Galactic Observer

John J. McCarthy Observatory

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Halloween spook

See page 19 for more information

The John J. McCarthy Observatory

New Milford High School
388 Danbury Road
New Milford, CT 06776

Phone/Voice: (860) 210-4117
Phone/Fax: (860) 354-1595
www.mccarthyobservatory.org

JJMO Staff

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

Steve Barone
Colin Campbell
Dennis Cartolano
Mike Chiarella
Jeff Chodak
Bill Cloutier
Doug Delisle
Cecilia Detrich
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Randy Fender
Louise Gagnon
John Gebauer
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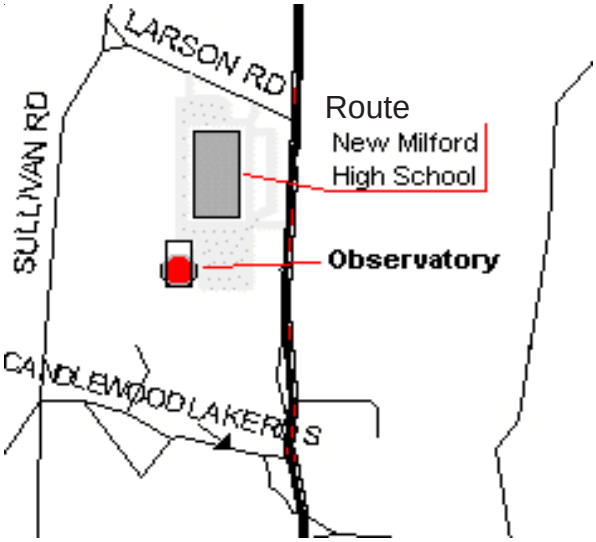
Amy Ziffer



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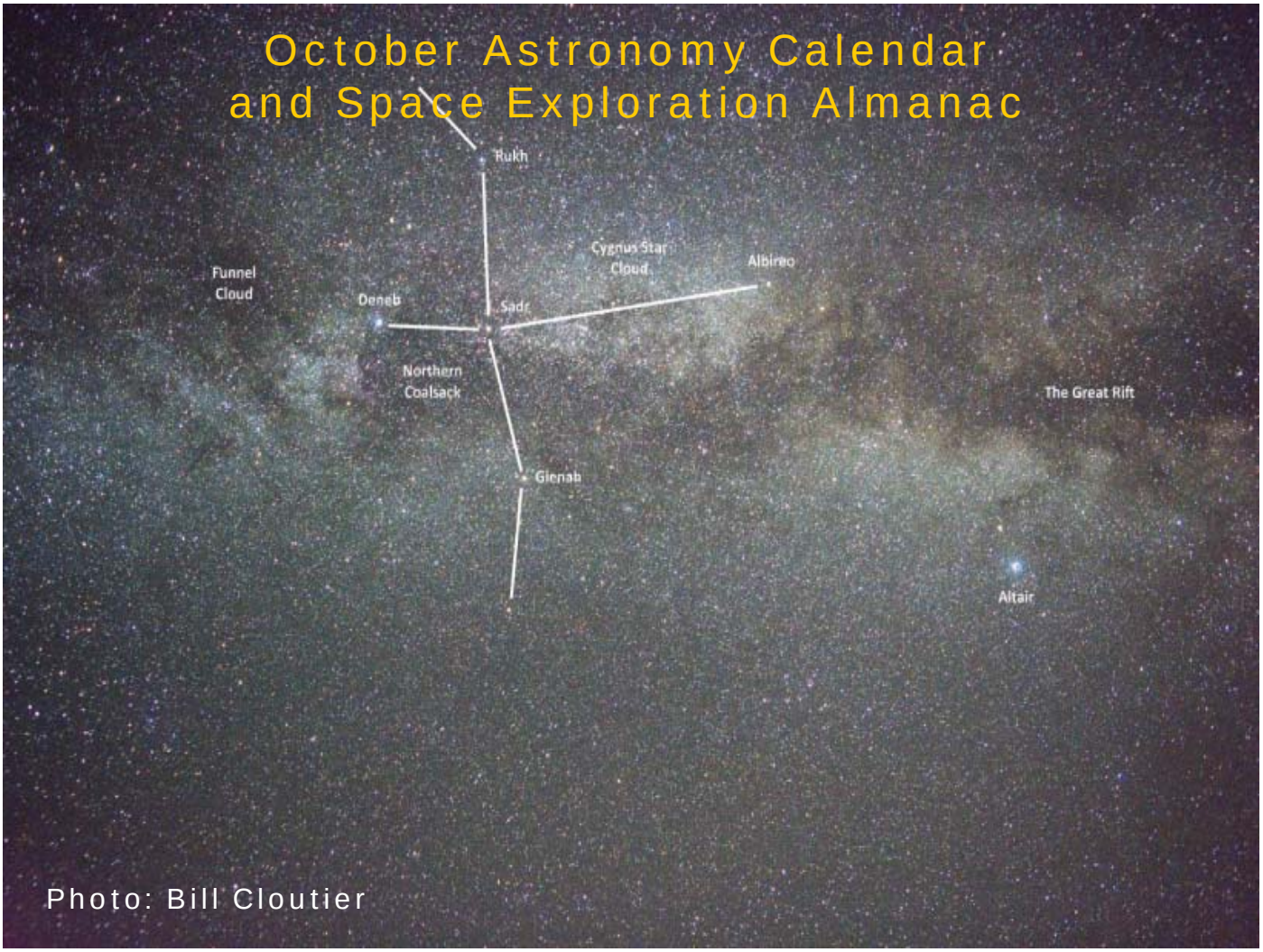


The Summer Milky Way Takes Flight

The bright stars that comprise the constellation Cygnus and the Great Rift (a dark band of dust and molecular gas within the next inward spiral arm of the Milky Way Galaxy) create the illusion of a grand celestial bird of prey traversing a dark river among the stars.

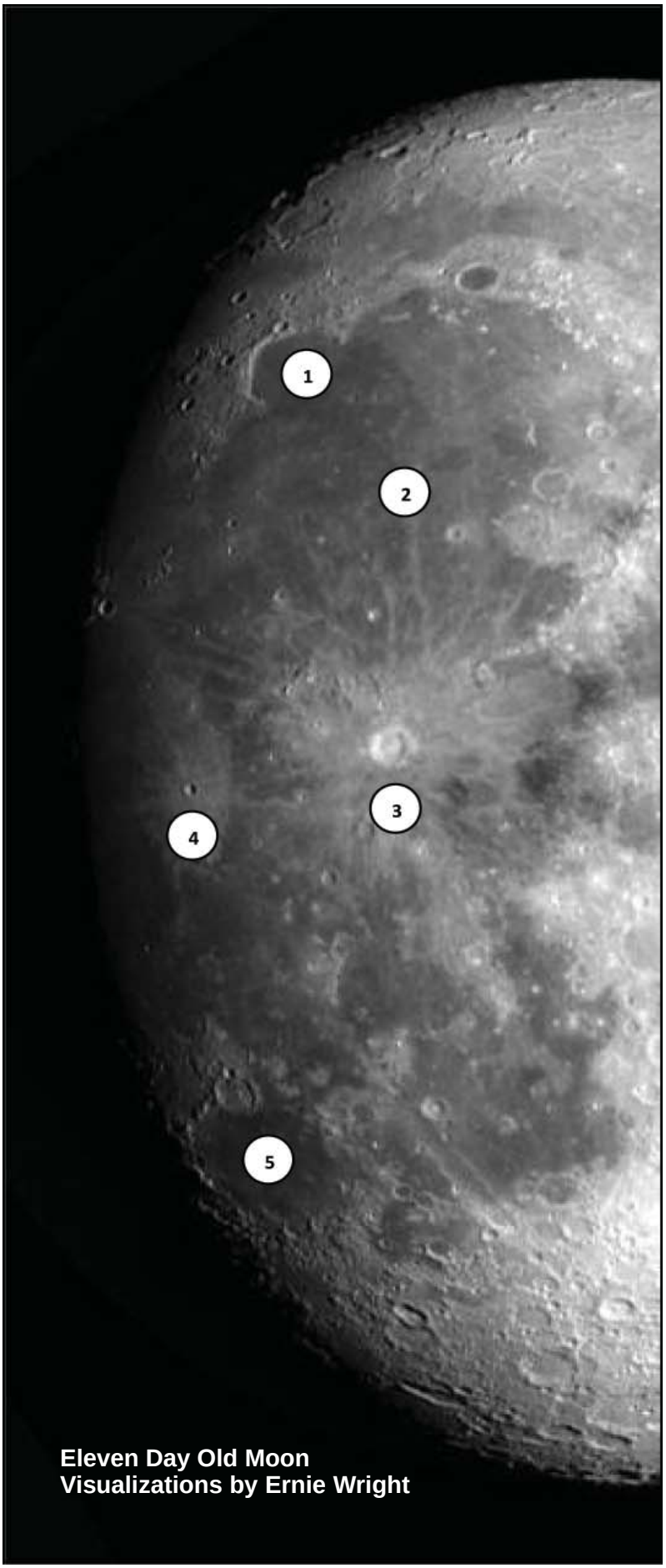
The Autumal Equinox on September 22nd marked the end of summer in the northern hemisphere. While the Summer Triangle (bounded by the stars Deneb, Altair and Vega), can still be seen well into autumn, our view of the Milky Way Galaxy is slowly changing. The Solar System is about 26,000 light years away from the center of a large spiral galaxy, over 100,000 light years in diameter. In the summer, the central portions of our galaxy, with its bright galactic bulge (the spherical nucleus of older stars), is visible when we look to the south, towards the constellation Sagittarius. In the winter, our view is in the opposition direction (towards the less populated edge of the galactic disk or the galaxy's anticenter) when the Auriga and Taurus constellations are in the southern sky.

Autumn is a great time to look "out" from our galaxy. A favorite observing target, the nearest, large spiral galaxy (the Andromeda Galaxy), is located below the Milky Way's galactic plane and away from the galactic center, relative to the Sun's position (conversely, in the spring, we are looking "up" towards the Virgo Galaxy Cluster).

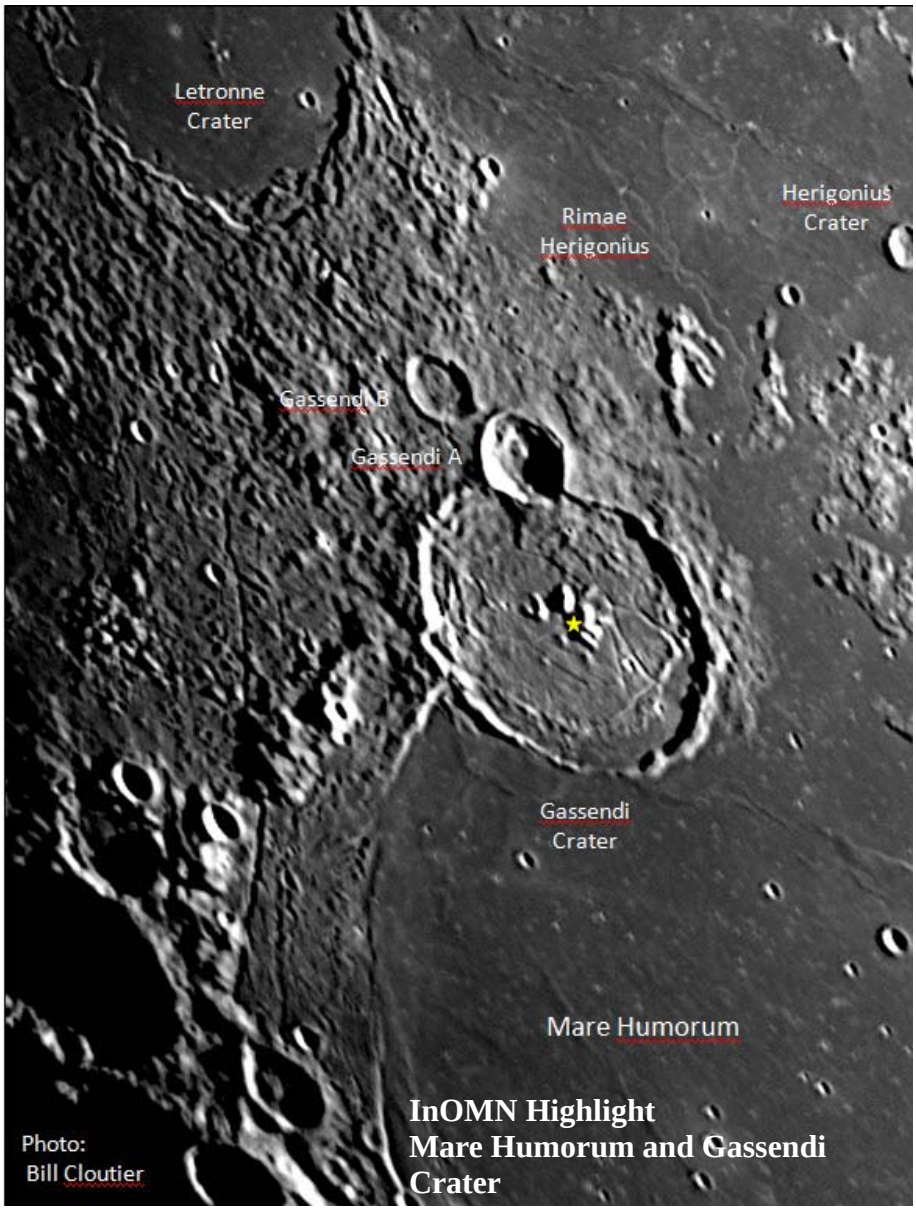
International Observe the Moon Night

OCTOBER 20 has been designated International Observe the Moon Night (InOMN). The event was first inspired by public outreach programs held in August 2009 by the Lunar Reconnaissance Orbiter (LRO) and Lunar CRater Observation and Sensing Satellite (LCROSS) educational teams at the Goddard Space Flight Center in Greenbelt, Maryland and at the Ames Research Center in Moffett Field, California, respectively. In 2010, the Lunar and Planetary Institute and Marshall Space Flight Center joined Goddard and Ames in a world-wide event to raise public awareness of lunar science and exploration. Information on InOMN events is available on their website *http://observethemoonnight.org/*.The Moon will rise at 4:33 pm (EDT) on the 20th and set in the early morning the following day. Approximately 84% of the near-side surface will be illuminated as the Sun sets and twilight deepens. With clear skies, the following lunar features will be visible along the terminator (day/ night boundary):

1. **Sinus Iridum:** a basaltic lava plain partially bounded by a buried crater rim that forms the Jura Mountains;
2. **Mare Imbrium:** flooded impact basin and one of the largest and youngest on the near side with a diameter of 710 miles (1,145 km);
3. **Copernicus Crater:** 58 miles (93 km) diameter impact crater that formed less than 1 billion year ago;
4. **Kepler Crater:** Copernican-aged crater with bright ray system;
5. **Mare Humorum** with the fractured-floor Gassendi crater disrupting its northern rim. Gassendi is a 68 mile (110 km) diameter complex crater.



Eleven Day Old Moon
Visualizations by Ernie Wright

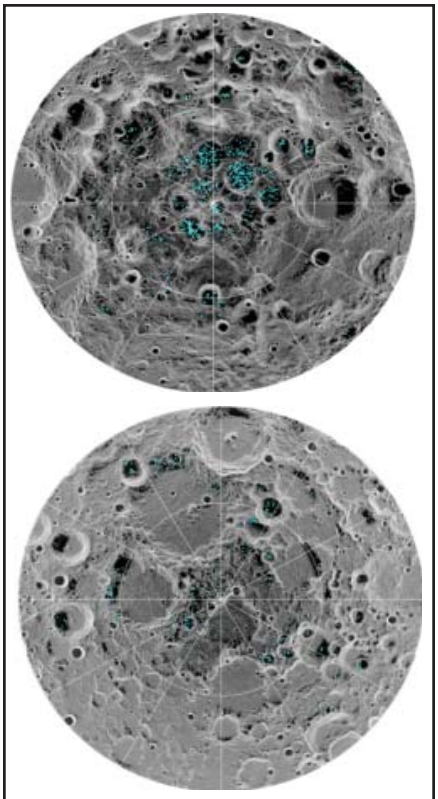


Lunar Ice

Water ice has been found at the poles of the planet Mercury and dwarf planet Ceres, but the evidence to date for water at the Moon's poles has been more circumstantial. While a hydrogen signature has been detected on the Moon, its form has remained elusive (e.g., H2O ice, OH [hydroxide], absorbed liquid or water bound in minerals).

A team of scientists, led by Shuai Li of the University of Hawaii and Brown University and including Richard Elphic from NASA's Ames Research Center in California's Silicon Valley, has now been able to differentiate between the liquid, solid and vapor phases of the water detected in the shadowed regions of the lunar poles, using data from NASA's Moon Mineral Mapper (M3) that flew aboard the Chandrayaan-1 spacecraft. The technique is called near-infrared reflectance (NIR) spectroscopy. NIR is able to directly measure the way molecules absorb infrared light and molecular vibrations that can be used to distinguish between forms.

Most of the ice lies in deeply shadowed areas where temperatures are colder than -250° F. No difference in the distribution of the ice (near-side vs. far side) was observed, suggesting that sunlight reflected off the Earth (earthshine) was not a significant factor in surface temperatures. The lower distribution of surface ice at the north pole was attributed to the low rate of new supply (for example, from impacts and volcanic outgassing) and impact gardening from micrometeoroids that mix the ice and regolith (Moon's pulverized surface). It is also hypothesized that the observed ice is ancient, accumulated prior to the wandering of the Moon's axis approximately 3 billion years ago.

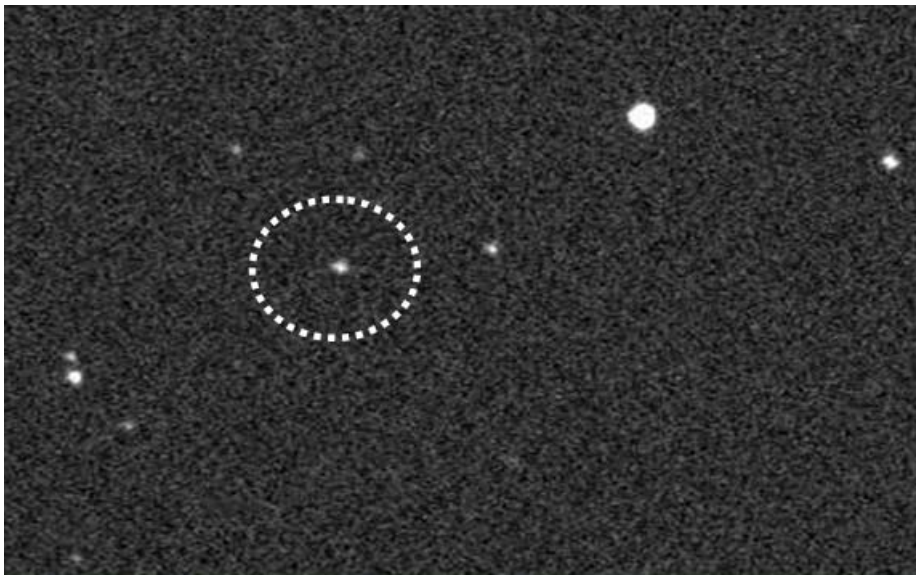


Distribution of surface ice (blue) at the Moon's poles from NASA's M3 instrument. The south pole (left) shows a greater abundance of ice than the north pole (right). Cold traps (areas that see no direct sunlight) are also more abundant at the south pole (shades of gray correspond to the Moon's surface temperature - darker gray being colder than the lighter shades)

Credits: NASA

Spotlight on the McCarthy Observatory Meteorite Collection

In the summer of 2018, the Observatory greatly expanded its meteorite teaching collection with the addition of a diverse and comprehensive set of meteoritic specimens from a reputable collector looking to convey his collection to someone who would maintain its integrity and capitalize on its intrinsic educational value. The collection includes whole stones, slices and fragments, numbering more than 200, from historic and scientific-significant falls and meteorite finds dating back to 1492. From time to time, we will highlight one or more of the specimens from the collection in this newsletter.



2008 TC3 captured in a 0.5 second exposure by the McCarthy Observatory's 16 inch (0.4 meter) Schmidt-Cassegrain telescope and SBIG ST-10 CCD camera

In the early morning of October 7, 2008, a meteor exploded in the sky 23 miles (37 km) above Sudan's Nubian Desert. The source of the meteor, a small asteroid 13-feet (4.1 meters) in diameter and designated as 2008 TC3 had been discovered less than 21 hours earlier by a Catalina Sky Survey telescope on Mount Lemmon, Arizona. It was the first time that an object had been observed before it hit the Earth.

Flashes from the detonation were reported by the pilot of a KLM airliner flying over Chad after being alerted to the possibility by Jacob Kuiper, a meteorologist at the National Weather Service in Amsterdam. The light from the denotation was also detected by a Meteosat weather satellite and the low-frequency sound by at least two ground stations. The dust cloud from the detonation was still visible in the predawn sky. The breakup of themeteor produced a shower of fragments scattered across the desert (of which 600 have been recovered); the biggest pieces are only a few inches in size. The meteorites, called Almahata Sitta (Station 6), after the nearest landmark, were recovered, initially by searches organized by the University of Khartoum with the assistance of Dr. Peter Jenniskens (SETI Institute and NASA Ames Research Center).

Prior to the entering of the Earth's shadow, the Minor Planet Center in Cambridge, Massachusetts, received over 883 visual observations from 26 professional and amateur observatories across the world. The McCarthy Observatory was one of the last observatories to observe and report positional observations (over a time period spanning 70 minutes and up until 15 minutes before the rapidly tumbling 2008 TC3 disappeared into the Earth's shadow).

The Almahata Sitta meteorites are mostly polymict ureilites, a rare type of stony meteorite that has olivine and pyroxene-rich clasts, a high concentration of rare earth elements, and clusters of tiny diamonds. Ureilites are believed to have formed deep inside protoplanets during the formative years of the solar system.

Diamond crystals in meteors can be formed from the compression of the carbon in the rock by several processes, including shock from high-energy impacts. However, according to the authors of an article published in the journal Nature Communications, the diamond's large size (which would require time for growth) and the chromites, phosphates, and nickel-iron sulfide inclusions within the diamonds can only be explained if the pressure was higher than 20 GPa (20 billion pascals). The carbon-crushing pressure would be found in a body at least 600 miles (1,000 km) in diameter. If the diamonds formed at the mantle-core boundary, the pressure requirement would correlate to a Mars-sized object. At a minimum, if the diamonds formed in the core, the object would be the size of Mercury. While the formation of a multitude of protoplanets in the solar nebula has been theorized (including one that collided with Earth to form our moon), this the first direct evidence for such objects.

Monty Robson, Director of the McCarthy Observatory, holding a large fragment of Almahata Sitta at the 2009 Prague international conference on "Bolides and Meteorite Falls"

The cosmic-ray exposure age of the 2008 TC3 asteroid (the time the asteroid was exposed to space before hitting Earth) has been calculated to be about 15 million years. It had likely spent the previous 4.5 billion years buried deep within a large relic or pile of rubble, left over from a catastrophic event (for example, a collision with another body) that occurred within the first 10 million years of the solar system's formation. Based upon its reflectance spectra, 2008 TC3 was classified as a F-class asteroid, objects found in the main asteroid belt between Mars and Jupiter and 2.4 to 2.5 AU (220-230 million miles) from the Sun.

The McCarthy Observatory's Almahata Sitta Meteorite. Image: Don Merchant

The McCarthy Observatory's meteoritic sample of Almahata Sitta is a 70 mg fragment. It does have a remnant of the fusion crust that was created as the air heated by the meteor's passage through the Earth's atmosphere melted the outer layer of the stone.

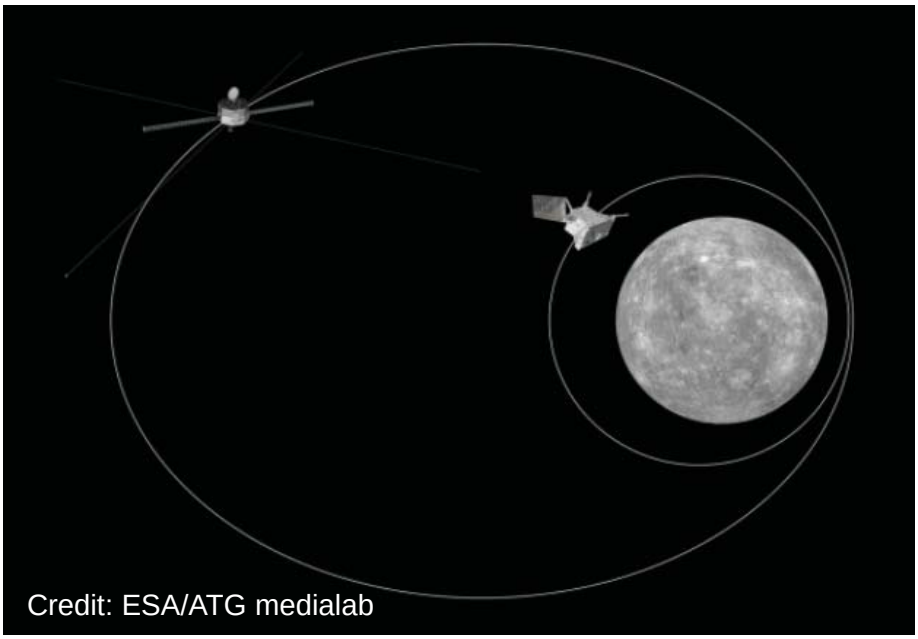
BepiColumbo

On the evening of October 18 (EDT), Arianespace will launch a spacecraft to explore the planet Mercury from its Kourou, French Guiana launch site. The spacecraft (consisting of two orbiters) and an associated propulsion module and thermal shielding will travel as a unit to the innermost planet for a one Earth-year (four Mercury-year) nominal mission when it arrives in 2025.

BepiColombo is a collaborative mission between the European Space Agency (ESA) and the Japan Aerospace Exploration Agency (JAXA). Once at Mercury, the orbiters will separate, with ESA's Mercury Planetary Orbiter studying the planet's surface and internal composition from a 300 by 900 mile (480 by 1,500 km) polar orbit, while JAXA's Mercury Magnetospheric Orbiter studies the planet's magnetosphere from a 370 by 7,200 mile (590 by 11,640 km) polar orbit.

Mercury's proximity to the Sun makes any mission to the planet challenging. Not only is heat a concern (with temperatures in excess of 660° F or 350° C), but spacecraft traveling into the inner solar system need to undergo braking maneuvers to shed excess velocity. After a three month commissioning phase in Earth orbit, the spacecraft will leave Earth orbit only to return after 18 months for a gravity assist and course deflection to Venus. Two Venus flybys, followed by six Mercury flybys, will slow the spacecraft and reduce its relative velocity to allow capture by Mercury's gravity.

ESA's spacecraft will complete an orbit of Mercury every 2.3 hours, while it will take the JAXA spacecraft 9.3 hours to do so. The BepiColombo spacecraft will join only two other spacecraft (Mariner 10 and MESSENGER) to explore this unique world.



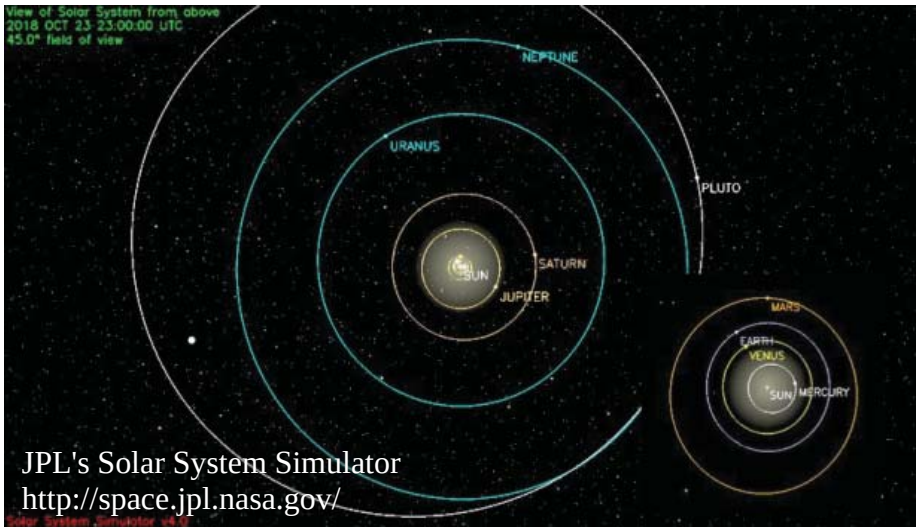
Uranus at Opposition

The Earth will come between Uranus and the Sun on October 23rd (EDT), i.e., "Opposition." On that day, Uranus will rise as the Sun sets and will be visible throughout the night (highest in the sky after midnight). At magnitude 5.68, it can be spotted by keen eyes in the constellation Aries under ideal sky conditions. Uranus will be approximately 1.7 billion miles (2.8 million km) from Earth at Opposition.

William Herschel is credited with the discovery of Uranus in 1781 with his home-made telescope, although the planet had been observed, and recorded as a star, by many observers, including Hipparchos in the 2nd century BC, the English astronomer John Flamsteed in 1690, and the French astronomer Pierre Le Monnier in the 1750s. Uranus was named for the Greek god of the sky, notwithstanding Herschel's preference to name the planet after his benefactor, King George III (Georgium Sidus).

Uranus is an ice giant and seventh planet from the Sun. Third largest planet in diameter, Uranus' spin axis is tilted more than 90° (the planet basically spins on its side). The tilt is likely the result of a collision with another planetoid billions of years ago. Thirteen faint rings surround the planet along with 27 small moons. A day on Uranus lasts about 17 Earth-hours and it takes 84 Earth-years to complete a single orbit around the Sun. Winters last 21 years with one half of the planet sunlit and the other in total darkness.

Methane in the atmosphere of Uranus gives the planet its blue-green color. Hydrogen, helium, water and ammonia are the other constituents of a slushy atmosphere that surrounds a rocky core. The planet is believed to have formed closer to



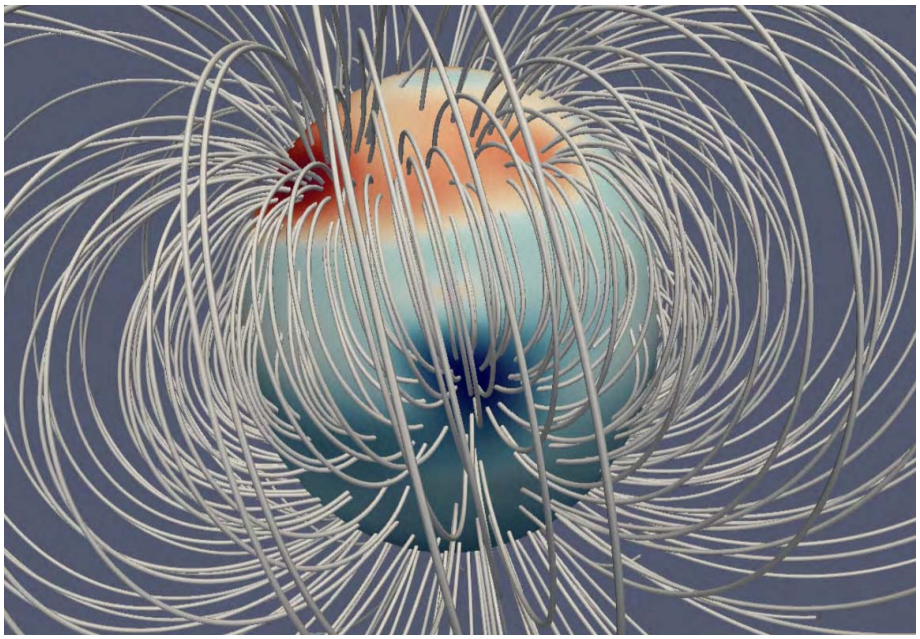
JPL's Solar System Simulator
http://space.jpl.nasa.gov/

1986. However, more recent observations from the Hubble Space Telescope and other Earth-bound observatories have detected dark clouds and storms with bright cloud tops.

A Most Unusual Magnetic Field

The Earth has a distinct magnetic pole in each hemisphere, close to its spin axis. By comparison, as discovered by NASA's Juno spacecraft, the magnetic pole(s) at Jupiter are more unusual, unorganized and chaotic, particularly in the planet's northern hemisphere. The Juno spacecraft has been studying Jupiter since its arrival in 2016. Its elongated, looping orbit brings the spacecraft within 2,500 miles (4,000 km) of the gas planet's cloud tops on every orbit.

The Earth's magnetic field is generated by convection within its iron core. Field lines stretch from one pole to the other. While Jupiter is comprised primarily of hydrogen and helium gas, the intense pressure deep within its atmosphere converts the hydrogen into



Depiction of Jupiter's magnetic field lines showing the elongated northern magnetic pole and a second pole, the "great blue spot" near the equator in the northern hemisphere. Graphic: Moore et al (Nature 2018)

a liquid metal that can conduct electricity. Convection of the liquid metal generates a magnetic field almost 20,000 time stronger than Earth's magnetic field. Juno's measurements, used to map Jupiter's magnetic field, reveal a "conventional" magnetic pole in the planet's southern hemisphere. In the northern hemisphere, a less-well-defined magnetic pole is joined by magnetic hotspots and patches. Near the equator, scientists also found a second "south pole" christened the "great blue spot."

Scientists are still deliberating and exploring various explanations for the peculiarities in Jupiter's magnetosphere, offering theories that attempt to explain the inner workings of the planet's core, including superconducting fluids mixing with rock and ice to helium rain and magnetic field reversals. NASA has recently extended Juno's mission through July 2021, giving scientists additional time to accomplish the spacecraft's prime science objectives and possibly reveal the inner workings of the gas giant's dynamo.

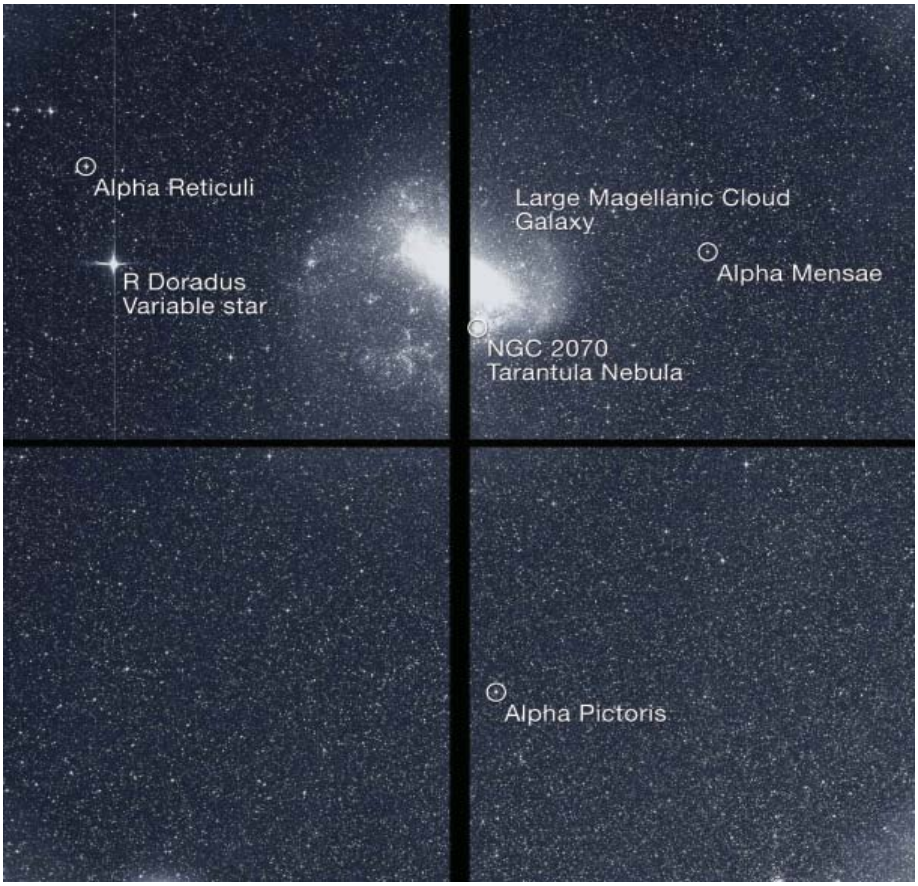
First Exoplanet Discoveries for TESS

The Transiting Exoplanet Survey Satellite (TESS) was launched on April 18, 2018, aboard a SpaceX Falcon 9 rocket. It was placed in a 13.5-day, highly elliptical orbit around Earth. After a two month readiness and calibration phase, the spacecraft began science operations in late July/August.

TESS is a follow-on mission to the exoplanet survey conducted by the Kepler Space Telescope. Unlike Kepler, which dedicated its resources on stars between 300 to 3,000 light-years away in a small area in the constellation Cygnus, TESS is scanning closer and brighter stars (30 to 300 light years away) over 85 percent of the sky (an area 400 times larger than monitored by Kepler) in its two year mission. TESS' science team expects to monitor more than 200,000 stars for transiting exoplanets (planets crossing in front of a star causes a momentary dimming of light and the amount of dimming and its duration can be used to determine the transiting object's size and orbit). This is the first all-sky exoplanet survey, using transit photometry, and expectations are that a significant number of planets as small as Earth-size will be found.

TESS transmits its science data every 13.5 days at its closest approach to Earth. Scientists have already identified two planetary candidates in the spacecraft's first set of observations. The first new planet discovered is called pi Men c and is approximately 4.8 times the mass of the Earth. It orbits its host star (Pi Mensae) every 6.7 days. Pi Men c joins another, much larger planet that had been previously discovered in the system (10 times the mass of Jupiter with an orbital period of 5.7 years). The density of the newly found planet is close to that of water, suggesting a small rocky core, planetary ocean and atmosphere of lighter gases. Future observations by large, ground-based telescopes and the James Webb Space Telescope (when launched) will allow astronomers to study planets like Pi Men c and their atmospheres in greater detail.

The second discovery was announced only three days after the



One of the first science images captured by TESS on August 7th. The image is from the satellite's fourth camera (black lines are from gaps in the camera's detectors). Credit: NASA/MIT/TESS

first. The second candidate planet is slightly larger than Earth and orbits a faint red dwarf star called LHS 3844, approximately 49 light years away from Earth. The planet orbits its host star every 11 hours. Its proximity would expose the planet to extreme temperatures, tidal heating and solar flares - all life-threatening conditions.

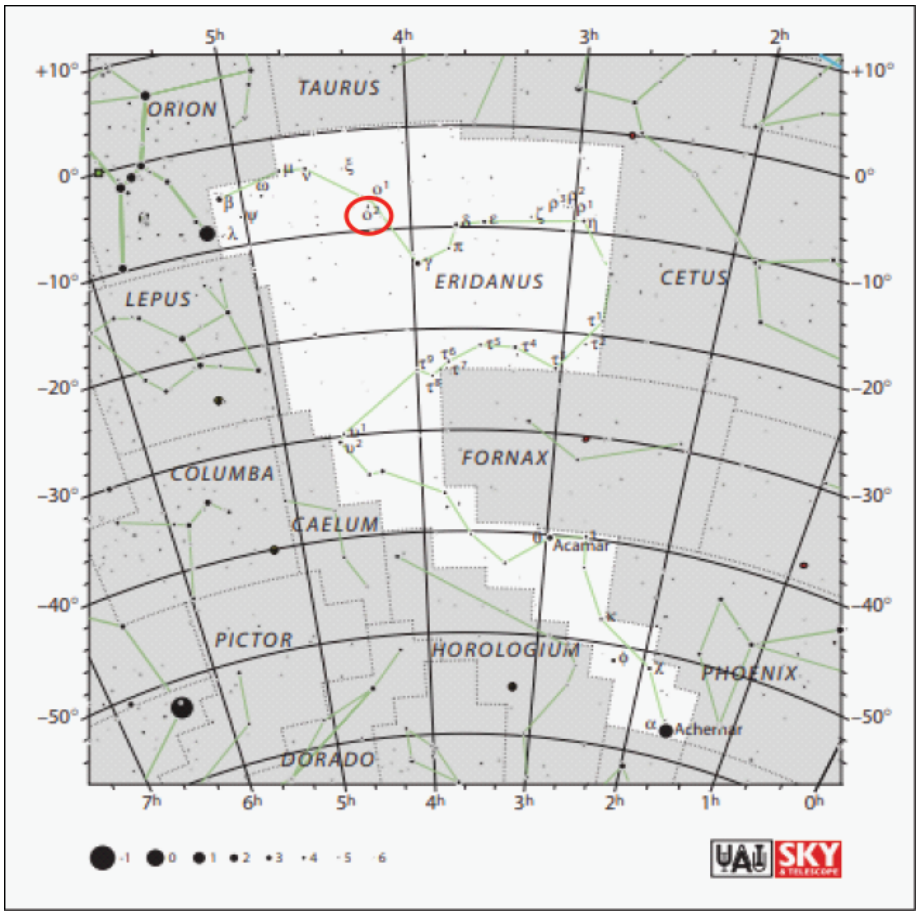
New Planet Discovered Around 40 Eridani A

The constellation Eridanus is the sixth largest of the 88 modern constellations (it was also one of the 48 ancient constellations listed by astronomer Ptolemy in the second century BC). The ancient "river" begins at the feet of Orion and flows down through the stars of the southern hemisphere. Not far downstream is the triple star system Omicron-2 Eridani, less than 17 light-years from the Sun. It is also known by its Flamsteed number 40 Eridani or by its Arabic name Keid. The primary star in the system, designated 40 Eridani A, or HD 26965, is slightly cooler than the Sun and about the same age. It is orbited by a pair of stars, one of which is a white dwarf (one of the brightest white dwarfs visible to Earth-bound observers).

The Dharma Planetary Survey monitors 100 or more nearby stars for low-mass planets. The high resolution optical spectrograph, mounted on an automatic telescope on Mt. Lemmon, has detected its first planet, a super-Earth around 40 Eridani A. The planet is located within the star's habitable zone and orbits its host star every 42 days.

The new planet was found using the Radial Velocity Method in which the spectra of the star is monitored for the gravitational effects of orbiting planets. The effects are seen in the minor shifts in the wavelength of light as the stars move towards and then away from the observer.

The discovery has created a buzz among Trekkies (fans of the fictional world of Star Trek). Gene Roddenberry, the creator of the original television series, which premiered in 1966, had identified 40 Eridani A as the host star of the planet Vulcan in a letter published in Sky and Telescope in 1991. Roddenberry worked with astronomers to select a host star for his fictional world based upon the star's age (needed for the development of an advanced civilization) and its similarities to our Sun (for example, temperature and magnetic cycle).



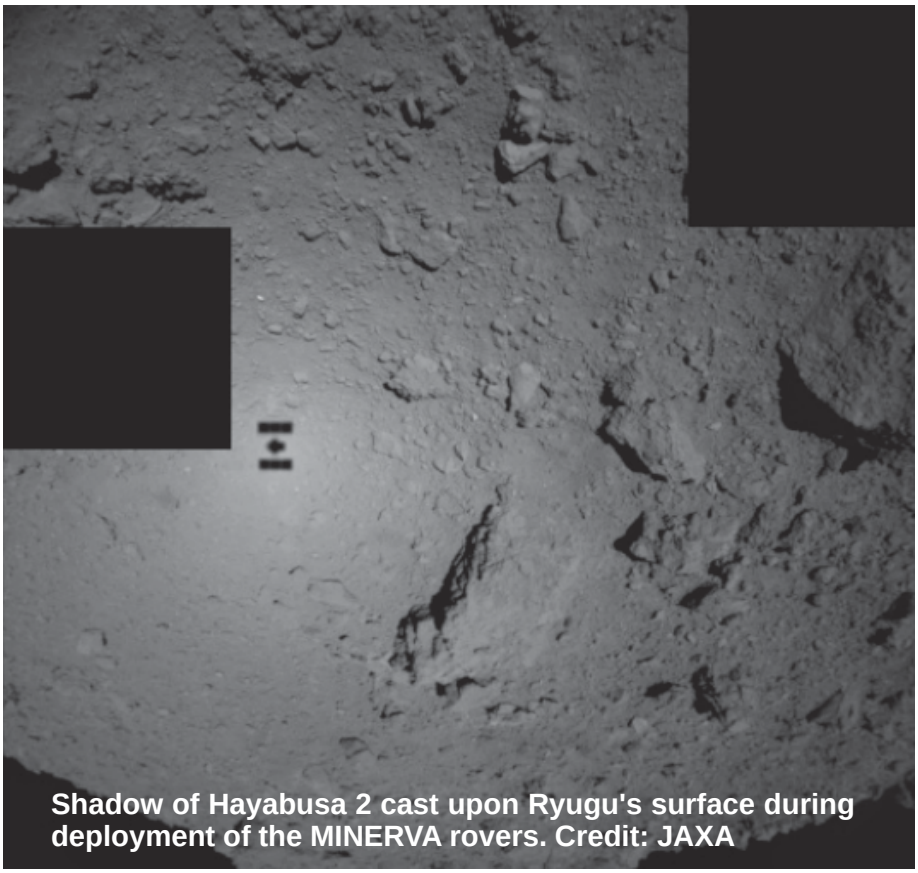
Location of the triple star system Omicron-2 Eridani in the constellation Eridanus and the newly found planet around HD 26965

Hopping Rovers Deployed to the Surface of Ryugu

Shortly after midnight on September 21 (EDT), Japan's Hayabusa 2 spacecraft dropped down to within 180 feet (55 meters) of the surface of the asteroid Ryugu, releasing two tiny robotic rovers, MINERVA-II 1A and MINERVA-II 1B. Both rovers landed successfully and have begun to transmit data and photos from the surface. The MINERVA rovers are disk shaped, 7 inches wide by 2.8 inches tall (18 by 7 centimeters). They weigh 2.4 pounds (1.1 kg) on Earth, but almost nothing on the 3,000 foot wide (900 meters) asteroid. The rovers are able to move about the surface, using the torque of two internalDC motors, by hopping. With such a low gravity field, the rovers are expected to move up 50

feet (15 meters) across the surface in a single hop, with a hang time (in-flight duration) of up to 15 minutes.

Hayabusa 2 is tentatively scheduled to deploy a small European-built lander, called MASCOT (Mobile Asteroid Surface Scout), to the asteroid's surface in October. The lander will also be able to move about (hop), allowing it to collect data from several locations during its 12 to 16-hour battery life. Early next year, the Hayabusa 2 spacecraft is expected to make its first contact (of three planned) with the Ryugu's surface and attempt to retrieve a sample (the sampling systems uses a Tantalum projectile to dislodge material from the surface, allowing it to float upward into the spacecraft's sampling system). Material collected by Hayabusa 2 is scheduled to be returned to Earth in December 2020.



Shadow of Hayabusa 2 cast upon Ryugu's surface during deployment of the MINERVA rovers. Credit: JAXA

Space Race History

On October 11, 1968, a Saturn 1-B rocket carried the first manned Apollo command and service module into low-Earth orbit. The test flight would last almost 11 days and complete 163 orbits of the Earth. Walter Schirra (5th American in space when he flew the Mercury-Atlas 8 mission on October 3, 1962), commanded the crew along with command module pilot Donn Eisele and lunar module pilot Walter Cunningham.

The Block II command module was a redesigned and much improved version of the Block I model that was involved in the Apollo 1 accident. The two-piece, inward opening and bolted hatch on the Block I model was replaced with a one-piece, outward opening, quick release hatch on the Block II module. The 100% oxygen atmosphere used in the Block I module was also replaced with a less flammable 60% oxygen and 40% nitrogen mixture at launch. The air in the Block II module was purged and converted to 100% oxygen as the flight progressed.

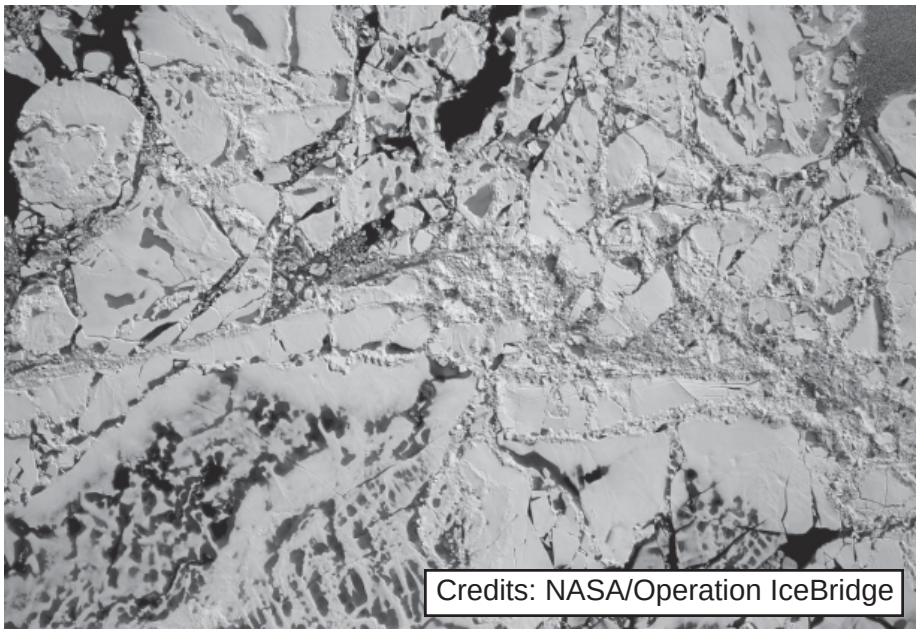
Apollo 7 did not carry a lunar lander, however, a simulated docking with the third stage was planned (the lunar lander would be carried within the third stage in future flights). Schirra canceled the docking maneuvers when one of the adapter panels on the third stage did not fully deploy (the panels were jettisoned with explosive charges on future flights to avoid such a reoccurrence since access to the lunar module was vital to a lunar mission).

There were relatively few problems with the spacecraft and most were resolved before Apollo 8 made its historic trip to the Moon in the following December. The service module's

main engine, required to enter into and leave lunar orbit performed flawlessly, restarting eight times during the mission. The overall performance of the Apollo 7 command and service module was a significant factor in NASA's decision to send Apollo 8 to the Moon after only one low-Earth test flight.

day covering 40% less area than it did in the 1970s and 1980s.

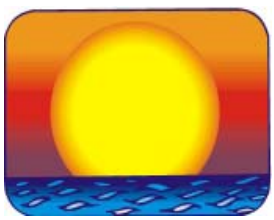
The photo at right shows a field of broken sea ice in the Chukchi Sea (an area just north of the Bering Strait and bounded by the East Siberian and Beaufort seas). The darker areas are open water and the lighter blue patches, melt water ponds. The melt water ponds, formed from surface melt, accelerate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


Credits: NASA/Operation IceBridge

Data from this year's summer season indicates that 2018 will likely be similar in ice coverage to 2008, which was the sixth lowest (since satellite measurements began in 1978). If the warming trends continue, ice could disappear from the summer Arctic Ocean before the middle of the century. Sea ice plays an important role in the polar ecosystem, regulating regional and global temperatures, affecting ocean salinity and circulation patterns, providing a habitat for animals, as well as protecting coastlines from erosion (by mitigating wave action). The disappearance of sea ice won't raise the sea level by itself (since it already floats on top of the water), but its disappearance may trigger other changes in the climate that will (for example, sea ice has been found to protect the ice front of freshwater glaciers from destructive wave action).

At the southern pole, the sea ice is reaching its maximum extent. Scientists have observed a short-term reversal in coverage from record highs in 2012 through 2014 to lows in 2015, 2016 and 2017. Overall, total sea ice has been decreasing since the 1970s.

As the nights grow longer and cooler our view of the night sky begins to change. Summer evenings showcase our own galaxy, the Milky Way. The center of our spiral galaxy is in the direction of the constellation Sagittarius, which appears in the southern sky throughout the summer. In the autumn, as Sagittarius disappears into the west, the stars forming the Great Square of Pegasus rise in the east. Following Pegasus is the Andromeda Galaxy, one of the most distant objects that can be seen with the unaided eye at approximately 2.5 million light years (14.7 million trillion miles). With the rising of Andromeda, we begin to look outward to the outer arms of our own galaxy and to other galaxies far, far away.



Sunrise and Sunset (from New Milford, CT)

Sun	Sunrise	Sunset
October 1st (EDT)	06:50	18:35
October 15th	07:06	18:12
October 31st	07:24	17:50

October Astronomy Calendar and Space Exploration Almanac

1st Atira Asteroid 2017 XA1 closest approach to Earth (1.216 AU)
1st History: NASA created by the National Aeronautics and Space Act (1958)
2nd Last Quarter Moon
2nd Atira Asteroid 2012 VE46 closest approach to Earth (0.277 AU)
2nd Kuiper Belt Object 2015 RR245 at Opposition (61.998 AU)
2nd History: opening of the Hayden Planetarium (1935)
3rd Amor steroid 2009 TK near-Earth flyby (0.073 AU)
3rd Apollo Asteroid 469219 (2016 HO3) closest approach to Earth (0.155 AU)
3rd History: first successful test launch of the German A-4 rocket (V-2) (1942)
3rd History: launch of the fifth Mercury flight, piloted by astronaut Walter Schirra (1962)
3rd History: fall of the Zagami Martian meteorite in Katsina Province, Nigeria; the meteorite is classified as a Shergottite and is the largest single individual Mars meteorite ever found at 40 pounds (1962)
3rd History: fall of the Chassigny Martian meteorite in Haute-Marne province, France; the meteorite is distinctly different from other Martian meteorites (shergottites and nakhilites) and is classified as its own subgroup - "chassignites" (1815)
4th History: Japanese lunar probe "Selenological and Engineering Explorer" (SELENE) enters lunar orbit; also known as Kaguya, the spacecraft was designed to study the geologic evolution of the Moon (2007)
4th History: SpaceShipOne rockets to an altitude of almost 70 miles to win the $10 million Ansari X Prize (2004)
4th History: launch of Luna 3; Soviet spacecraft was first to photograph the far side of the Moon (1959)
4th History: launch of Sputnik 1, world's first artificial satellite (1957)
5th Moon at perigee (closest distance to Earth)
5th Neil deGrasse Tyson's 60th birthday (1958)
5th History: Edwin Hubble's discovery of Cepheid Variable Star V1, a special class of variables that can be used measure large cosmic distances (1923)
5th History: launch of the space shuttle Challenger (STS-41-G), crew included astronaut Kathryn Sullivan, first American women to walk in space (1984)
5th History: Robert Goddard born, founding father of modern rocketry (1882)
6th History: Asteroid 2008 TC3 discovered by astronomers on Mt. Lemmon less than 24 hours before exploding over the Sudan. The McCarthy Observatory submitted the last accepted observation. Fragments of the asteroid were eventually recovered. (2008)
6th History: launch of the space shuttle Discovery and the solar polar orbiter spacecraft Ulysses (1990)
7th Apollo Asteroid 2006 HE2 near-Earth flyby (0.096 AU)
8th New Moon
8th Kuiper Belt Object 2008 ST291 at Opposition (60.017 AU)
8th History: discovery of Supernova 1604 (Kepler's Nova) (1604)
9th Draconids Meteor Shower peak (produced by debris from Comet Giacobini-Zinner)
9th History: LCROSS impacts crater Cabeus near the Moon's south pole in search of water (2009)
9th History: Peekskill meteorite fall; 27 pound meteorite hits a 1980 Chevy Malibu sitting in its driveway in Peekskill, NY (1992)
10th History: inauguration of the Very Large Array, one of the world's premier astronomical radio observatories; located west of Socorro, New Mexico (1980)
10th History: enactment of the Outer Space Treaty: 1) prohibited placement of nuclear and other weapons of mass destruction in orbit, on the Moon or other celestial body and 2) limited the use of the Moon and other celestial bodies to peaceful purposes (1967)

Astronomical and Historical Events (continued)

10th History: discovery of Neptune's moon Triton by William Lassell (1846)
11th Scheduled launch of a Russian Soyuz spacecraft from the Baikonur Cosmodrome in Kazakhstan to the International Space Station with the next Expedition crew
11th Apollo Asteroid 2015 HG182 near-Earth flyby (0.013 AU)
11th History: NASA's historic 100th space shuttle flight as Discovery carries the Z1 Truss (first piece of the ISS structural backbone) into space (2000)
11th History: Magellan spacecraft burns up in the Venusian atmosphere after completing its mission to map the planet with its imaging radar (1994)
11th History: launch of first manned Apollo mission (Apollo 7) with astronauts Schirra, Eisele and Cunningham (1968)
11th History: launch of WAC Corporal, first man-made object (16 foot rocket) to escape Earth's atmosphere (1945)
12th History: launch of Voskhod 1; Soviet spacecraft was first to carry multiple (3) cosmonauts (a pilot, scientist and physician) into space. Due to the cramped conditions the crew flew without spacesuits, ejection seats, or an escape tower (1964)
12th History: first Symposium on Space Flight held at the Hayden Planetarium in New York City; participants included Wernher von Braun, Willy Ley, and Fred L. Whipple; topics included an orbiting astronomical observatory, survival in space, circumlunar flight, a manned orbiting space station, and the question of sovereignty in outer space (1951)
13th Second Saturday Stars at the McCarthy Observatory (7:00 PM)
13th Kuiper Belt Object 303775 (2005 QU182) at Opposition (51.857 AU)
13th History: launch of Shenzhou 6, China's second manned spacecraft (2005)
13th History: launch of Explorer 7; spacecraft measured solar X-rays, energetic particles, and cosmic rays (1959)
13th History: formation of the British Interplanetary Society by Phillip Cleator in Liverpool (1933)
14th Apollo Asteroid 2012 CU near-Earth flyby (0.061 AU)
14th Aten Asteroid 2016 TH10 near-Earth flyby (0.061 AU)
14th Apollo Asteroid 4450 Pan closest approach to Earth (0.862 AU)
14th Kuiper Belt Object 19308 (1996 TO66) at Opposition (46.447 AU)
14th History: three main belt asteroids discovered by the McCarthy Observatory while searching for NEOs. 2003 TG10 (its provisional name) was subsequently named after Monty Robson (115449 Robson), the founder and director of the observatory (2003)
14th History: launch of Shenzhou 5, first Chinese manned spacecraft (2003)
14th History: Air Force Captain Chuck Yeager breaks the sound barrier in the Bell X-1 rocket plane (called "Glamorous Glennis" as a tribute to his wife). The plane reached a speed of 700 miles per hour after being launched from the bomb bay of a Boeing B-29 (1947)
15th Centaur Object 2015 JH1 at Opposition (6.532 AU)
15th History: launch of the Cassini spacecraft to the planet Saturn (1997)
16th First Quarter Moon
16th Mars Winter Solstice (northern hemisphere)
16th Apollo Asteroid 2016 UO41 near-Earth flyby (0.096 AU)
16th History: launch of GOES 1, first weather satellite placed in geosynchronous orbit (1975)
18th History: launch of the space shuttle Atlantis (STS-34) and Galileo spacecraft to Jupiter (1989)
17th Moon at apogee (furthest distance from Earth in its orbit)
17th Aten Asteroid 2014 US7 near-Earth flyby (0.008 AU)
18th Scheduled launch of the BepiColombo spacecraft (Mercury orbiters) from the Kourou launch facility in French Guiana. BepiColombo will embark on a seven-year journey to Mercury, carrying with it European Space Agency and the Japan Aerospace Exploration Agency orbiters

Astronomical and Historical Events (continued)

18th Apollo Asteroid 2016 GC221 near-Earth flyby (0.022 AU)
18th Aten Asteroid 2013 UG1 near-Earth flyby (0.027 AU)
18th Apollo Asteroid 5143 Heracles closest approach to Earth (1.881 AU)
18th Dwarf Planet 136199 Eris at Opposition (95.121 AU)
18th History: discovery of Chiron by Charles Kowal; Chiron has the characteristics of both a comet and an asteroid. These types of objects are called Centaurs after a mythological being that are half human/half horse (1977)
18th History: Soviet spacecraft Venera 4 enters the atmosphere of Venus; first probe to analyze the environment (in-situ) of another planet (1967)
18th History: discovery of Asteroid 8 Flora by John Hind (1847)
19th Apollo Asteroid 2009 UC19 near-Earth flyby (0.052 AU)
19th Kuiper Belt Object 202421 (2005 UQ513) at Opposition (47.147 AU)
19th History: launch of the IBEX (Interstellar Boundary Explorer) (2008)
19th History: flyby of the planet Venus by the Mariner 5 spacecraft (1967)
19th History: Subrahmanyan Chandrasekhar born; awarded Nobel Prize in Physics (1983) for studies of the structure and evolution of stars; NASA named its premier X-ray observatory the Chandra X-ray telescope in his honor (1910)
20th International Observe the Moon Night
20th Aten Asteroid 3362 Khufu closest approach to Earth (1.336 AU)
20th History: launch of the Soviet spacecraft Zond 8; moon flyby mission (1970)
20th History: discovery of asteroid 577 Rhea by Max Wolf (1905)
21th Orionids Meteor Shower peak (produced by debris from Comet Halley)
21th Apollo Asteroid 2017 UG near-Earth flyby (0.100 AU)
21st History: NASA's Mars Atmosphere and Volatile Evolution (MAVEN) spacecraft successfully entered orbit around Mars - first spacecraft dedicated to studying the Martian atmosphere and its connection to the Red Planet's climate (2014)
21th History: dedication of the Yerkes Observatory in Williams Bay, Wisconsin; home of the world's largest refractor with its 40-inch objective lens ground and polished by Alvan Clark and Sons (1897)
22th History launch of Chandrayaan-1, India's first mission to the Moon (2008)
22th History: Soviet spacecraft Venera 9 touches down on Venus and transmits first pictures (black and white) of its surface (1975)
22th History: launch of the Soviet Moon orbiter Luna 12 to take high-resolution photos of the Moon's surface from lunar orbit (1966)
23rd Uranus at Opposition, rising with the setting Sun and highest in the sky at midnight
23rd Amor Asteroid 2016 TS55 near-Earth flyby (0.087 AU)
23rd Aten Asteroid 2014 UR near-Earth flyby (0.091 AU)
23rd Atira Asteroid 413563 (2005 TG45) closest approach to Earth (0.424 AU)
23rd Kuiper Belt Object 308379 (2005 RS43) at Opposition (42.741 AU)
23rd History: India's Mars Orbiter Mission (MOM) entered orbit around Mars (2014)
23rd History: first time female commanders led orbital missions at the same time: Pamela Melroy commanded space shuttle Discovery (STS-120) to the ISS while Peggy Whitson led the Expedition 16 team aboard the ISS in the installation of a new orbital node (2007)
24th Full Moon
24th Apollo Asteroid 2004 FW1 near-Earth flyby (0.065 AU)
24th Apollo Asteroid 2017 UO7 near-Earth flyby (0.099 AU)

Astronomical and Historical Events (continued)

24th Apollo Asteroid 2017 UO7 near-Earth flyby (0.099 AU)
24th Apollo Asteroid 217628 Lugh closest approach to Earth (0.682 AU)
24th History: launch of Chang'e-1, Chinese lunar orbiter, from the Xichang Satellite Launch Center in the southwestern province of Sichuan (2007)
24th History: Mars Odyssey enters orbit around Mars (2001); science goals included mapping the elemental composition of the surface
24th History: launch of Deep Space 1; first of a series of technology demonstration probes developed by NASA's New Millennium Program; propulsion was provided by a xenon ion engine that operated for a total of 16,265 hours (1998)
24th History: Over 100 people killed in a launch pad explosion when Air Marshal Mitrofan Nedelin, commander of the USSR's Strategic Rocket Forces, orders workers back to the pad to repair a defective R-16 missile without first unloading the unstable fuel (1960)
24th History: discovery of Uranus' moons Umbriel and Ariel by William Lassell (1851)
25th Apollo Asteroid 2017 UH8 near-Earth flyby (0.058 AU)
25th Amor Asteroid 153591 (2001 SN263) (2 Moons) closest approach to Earth (1.091 AU)
25th History: launch of the twin Solar Terrestrial Relations Observatories (STEREO A and B); 3-D studies of the Sun and coronal mass ejections (2006)
25th History: Soviet spacecraft Venera 10 touches down on Venus 2,200 km from its twin Venera 9; lands on a flat boulder that was determined to be similar in composition to basalt on Earth (1975)
25th History: discovery of Saturn's moon Iapetus by Giovanni Cassini (1671)
27th Kuiper Belt Object 55636 (2002 TX300) at Opposition (41.690 AU)
27th History: first test flight of the Saturn I rocket (1961)
28th Centaur Object 20461 Dioretsa at Opposition (29.433 AU)
28th History: first (and last) test flight of the Ares I-X rocket; a two minute powered suborbital flight (2009)
29th Aten Asteroid 475534 (2006 TS7) near-Earth flyby (0.019 AU)
29th Aten Asteroid 302169 (2001 TD45) near-Earth flyby (0.099 AU)
29th Aten Asteroid 3753 Cruithne closest approach to Earth (0.542 AU)
28th History: launch of Prospero spacecraft, Great Britain's first space launch (1971)
29th History: launch of the space shuttle Discovery (STS-95) with astronaut and then U.S. Senator, John Glenn (1998)
29th History: flyby of asteroid Gaspra by the Galileo spacecraft on mission to Jupiter (1991)
30th Scheduled launch of a Russian Progress spacecraft from the Baikonur Cosmodrome in Kazakhstan to the International Space Station with equipment and supplies
30th History: discovery of the Los Angeles (Mars) Meteorite (1999)
30th History: launch of Venera 13, Soviet Venus lander; lander survived for 127 minutes on the surface where the temperature was recorded at 855 °F (1981)
30th History: Mercury Theatre broadcasts Orson Welles' adaptation of H.G. Wells "War of the Worlds" (1938)
31st Last Quarter Moon
31st Moon at perigee (closest distance to Earth)
31st Amor Asteroid 2016 WZ7 near-Earth flyby (0.066 AU)
31st Kuiper Belt Object 42301 (2001 UR163) at Opposition (52.008 AU)
31st History: Walter Baade's discovery of the first Centaur Object, 944 Hidalgo (1920)
31st History: birthday of Apollo 11 Command Module pilot Michael Collins (1930)
31st History: first rocket engine tests by three young rocketeers that would be the beginning of what would become the Jet Propulsion Laboratory (1936)

Commonly Used Terms

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

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/Iridium Satellites

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

Solar Activity

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

NASA's Global Climate Change

Vital Signs of the Planet: https://climate.nasa.gov/

Lagrange Points

Five locations discovered by mathematician Joseph Lagrange where the gravitational forces of the Sun and Earth (or other large body) and the orbital motion of the spacecraft are balanced, allowing the spacecraft to hover or orbit around the point with minimal expenditure of energy. The L2 point (and future location of the James Webb telescope) is located 1.5 million kilometers beyond the Earth (as viewed from the Sun).

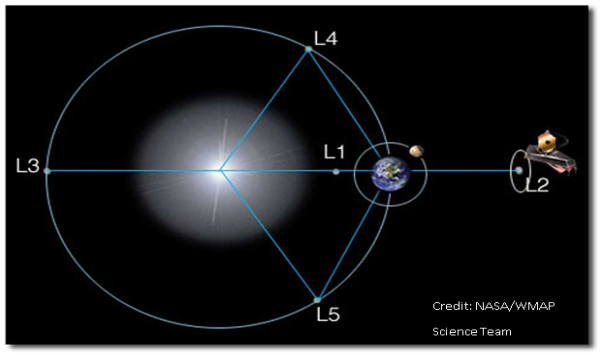


Image Credits

Front page design and graphic calendar: Allan Ostergren

Second Saturday Stars poster: Marc Polansky

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

Front Page Image

For as long as humans have gazed out at the heavens their eyes settled on objects and features that give meaning or identity to them. On a broader scale, distant galaxies take on shapes and colors illustrated by the tools of observation—infrared, radio, ultraviolet, x-ray or other technologies. And when an artist is assigned to render an image, these visual traits are all blended into a composite and wordsmiths are engaged to give interpretive meaning to the curious public.

The cover image is of the Ghost Nebula, a reflection nebula within the constellation *Cepheus* in the northern sky. Reflection nebulae are not themselves luminous, but their scattered dust absorbs light from nearby stars, reflecting it back into the cosmos in an endless variety of shapes and forms.

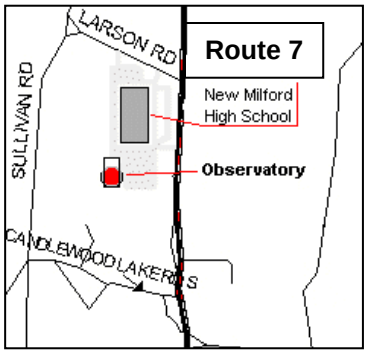
Source: *https://apod.nasa.gov/apod/ap161116.html*.

Contact Information

The John J. McCarthy Observatory
P.O. Box 1144
New Milford, CT 06776

New Milford High School
388 Danbury Road
New Milford, CT 06776

Phone/Message: (860) 946-0312
www.mccarthyobservatory.org



www.mccarthyobservatory.org

@McCarthy Observatory

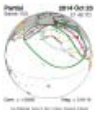
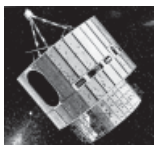
@McCarthy Observatory

mccarthy.observatory@gmail.com

@JJMObservatory

October 2018

Celestial Calendar

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
	1  NASA created by the National Aeronautics and Space Act (1958)	**2**  Hayden Planetarium founded (1935)	**3** Launch of Mercury-Atlas 8 with Walter Schirra (1962)   Chassigny meteorite, determined origin of Mars (1815) Zagami Martian meteorite in Katsina Province, Nigeria (1962) 	**4**  Luna 3; Soviet spacecraft, first to photograph the far side of the Moon (1959) SpaceShipOne, 70 miles up, to win Ansari X Prize (2004)   World Space Week, Oct. 4-10 "The Era of Deep Space Discovery" Launch of first manned Apollo mission (1968) 	**5** Draconids meteor shower peak   Robert Goddard born, founding father of modern rocketry (1882)	**6**  Launch of space shuttle Discovery and solar polar orbiter spacecraft Ulysses (1990) Asteroid 2008 TC3, tracked by McCarthy Observatory, explodes over Sudan (2008) 
7  Launch of Explorer 6, with "paddlewheel satellite," a photocell scanner transmitting a crude picture of the earth's surface and cloud cover (1959))	**8**  Discovery of Supernova 1604 - Kepler's Nova (1604) Pioneer Venus orbiter concludes mission and begins fiery plunge into Venusian atosphere (1992)  Total Lunar Eclipse, with totality beginning shortly before sunrise on the east coast 	**9**  LCROSS impacts Moon's south pole (2009)   Peekskill meteorite hits Chevy Malibu (1992)	**10** Enactment of outerspace treaty (1967)   Inauguration of the Very Large array in New Mexico (1980)	**11**  WAC Corporal, first rocket to escape Earth's atmosphere (1945) 100th space shuttle flight carries Z1 Truss, backbone of the ISS (2000) 	**12**  First symposium on space travel, held at Hayden Planetarium (1951)  Launch of Voskhod 1, Soviet spacecraft, first to carry multiple cosmonauts (1964)	**13**  Launch of Explorer 7 spacecraft (1959) Launch of Shenzou 6, China's 2nd manned spacecraft (2005)   British Interplanetary Society founded (1933) 2nd Saturday Stars Open House McCarthy Observatory 
14  Launch of Shenzou 5, China's 1st manned spacecraft (2003) Chuck Yeager breaks sound barrier (1947)   Three main belt asteroids discovered by McCarthy Observatory (2003)	**15** Dwarf Planet Eris (formally 2003 UB313 and/or Xena) at Opposition (95.542 AU)   Launch of Cassini spacecraft to planet Saturn (1997)	**16**  Launch of GOES 1, first weather satellite in geosynchronous orbit (1975)	**17** Moon at Apogee (farthest from earth)   Mae Carol Jemison born, American physician and NASA astronaut; became first black woman in space aboard the Shuttle Endeavour on September 12, 1992; has appeared on television several times, including an episode of *Star Trek: The Next Generation.* (1956)	**18**  Soviet spacecraft Venera 4 probes atmosphere of Venus; (1967) Discovery of Asteroid 8 Flora by John Hind (1847)  Discovery of asteroid/ comet Chiron in Taurus by Charles Kowal (1977) Launch of space shuttle Atlantis and Galileo spacecraft to Jupiter (1989) 	**19** launch of IBEX (Interstellar Boundary Explorer) to explore the edge of solar system (2008) Subrahamanyan Chandrasekar wins Nobel physics prize for study of star evolution (1983) 	**20** Discovery of asteroid 577 Rhea by Max Wolf (1905) Launch of Soviet spacecraft Zond 8, Moon flyby mission (1970)
21 Opening of the Yerkes Observatory, Williams Bay, Wisonsin, with world's largest refractor lens (40") (1897) Orionids meteor shower peak	**22** Soviet spacecraft Venera 9 lands on Venus, takes first b/w pictures of Venus' surface(1975) Launch of the Soviet orbiter Luna 12 to take high-resolution photos of the Moon's surface from lunar orbit (1966) Launch of India's first Moon mission Chandrayaan-1 (2008) 	**23** Partial Solar Eclipse, visible from eastern United States Pamela Melroy and Peggy Whitson first women to lead two missions at same time (shuttle and space station) (2007)	**24** Launch of Deep Space 1 (1998) Launch of Chang'e-1, Chinese lunar orbiter (2007) Discovery of Uranus' moons Umbriel and Ariel by William Lassell (1851)	**25** Discovery of Saturn's moon Iapetus by Giovanni Cassini (1671) Launch of twin Solar Terrestrial Relations Observatories (STEREO A&B) for 3-D studies of Sun (2006) Soviet spacecraft Venera 10 touches down on Venus (1975)	**26** Soviet Union releases first images of the far side of the Moon, taken by Luna III spacecraft, showing a more mountainous terrain than seen from Earth and only two dark, low-lying regions. (1959)	**27** first test flight of the Saturn I rocket (1961) Cañon City, Colorado meteor hits garage - 1973
First test flight of the Ares I-X rocket; a two minute powered suborbital flight (2009) **28** Launch of Prospero, Britain's first space mission (1971) Interna-tional Observe the Moon Night	**29** Launch of space shuttle Discovery (STS-95) with astronaut and former senator John Glenn (1998) Flyby of asteroid Gaspra by the Galileo spacecraft on mission to Jupiter (1991)	**30** Mercury Theatre War of Worlds broadcast with Orson Welles produces panic(1938) Discovery of the Los Angeles (Mars) Meteorite (1999) Launch of Venera 13, Soviet Venus lander; survived for 127 minutes on the surface where the temperature was recorded at 855 °F (1981) 	**31** Apollo 11 Command module pilot Michael Collins born (1930) First rocket engine tests that spawned the Jet Propulsion Laboratory (1936) 	**Phases of the Moon** Oct 8 Oct 16 Oct 24 Oct 31