marks the beginning of the end of the Soviet Moon program. While publicly denying its intentions to send cosmonauts to the Moon during the 1960s, the Soviets were secretly constructing rockets of mammoth proportions (rivaling the Saturn V). On February 21, 1969, the first N1 Moon rocket exploded during its test flight.

The launch of three more N1 rockets would fail before the Soviet government would abandon their manned-Moon program.



The historic photo on the right shows two N1 rockets on pads at the Soviet Union's launch site at the Baikonur Cosmodrome (also known as Tyuratam) in Kazakhstan. The five stage rockets stood approximately 340 feet high with a first stage powered by 30 individual engines.

Jupiter and its Moons



Jupiter reaches Opposition on March 8th, rising only two hours after sunset at the beginning of February. As one of the brightest star-like objects in the night sky, Jupiter can be found in the constellation Leo.

One of the more interesting and easier events to observe through a telescope is the projection of a shadow from one of Jupiter's moons on the Jovian disk as the moon passes in front of (or transits) the planet. The photo on the right shows the shadow of Ganymede on the Jovian disk. On nights of good visibility the following events should be visible through a moderately-sized telescope (between approximately 7 pm and midnight).

For example, on the 16th, Jupiter's largest moon Ganymede passes in front of the planet. It's shadow will be visible on the cloud tops starting around 11 pm EST.

Jupiter Moon Transits

Date	Moon	Transit Begins	Transit Ends
3rd	Europa	6:26 pm	9:15 pm
4th	Io	10:57 pm	1:13 am (5th)
9th	Ganymede	6:59 pm	10:21 pm
11th	Europa	9:02 pm	11:51 pm
13th	Io	7:19 pm	9:34 pm
16th	Ganymede	10:57 pm	2:18 am (17th)
18th	Europa	11:38 pm	2:27 am (19th)
20th	Io	9:12 pm	11:28 pm
27th	Io	11:06 pm	1:21 am (28th)

Transit of Jupiter's Red Spot

The Red Spot is a large cyclone in the upper Jovian atmosphere. The rapid rotation of this gas giant (10 hours) may be responsible for the longevity of this storm, which has been observed for over 300 years. The Red Spot will cross the center line of the planetary disk on the following evenings during the hours between 7 pm to midnight local time (EST):

Date	Transit Time	Date	Transit Time
Jan 31st	11:28 pm	15th	8:49 pm
1st	7:19 pm	17th	10:27 pm
3rd	8:57 pm	20th	12:05 am
5th	10:35 pm	20th	7:56 pm
8th	12:13 am	22nd	9:34 pm
8th	8:04 pm	24th	11:12 pm
10th	9:42 pm	25th	7:03 pm
12th	11:20 pm	27th	8:41 pm
13th	7:11 pm		

Sunrise and Sunset

Sun	Sunrise	Sunset
February 1st (EST)	07:06	17:09
February 15th	06:50	17:27
February 29th	06:29	17:44

Astronomical and Historical Events

1st Scheduled flyby of Saturn's largest moon *Titan* by the Cassini spacecraft
1st Comet 17P/Holmes at Opposition (3.384 AU) - on October 24, 2007, the comet brightened by nearly a million times overnight
1st History: loss of the space shuttle Columbia upon reentry (2003)
1st History: launch of Explorer 1; first artificial satellite by the United States (1958)
2nd History: Soviet space station Salyut 4 reenters the Earth's atmosphere (1977)
3rd History: Apollo 14, with astronauts Alan Shepard, Stuart Roosa and Edgar Mitchell, lands in the Moon's Fra Mauro region; 3rd manned Moon landing (1971)
3rd History: Soviet spacecraft Luna 9 becomes first spacecraft to soft land on the Moon (1966)
4th History: launch of Lunar Orbiter 3; photographed potential Apollo landing sites (1967)
4th History: Clyde Tombaugh born (1906); discovered the dwarf planet Pluto in 1930
5th Aten Asteroid 367943 *Duende* closest approach to Earth (1.786 AU)
5th History: flyby of Venus by the Mariner 10 spacecraft on its way to Mercury; first U.S. spacecraft to photograph Venus, first to use gravity of one planet to propel itself to another, and the first spacecraft to visit Mercury (1974)
6th Apollo Asteroid 2015 XA379 near-Earth flyby (0.020 AU)
6th History: Soviet space station Salyut 7 reenters Earth's atmosphere (1991)
7th Mercury at its greatest western elongation (26°) – apparent separation from the Sun in the morning sky
7th Apollo Asteroid 2013 VA10 near-Earth flyby (0.022 AU)
7th Aten Asteroid 2014 QD364 near-Earth flyby (0.036 AU)
7th Apollo Asteroid 2015 BN509 near-Earth flyby (0.084 AU)
7th Scheduled launch of a SpaceX cargo-carrying Dragon spacecraft from the Cape Canaveral Air Force Station, Florida, to the International Space Station
7th History: launch of the Stardust spacecraft for a rendezvous with Comet Wild 2 (1999)
7th History: Astronomical Society of the Pacific founded (1889)
7th History: William Huggins born, pioneered work in astronomical spectroscopy and first to differentiate nebular and galactic spectra (1824)
8th New Moon
8th Winter Star Party (through the 14th) on Big Pine Key, Florida
8th History: discovery of the SAU 094 Mars meteorite in Sayh al Uhaymir, Oman; one of the largest Mars meteorites recovered and the only one with a documented strewn field (2001)
8th History: discovery of GRV 99027 Martian Meteorite on the ice sheet near the Grove Mountain region of Antarctica; the 9.97 gram meteorite was later characterized as a shergottite (2000)
8th History: flyby of Jupiter by the Ulysses spacecraft on its way to study the polar regions of the Sun (1992)
8th History: return of Skylab III crew (astronauts Gerald Carr, William Pogue and Edward Gibson) to Earth after a 3 month stay on the space station (1974)
8th History: Jules Verne born, author and futurist (1828)
9th Asteroid 5261 *Eureka* (Mars Trojan) closest approach to Earth (0.766 AU)
9th Aten Asteroid 341843 (2008 EV5) closest approach to Earth (1.832 AU)
10th Moon at perigee (closest distance from Earth)
10th Atira Asteroid 413563 (2005 TG45) closest approach to Earth (0.592 AU)
10th History: flyby of Venus by the Galileo spacecraft (for a gravity assist) on its way to Jupiter; the encounter provided the first views of mid-level clouds on Venus and confirmed the presence of lightning (1990)

Astronomical and Historical Events (continued)

10th History: flyby of Mars by the Soviet Mars 4 spacecraft; failed to enter orbit but did detect night-side ionosphere (1974)
11th Apollo Asteroid 719 *Albert* closest approach to Earth (2.958 AU)
11th History: launch of NASA's Solar Dynamics Observatory from Cape Canaveral, Florida; the first mission in the space agency's "Living with a Star" program; five-year mission to study the Sun's energy and its influence on space weather (2010)
11th History: launch of the space shuttle Discovery (STS-82), second Hubble Space Telescope servicing mission; **shuttle tire** on display at the Observatory is from this mission (1997)
11th History: launch of first Japanese satellite: Oshumi (1970)
12th Scheduled launch of the Japan Aerospace Exploration Agency's Astro-H X-ray observatory from the Tanegashima Space Center, Japan
12th History: landing of the Near Earth Asteroid Rendezvous (NEAR) – Shoemaker spacecraft on the asteroid Eros (2001)
12th History: Soviet spacecraft Mars 5 enters orbit around Mars, providing information on surface temperatures, CO_2 concentrations, and detecting a thin ozone layer and water vapor concentrations near the Tharsis region (1974)
12th History: Sikhote Alin meteorite fall in Russia, one of the largest modern falls at 28 tons (1947)
13th Second Saturday Stars – Open House at the McCarthy Observatory
13th Apollo Asteroid 3671 *Dionysus* closest approach to Earth (2.022 AU)
13th Amor Asteroid 4957 *Brucemurray* closest approach to Earth (2.074 AU)
14th Distant flyby of Saturn's moon *Polydeuces* by the Cassini spacecraft
14th Apollo Asteroid 2014 EK24 near-Earth flyby (0.036 AU)
14th Aten Asteroid 99942 *Apophis* closest approach to Earth (1.505 AU)
14th History: flyby of Comet Tempel 1 by the Stardust spacecraft (2011)
14th History: NEAR-Shoemaker enters orbit around Eros, one of the largest of the near-Earth asteroids (2000)
14th History: Voyager 1 points its camera back towards the Sun and takes a family portrait, capturing six planets (Venus, Earth, Jupiter, Saturn, Uranus and Neptune) from a distance of approximately 4 billion miles; Mercury was too close to the Sun to be seen and Mars was lost in the scattered sunlight (1990)
14th History: launch of the Solar Maximum Mission (1980) to study the Sun during the peak of the solar cycle; a malfunction less than a year later cut the mission short. However, the satellite was recovered and repaired by the Space Shuttle Challenger in April 1984; operated successfully until burning up in the Earth's atmosphere in December 1989
14th History: launch of Luna 20, Soviet Moon sample return (1972)
14th History: launch of Syncom 1, the first geosynchronous satellite (1963)
15th First Quarter Moon
15th Distant flyby of Saturn's moon *Telesto*, *Epimetheus* and *Titan* by the Cassini spacecraft
15th Comet 67P/Churyumov-Gerasimenko, target of the Rosetta mission, closest approach to Earth (1.485 AU)
15th Asteroid 5 *Astraea* at Opposition (8.7 Magnitude)
15th Aten Asteroid 2006 XP4 near-Earth flyby (0.064 AU)
15th Amor Asteroid 3122 *Florence* closest approach to Earth (1.294 AU)
15th Apollo Asteroid 11311 Peleus closest approach to Earth (1.872 AU)
15th History: meteor explodes over the Russian city of Chelybinsk causing hundreds of injuries (2013)
15th History: flyby of the Moon by the Hiten spacecraft; Earth orbiting satellite designed by the Japanese Space Agency to test technologies for lunar and planetary missions (1992)

Astronomical and Historical Events (continued)

- 15th History: Galileo Galilei born (1564)
- 16th Flyby of Saturn's largest moon *Titan* by the Cassini spacecraft
- 16th Apollo Asteroid 24761 *Ahau* closest approach to Earth (0.894 AU)
- 16th History: Gerard Kuiper discovers Uranus' moon Miranda (1948)
- 17th Kuiper Belt Object 55565 (2002 AW197) at Opposition (44.762 AU); trans-Neptunian object (TNO) discovered in 2002 by Michael Brown et al., classified as a cubewano
- 17th History: launch of Ranger 8; Moon impact mission (1965)
- 17th History: launch of NEAR spacecraft, asteroid orbiter/lander; first of NASA's Discovery missions and the first mission to go into orbit around an asteroid (1996)
- 17th History: launch of Vanguard 2; designed to measure cloud-cover distribution over Earth (1959)
- 18th Apollo Asteroid 1999 VF22 near-Earth flyby (0.094 AU)
- 18th Atira Asteroid 1998 DK36 closest approach to Earth (0.705 AU)
- 18th History: Mike Brown and Jean-Luc Margot's discovery of *Romulus*, the larger of two moon that orbit Asteroid 87 *Sylvia* (2001)
- 18th History: American astronomer Clyde Tombaugh discovers Pluto (1930)
- 19th History: Nicolas Copernicus born (1473)
- 20th Kuiper Belt Object 148209 (2000 CR105) at Opposition (59.539 AU)
- 20th History: Clementine spacecraft enters lunar orbit and starts photographic survey; joint project between the Strategic Defense Initiative Organization and NASA, first of a new class of small spacecraft to enable long-duration, deep space missions at low cost using lightweight satellite technology (1994)
- 20th History: launch of the core module of the Soviet space station Mir (1986)
- 20th History: launch of Mercury-Atlas 6 and Friendship 7 with astronaut John Glenn; first American in orbit (1962)
- 21st Apollo Asteroid 2329 *Orthos* closest approach to Earth (2.924 AU)
- 21st History: Soviet moon rocket (N-1) explodes during first test flight (1969)
- 22nd Full Moon (Full Snow Moon)
- 22nd Aten Asteroid 2010 WD1 near-Earth flyby (0.032 AU)
- 22nd History: launch of Viking, Sweden's first satellite (1986)
- 22nd History: launch of Soviet spacecraft Kosmos 110, with dogs Veterok and Ugolyok (1966)
- 22nd History: Max Wolf discovers asteroids 587 Hypsipyle and 588 Achilles (1906)
- 23rd Apollo Asteroid 2009 DZ near-Earth flyby (0.084 AU)
- 23rd History: Supernova 1987A detected in the Large Magellanic Cloud (1987)
- 24th Aten Asteroid 326290 *Akhenaten* closest approach to Earth (0.225 AU)
- 24th History: launch of the Space Shuttle Discovery (STS-133) on its final mission. The shuttle delivered space parts and critical components to the ISS (2011)
- 24th History: launch of Mariner 6; Mars flyby mission returned images showing the south polar cap as being composed predominantly of carbon dioxide; refined estimates of the mass, radius and shape of Mars (1969)
- 24th History: Jocelyn Bell announces discovery of rapidly rotating radio sources, later determined to emanate from neutron stars or pulsars (1968)
- 24th History: launch of Bumper WAC, first two-stage liquid-propellant rocket and the first human-made object to achieve hypersonic speeds (1949)
- 25th Apollo Asteroid 2011 OJ45 near-Earth flyby (0.076 AU)
- 25th Aten Asteroid 2012 BF86 near-Earth flyby (0.080 AU)
- 25th History: flyby of Mars by the Rosetta spacecraft (2007)
- 25th History: Soviet spacecraft Luna 20 returns lunar soil sample (30 grams) to Earth (1972)
- 26th Apollo Asteroid 2008 CE119 near-Earth flyby (0.071 AU)

Astronomical and Historical Events (continued)

26th Plutino *90482 Orcus* at Opposition; discovered on February 17, 2004; the plutino has one large moon called *Vanth* (47.116 AU)
26th History: launch of the first Saturn 1B rocket booster (1966)
27th Moon at apogee (furthest distance from Earth)
27th Apollo Asteroid 2008 DL5 near-Earth flyby (0.046 AU)
27th Apollo Asteroid *3838 Epona* closest approach to Earth (0.656 AU)
28th History: flyby of Jupiter by the New Horizons spacecraft bound for Pluto (2007)
28th History: launch of Discoverer 1; first of a series of satellites which were part of the Corona reconnaissance satellite program and first satellite launched into polar orbit (1959)
29th History: original Gemini 9 crew, command pilot Elliot See and pilot Charles Bassett, killed in a crash while flying a T-38 jet trainer to the McDonnell Aircraft plant in St. Louis, Missouri to inspect their spacecraft (1966)riginal Gemini 9 crew, command pilot Elliot See and pilot Charles Bassett, killed in a crash while flying a T-38 jet trainer to the McDonnell Aircraft plant in St. Louis, Missouri to inspect their spacecraft (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 unlike Apollos, Atens spend most of their time inside Earth orbit.
- **Atira**: a group of near-Earth asteroids whose orbits are entirely within Earth's orbit
- **Centaur**: icy planetesimals with characteristics of both asteroids and comets
- Kuiper Belt: region of the solar system beyond the orbit of Neptune (30 AUs to 50 AUs) with a vast population of small bodies orbiting the Sun
- **Opposition**: celestial bodies on opposite sides of the sky, typically as viewed from Earth
- **Plutino**: an asteroid-sized body that orbits the Sun in a 2:3 resonance with Neptune
- **Trojan**: asteroids orbiting in the 4th and 5th Lagrange points (leading and trailing) of major planets in the Solar System.

References on Distances

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

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

International Space Station/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.*

Front Page

An epic battle is underway in the galaxy NGC 4258 (M106), only 23 million light years away in the Milky Way. Although a spiral galaxy like our own, it has two additional arms that glow in the X-ray, optical and radio spectrums, and are out of alignment with the plane of the galaxy,

The image is a composite of X-rays from NASA's Chandra observatory (blue), radio waves from the Very Large Array (purple), optical data from the Hubble spacecraft (yellow), and infrared data from the NASA's Spitzer. Space Telescope (red).

A supermassive black hole (white) at the center of the galaxy appears to be emitting jets of intense high energy particles that are heating the surrounding regions and sending super hot hydrogen out into space. Deprived of its hydrogen, the galaxy will be unable to generate the creation of new solar systems.

For more information, go to http://www.nasa.gov/chandra/multimedia/galactic-pyrotechnics.html.

Image Credit: X-ray: NASA/CXC/Caltech/P.Ogle et al; Optical: NASA/STScI; IR: NASA/JPL-Caltech; Radio: NSF/NRAO/VLA.

Image Credits

Front page design and graphic calendars: Allan Ostergren

Page 3 Photo: A waxing crescent moon setting in the western sky -Bill Cloutier.

Second Saturday Stars poster: Sean Ross, Ross Designs

Cartoon - Jupiter Weather by Bucky Milam, Danbury Area Computer Society

All other non-credited photos were taken by the author: Bill Cloutier

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

February 13th

7:00 - 9:00 pm

Live from Pasadena, California

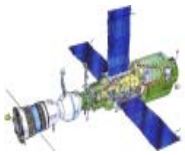
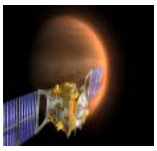
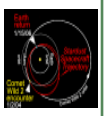
Robotic Exploration of the Solar System

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

Map

February 2016

Celestial Calendar

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
	1  Launch of Explorer I (1958) Space Shuttle Columbia breaks up on reentry from orbit (2003) 	**2**  Soviet space station, Salyut 4 reenters Earth's atmosphere (1977)	**3**  Chinese New Year Soviet Luna 9 lands on Moon (1966)   Apollo 14 - 3rd Moon landing- Shepard, Roosa, Mitchell (1971)	**4**  Clyde Tombaugh born (1906)  discoverer of Pluto  Launch of Lunar Orbiter 3, to locate Apollo landing sites (1967)	**5**  Flyby of Venus by Mariner 10 spacecraft en route to Mercury (1974)	**6**  Soviet space station Salyut 7 reenters Earth's atmosphere (1991)
7 William Huggins born, pioneer of astronomical spectroscopy (1824)   Astronomical Society of the Pacific founded (1889) Launch of Stardust spacecraft for rendezvous with comet Wild 2 (1999) 	**8**  Jules Verne born (1828) Mars meteorites found - Oman (2001); Antarctica (2000)   Return of Skylab 3 crew after 3 months on space station (1974)	**9**   Astronaut Bernard A. Harris becomes first African-American to perform extra vehicular activity, during shuttle mission STS-63 to Mir spacecraft, flown by first woman shuttle pilot, Eileen Collins (1995)	**10**  Moon at perigee (closest distance to Earth)   Flyby of Venus by Galileo spacecraft on way to Jupiter (1990)  Flyby of Mars by Soviet Mars 4 spacecraft (1974)	**11**  Launch of NASA Solar Dynamics Observatory 2010 Launch of Japanese satellite Oshumi (1970)   A solar eclipse inspires Nat Turner to launch slave revolt in Virginia (1831) Scheduled launch of the ESA's Intermediate eXperminental Vehicle (IXV) from Kourou, French Guiana 	**12**  Moon at apogee (farthest from Earth) NEAR spacecraft lands on asteroid Eros (2001)   Sikhote Alin meteorite falls in Russia (1947) Soviet Mars 5 spacecraft in orbit (1974) 	**13**  John Louis Emil Dreyer born, Danish/Irish astronomer and biographer of Tycho Brahe; continued Herschel's work by publishing catalogue of nebulae and clusters (1852) 2nd Saturday Stars Open House McCarthy Observatory 
14  Launch of Syncom 1, first geosynchronous satellite (1963) Launch of Solar Maximum Mission to study Sun during peak of cycle (1980)  Flyby of Comet Tempel 1 by the Stardust spacecraft (2011)	**15**  Galileo Galilei born (1564) Flyby of Moon by Japan's Hiten spacecraft (1992) 	**16** Winter Star Party (through the 22nd), Big Pine Key, Florida   Gerard Kuiper discovers Uranus' moon, Miranda (1948)	**17** Launch of Ranger 8, Moon impact mission (1965)  Launch of Vanguard 2, to measure Earth cloud cover (1959) Plutino 90482 Orcus discovered - has one moon, Vanth (2004)	**18** American astronomer Clyde Tombaugh discovers Pluto (1930)	**19** Nicholas Copernicus born (1473)	**20** Launch of Mercury Atlas 6 and Friendship 7 with John Glenn, 1st American in orbit (1962) Launch of core module of Soviet Mir space station (1986)
21 Soviet Moon rocket (N-1) explodes (1969) Tom Gehrels born , astronomer and co-discoverer of over 4,000 asteroids (1925)	**22** Launch of Soviet spacecraft Kosmos 110, with dogs Veterok and Ugolyok (1966)	**23** Supernova 1987A detected in Large Magellanic Cloud (1987)	**24** Launch of Bumper WAC, first two-stage liquid ropellant rocket (1949) Launch of Mariner 6, Mars flyby (1969) Jocelyn Bell's discovery of pulsars (1968) Shuttle Discovery final mission (2011)	**25** Flyby of Mars by Rosetta spacecraft (2007) Soviet spacecraft Luna 20 returns 30-gram soil sample to Earth (1972)	**26** Launch of first Saturn 1B rocket booster (1966)	**27** Moon at apogee (farthest from Earth) Bernard Ferdinand Lyot born, French astronomer and inventor of the coronagraph to observe the sun's corona without waiting for an eclipse, (1897)
28 Launch of Discoverer 1, first of Corona reconnaissance satellite program (1959) Flyby of Jupiter by New Horizons spacecraft bound for Pluto (2007)	**29** Original Gemini 9 crew, Elliot See and Charles Bassett, killed in a trainer jet crash enroute to inspect their spacecraft (1966) Christopher Columbus uses prediction of lunar eclipse by astronomer Johannes Müller von Königsberg to exact provisions from Jamaican natives (1504)					

Phases of the Moon

Feb 8 Feb 15 Feb 22 Mar 1

Feb 18 Feb 25