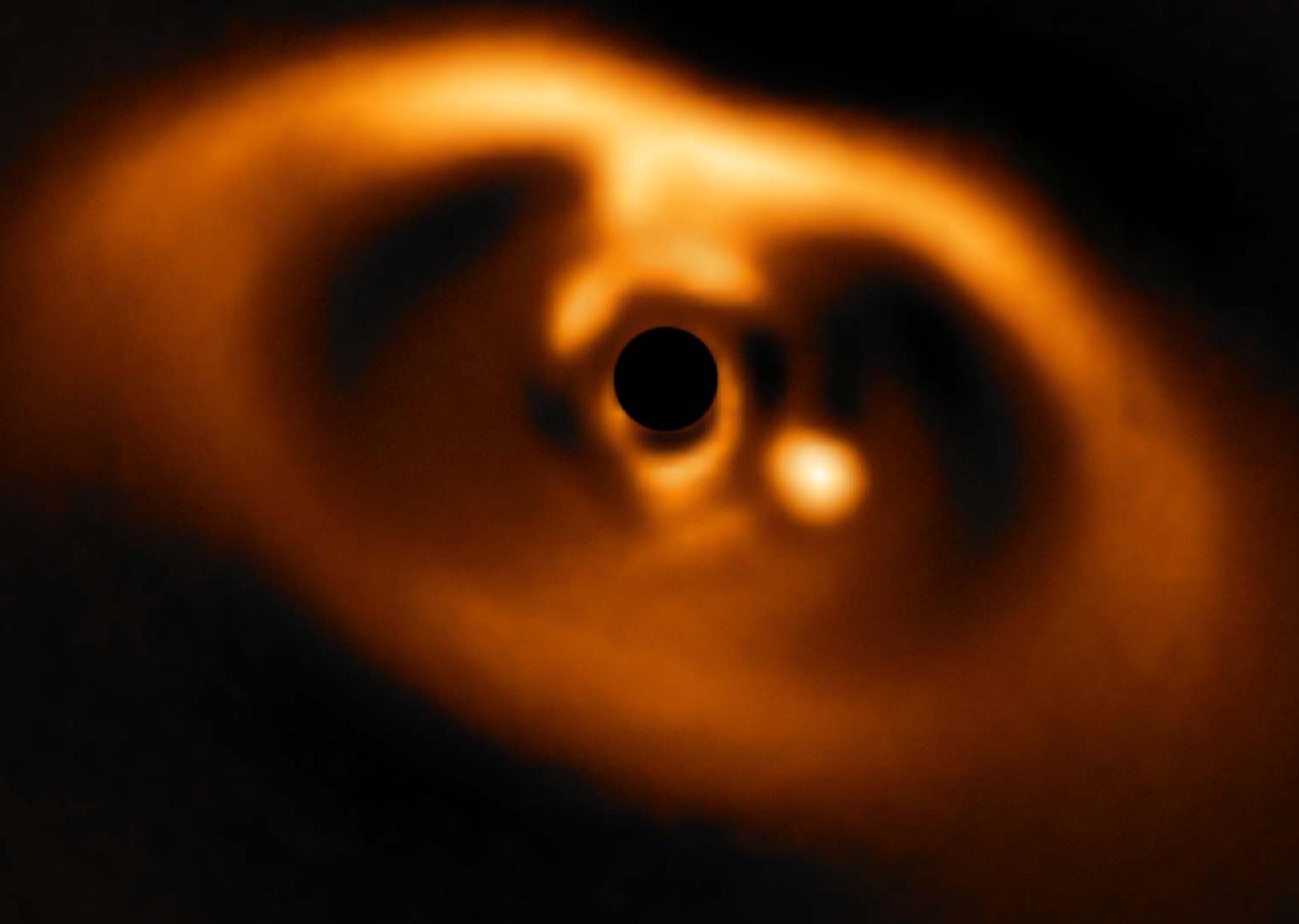


Galactic Observer

John J. McCarthy Observatory

Volume 12, No. 6

June 2019



A PLANET IS BORN

See page 18 inside

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	Peter Gagne	Marc Polansky
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Managing Editor

Bill Cloutier

Production & Design

Allan Ostergren

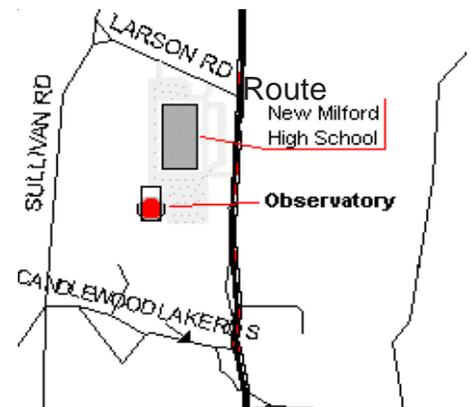
Website Development

Marc Polansky

Technical Support

Bob Lambert

Dr. Parker Moreland

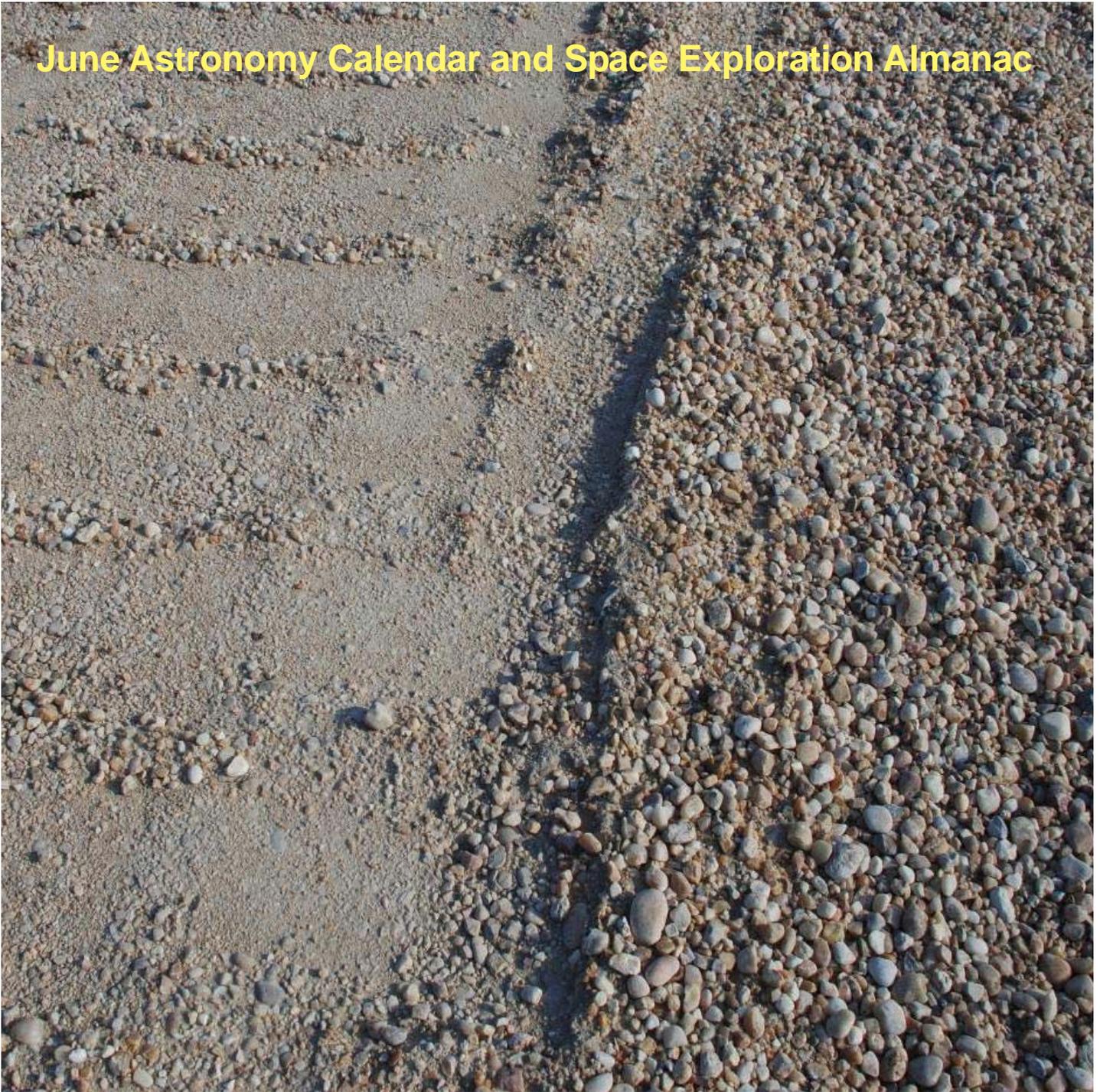


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June Astronomy Calendar and Space Exploration Almanac



The Road to the Moon

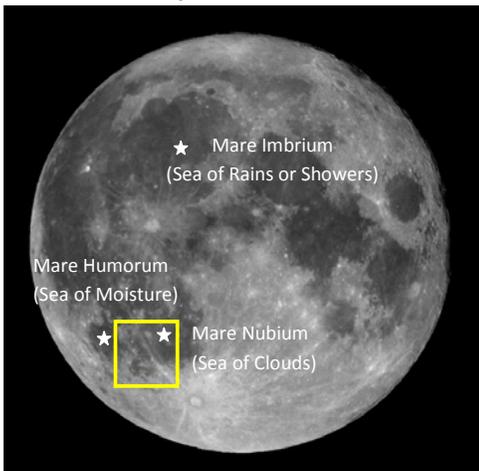
Launch Pad 39A is approximately 3.4 miles (5.5 km) from the Vehicle Assembly Building where the mighty Saturn V rocket was assembled. Two behemoth crawlers, each weighing 6.6 million pounds were built in 1965 to carry the Saturn V and its mobile launch pad to the launch site. The crawlers, able to carry up to 18 million pounds, move at a leisurely one mile per hour along a road specially built to handle the load. The road has an overall width of 130 feet (40 meters) and has two 40-foot-wide (12 meters) lanes separated by a 50-foot (15 meter) median. The average depth of the roadway is 7 feet (2 meters) with the top 4-8 inches (10.16-20.32 cm) comprised of Alabama river rock to reduce surface friction.

Photo Credit: Bill Cloutier

June Astronomy Calendar and Space Exploration Almanac

Out the Window on Your Left

It's been more than 45 years since we left the last footprint on the dusty lunar surface. As a nation founded on exploration and the conquest of new frontiers, today's commitments have been as fleeting as the funding. But, what if the average citizen had the means to visit our only natural satellite; what would they see out the window of



Lunar seas are actually expansive low-lying plains formed by ancient lava flows.

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).

The Sun is rising on Mare Nubium (Sea of Clouds) in this month's image. It was an area first targeted by NASA's Lunar Reconnaissance Orbiter's camera (LROC) when the spacecraft arrived on orbit in 2009. The impact basin in which the mare resides has a diameter of approximately 430 miles (690 km) and is older than the nearby Imbrium and Humorum basins.

Impacts, such as the one that created Bullialdus crater (38 miles or 61 km in diameter), have excavated rock from beneath the relatively thin mare (estimated at less than 1,600 feet or 500 meters

thick). Starting at Bullialdus, lunar observers can locate the flooded crater Kies (28 miles or 46 km in diameter) to the south, along the basin's edge. In the

mare east of Kies crater is the lava dome Kies (Pi). The dome is approximately 6 miles wide (10 km), with gently sloping sides and a distinct caldera,



East - West profile of Kies Pi Dome. Credit: LROC Quickmap.

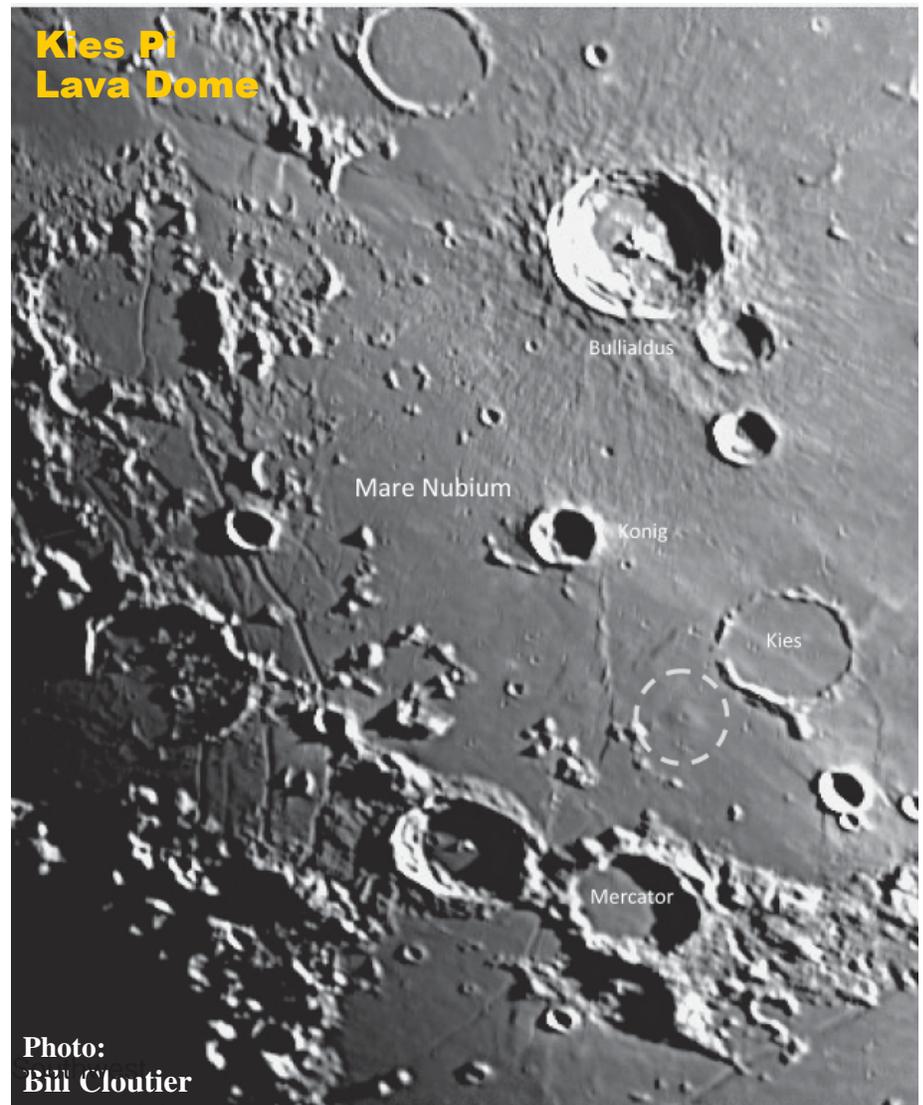


Photo:
Bill Cloutier

similar in appearance to shield volcanoes on Earth.

Lunar domes likely formed during the later stages of lunar volcanism. They range in size from 5 to 8 miles (8 to 12 km) in

diameter and 600 to 700 feet high (200 meters). Shield volcanoes form when lava, with a low viscosity that allows it to flow easily, begins cool and crystalize, building up over time around

vents and fissures. Accumulating lava flows form a broad mound until the source of magma is exhausted and/or retreats. Collapse of magma lakes or pools create pits near the summit.

Jupiter at Opposition

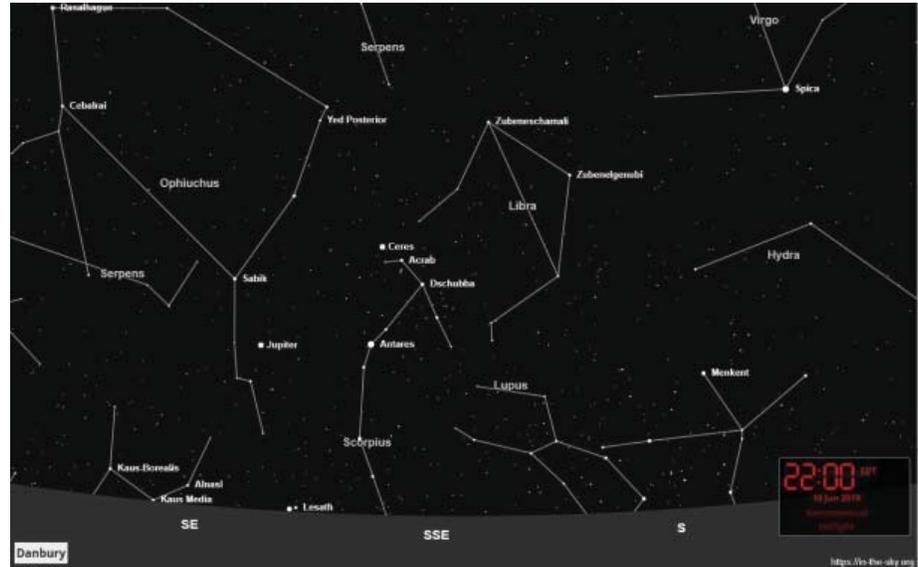
Jupiter rules the evening sky in the month of June the gas giant approaches Opposition on the 10th. (Opposition occurs for a planet further from the Sun than the Earth, when it is opposite the Sun in the Earth's sky, rising at sunset and setting at sunrise). At the start of the month, Jupiter rises in the southeast just before 9 pm EDT (forty minutes after sunset). By month's end, the largest planet in the solar system is above the horizon two hours before the sun sets.

On June 10th, the gas giant will be visible all night and at its highest in the sky around 1 am local time. With an orbital period of 11.86 years, Jupiter aligns with the Earth and Sun every 399 days. This year, the gas giant can be found in the constellation Ophiuchus, just to the east of the star Antares, and shining at a bright -2.6 magnitude.

Artemis

Jim Bridenstine, NASA's Administrator, has revealed the name for the agency's latest attempt to return to the Moon. In keeping with the mythological theme of the original project, the new endeavor will be called Artemis after Apollo's sister. Artemis was the Greek goddess of the Moon, as well as the hunt.

The Artemis program consolidates the individual components, including the Space Launch System's heavy-lift rocket, Orion crew vehicle and Gateway lunar outpost. To meet the goal of landing astronauts at the Moon's south pole by 2024, the current admin-



The evening sky on the night of Opposition, looking south-southeast from the Danbury, Connecticut area. Source: Graphics: In-the-Sky.org, © Dominic Ford



The 200-foot-tall liquid hydrogen tank for the Space Launch System in a test stand at NASA's Marshall Space Flight Center in Huntsville, Alabama. Image Credit: NASA/Tyler Martin

istration has added \$1.6 billion in funding to NASA's 2020 budget. The funding will be used to accel-

erate work, in particular, on the lunar landing system. To meet the 2024 date, the first missions

would be short-term stays—the goal of establishing a long-term presence will be deferred to 2028.

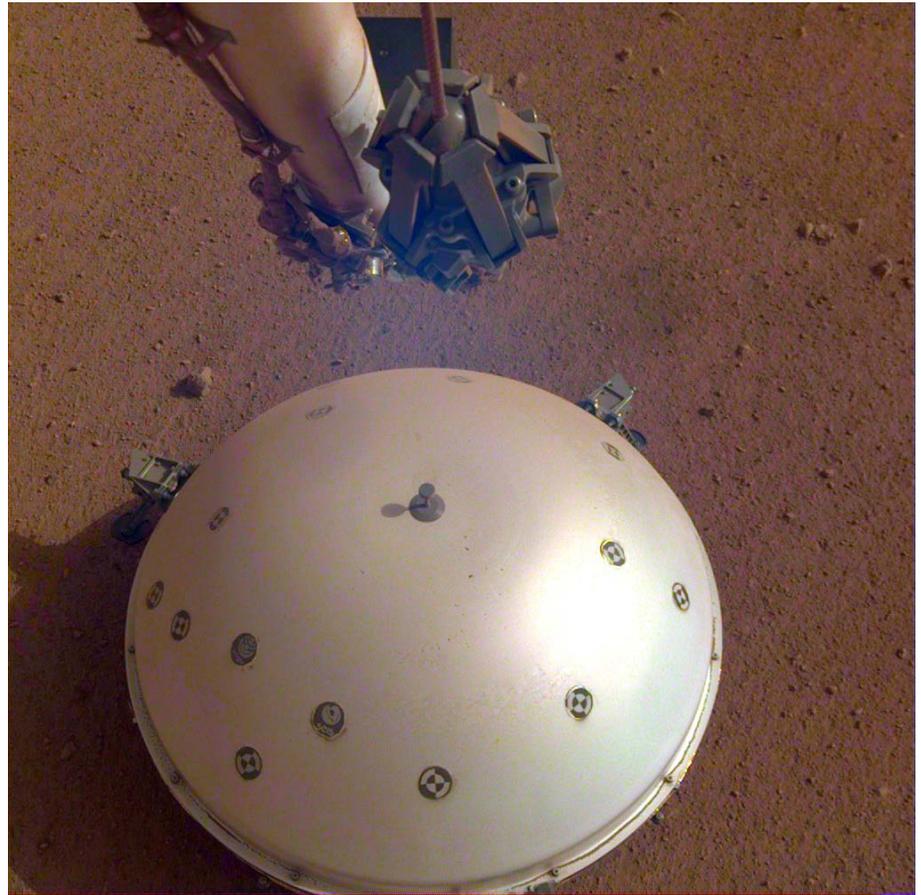
Mars Rumble

The seismometer deployed by NASA's InSight lander has detected several faint tremors, but the seismic signal detected on April 6 was different and appeared to have originated from inside the planet (as opposed to surface forces such as the wind). The signal was too faint to reveal any tangible data on the interior of Mars, but the signal did match the profile of moonquakes detected by the instrumentation left behind by the Apollo astronauts. Neither Mars nor the Moon have tectonic plates, so quakes would likely be caused by the cooling and contraction of their interiors, which would induce stress. Quakes occur when that pent-up stress is released.

MARSHA

AI SpaceFactory placed first (out of 60 competitors) in NASA's "3D Printed Habitat Challenge." The company was awarded \$500,000 for the successful construction of a 15-foot-tall scale model Mars habitat called MARSHA. The habitat was "printed" in 30 hours using a biopolymer basalt composite. The final product withstood NASA's pressure, smoke, and impact tests. The material used by AI SpaceFactory was found to be stronger and more durable than the concrete used by some of its competitors.

AI SpaceFactory's building material is a comprised of a basaltic fiber that can be processed from natural materials found on Mars and renewable bioplastic (polylactic acid, or PLA) derived from plants



The lander's Seismic Experiment for Interior Structure (SEIS) instrument is protected by the domed Wind and Thermal Shield visible in the image. Credit: NASA/JPL-Caltech



The MARS Habitat, MARSHA shown full-scale. The interior would feature multiple living and working areas with windows providing natural light. © AI SpaceFactory and Plomp

that could be grown on Mars. The 3-D printed structure ranked high in overall strength and its plastic component effective as a shield

Moonquakes

The Moon has been long considered a dead world with even the youngest of the lava flows that fill the impact basins dating back several billion years. Now, images captured by NASA's Lunar Reconnaissance Orbiter Camera (LROC) are suggesting more recent activity. In a study released in March, researchers found evidence of much younger, tectonically created features called wrinkle ridges. These features, curved hills and shallow trenches, are created when the lunar surface contracts as the Moon's interior cools. While this process had been thought to have ended billions of years ago, LROC images from the Mare Frigoris (Sea of Cold) suggest that this lunar sea has been cracking and shifting in the relative recent past and may still be doing so today.

The Apollo missions left several seismometers on the lunar system. These instruments recorded thousands of moonquakes between 1969

for ionizing cosmic radiation. PLA is also stable, with a low expansion coefficient, which works well with the basalt fiber,

and 1977. The majority of the quakes occurred deep within the interior, but others were confined to the Moon's crust. Since the Moon doesn't have tectonic plates, internal stress is primarily caused by heat loss and the resulting shrinking. This new research suggests the Moon could still be geologically active.

Wrinkle ridges can run for several miles. The longest one in Mare Frigoris stretches for about 250 miles (400 km) and cuts through older craters (which is an indication of its age). The ridges can rise as much as 1,000 feet (333 meters) above the surrounding surface.

Ryugu Revealed

Japan's Hayabusa2 spacecraft has spent the past year exploring the asteroid Ryugu, collecting a sample of its rugged surface in February. In April, the spacecraft released a copper impactor containing an explosive charge in an attempt to expose subsurface material. Following the release, Hayabusa2 was

yielding a non-toxic, low conductivity building material. Together, they form an effective insulator against the harsh Martian environment.

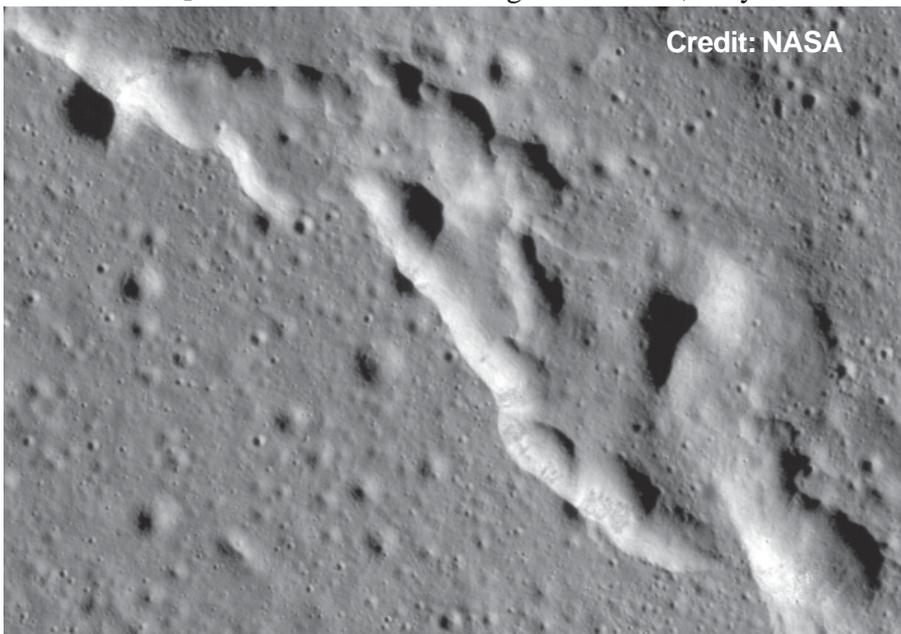
moved to a position behind the asteroid to avoid any debris from the explosion and then to its home position, 12.4 miles (20 km) away.

Now that it is safe to do so, ground controllers have moved the spacecraft closer to the asteroid in a search of the fresh crater. What they found was a crater approximately 66 feet (20 meters) in diameter, twice the size as expected (*see next page*).

Project scientists had planned that the spacecraft would attempt to collect a sample from within the crater, however, a recent attempt to drop a highly reflective navigation marker on the asteroid's surface was automatically aborted 164 feet (50 meters) above the surface. The agency is investigating the cause of the abort, but a similar event that occurred last September was attributed to spacecraft's radar system's difficulty receiving signals for the surface due to the asteroid's low surface reflectivity.

While the spacecraft will not depart for Earth until the end of this year, any sampling attempt would have to be done before that asteroid's surface temperature exceeds 212°F (100°C) where the heat radiated by the asteroid that could be damaging to the spacecraft (Ryugu is nearing perihelion, its closest approach to the Sun in its orbit). With one successful sampling attempt earlier this year, JAXA is evaluating the risk on a second attempt.

Hayabusa2 is scheduled to fly by Earth in December 2020 at which time it will release a sample return capsule. The capsule will land under parachute in the Woomera Test Range, in south Australia.



LROC image of relatively young wrinkle ridges in Mare Frigoris.

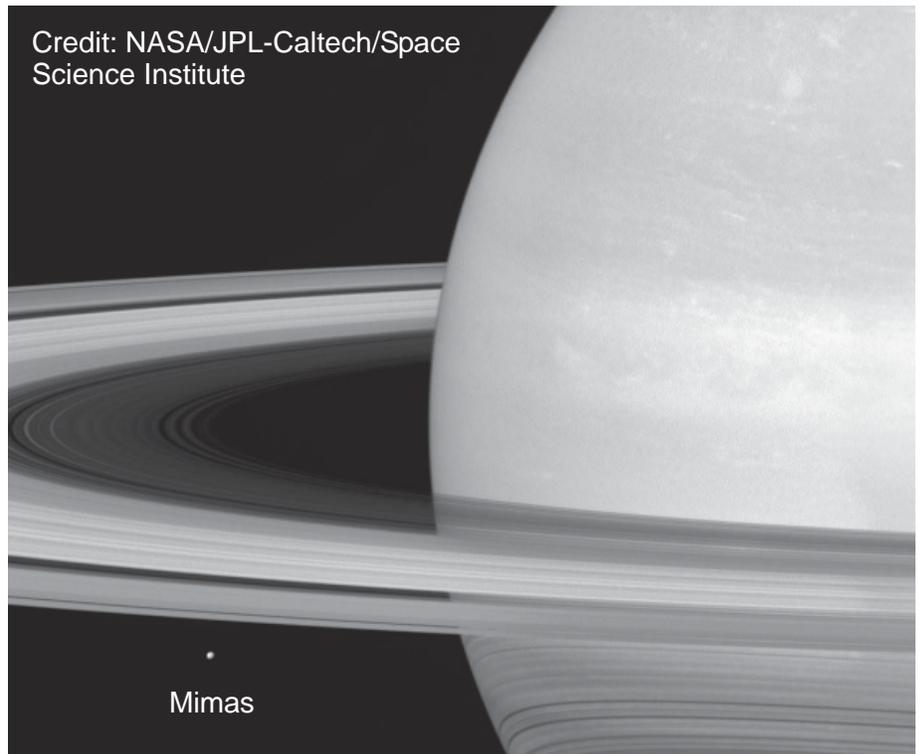


The surface of Ryugu, pre- and post-impact showing the newly excavated surface.
Credit: Japan Aerospace Exploration Agency

Does the Solar System Need to be Protected from Earthlings?

The exploitation of Earth's resources has left its mark on the environment and, in some instances, changed the landscape. As we start to expand our presence in the solar system, should we worry about the exploitation of other worlds? Should Saturn's rings be afforded the same protection as the Grand Canyon or a World Heritage Site?

As space becomes more accessible to entrepreneurs and teleoperation of robots on other worlds with virtual reality technology matures, precious metals, minerals and other valuable materials, including helium-3 and water ice, will be the most likely targets for off-world mining operations. In one analysis, an eighth of the solar system's most accessible resources could be exhausted in as little as 400 years. It might be time to start the discussion on how best to proceed.



Credit: NASA/JPL-Caltech/Space Science Institute

Mimas

Saturn and Mimas. The rings, comprised primarily of water ice, could be exploited for rocket fuel, oxygen and drinking water by future explorers. While looming large, the rings contain relatively little mass - about 40% of the mass of Mimas. Would mining the rings spoil one of nature's majestic wonders?

Summertime Sights

The constellation Sagittarius (the Archer) graces the southern

JJMO

summer evening sky. The center of our Milky Way galaxy lies in the direction of Sagittarius.

<http://www.mccarthyobservatory.org>

Surrounding the galaxy's core is a halo of older stars and many compact, spherical groupings of stars, called globular clusters. One of the most centrally concentrated globular clusters is Messier 75 (designated such as it was catalogued by Charles Messier in 1780). The cluster is 67,000 light years from the Earth and contains approximately 400,000 stars. The stars in the cluster are believed to be 13 billion years old and are mostly low-mass red stars and intermediate-mass yellow stars.

The cluster is located in the western part of Sagittarius. With a dense core, it is an easy object to locate for binoculars and small telescopes at magnitude 8.6, however, a larger telescope is needed to resolve individual stars. The best month to observe the cluster is in August.



Messier 75 as captured by the NASA/ESA Hubble Space Telescope's Advanced Camera for Surveys. Credit: ESA/Hubble & NASA, F. Ferraro et al.

Charles Messier catalogued 29 globular clusters (there are 150 known clusters in the Milky Way Galaxy). Brighter ones, like Messier 13 in the constellation

Hercules (northern hemisphere) and Omega Centauri in Centaurus (southern hemisphere), can be seen on a dark night without any optical aid.

Remembering Opportunity

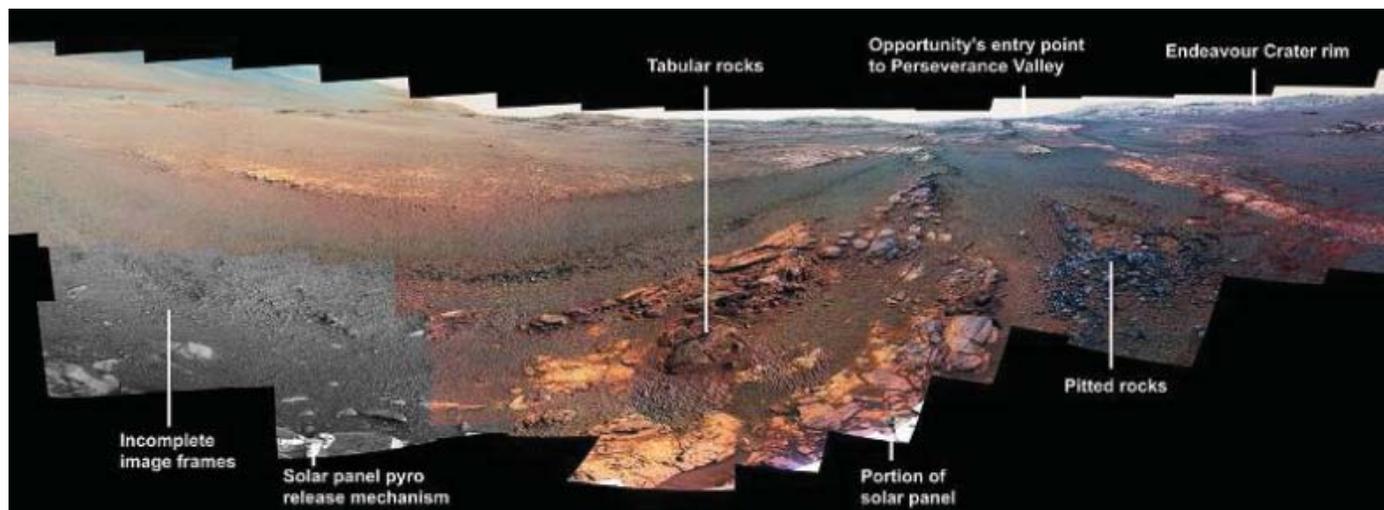
One year ago, the Mars Exploration Rover, Opportunity, was crossing Perseverance Valley, an opening in the western rim of the crater Endeavour that appeared to have been formed by running water. The rover was working on a panorama when it was engulfed by a global dust storm. The rover's last

transmission was received on June 10th.

The panorama is composed of 354 images and is presented in false color to accentuate the differences in materials. A portion of the final image is in black and white as Opportunity was unable to complete a full set of images through

the Panoramic Camera's three filters before the storm arrived.

Perseverance Valley runs about 600 feet (180 meters) from crater rim to crater floor. The rocky outcrop, called "Ysleta del Sur," is about 23 feet (7 meters) distant from the camera, while the crater's rim is about 250 feet (76 meters)



Endeavour Crater from Perseverance Crater. Image Credit: NASA/JPL-Caltech/Cornell/ASU

to the west. The small hill on the rim is 210 feet (64 meters) away.

Opportunity entered the valley on May 20, 2017, on its 4,736 Martian day, or Sol, since landing in January 2004. The tabular rocks, notated in the image, were the last surface feature analyzed by the rover. The final odometer reading for the rover was 28.06 miles (45.16 km). Attempts to reestablish contact with the intrepid explorer (more than 1,000 commands were sent after the dust storm abated) concluded on Sol 5352 (February 12, 2019).

Opportunity, and its twin Spirit, were mobile geologists. Their discoveries contributed to our knowledge of Mars and the premise that the planet was potentially hospitable to life in the past.

Blue Moon

Jeff Bezos, founder of Blue Origin (and Amazon), recently unveiled a life-size mockup of the company's lunar lander, named Blue Moon. The lander is designed to initially carry rovers and other large payloads (several metric tons) to the lunar surface. For crewed missions, a pressurized ascent stage would be added atop the lander's platform.

The lander will be powered by Blue Origin's BE-7 engine which uses liquid oxygen and liquid hydrogen as a propellant. Its precision guidance system will allow it to land anyway on the lunar surface. Blue Origin is one of 11 companies selected by NASA to conduct studies and produce prototypes for crew-rated landers.

The lander competition is part of NASA's return-to-the-Moon initiative (Artemis), with the goal of landing the first American astronauts at the Moon's south pole by 2024 and to establish a permanent presence by 2028.

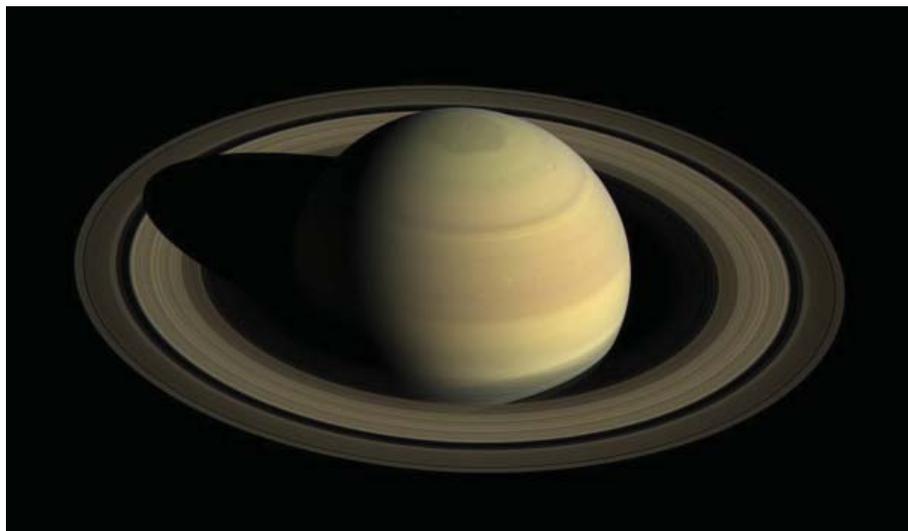


The Blue Moon lunar lander. Credit: Blue Origin

Cassini History

Fifteen years ago, the Cassini-Huygens spacecraft entered orbit around the planet Saturn. The next thirteen years yielded a bounty of scientific data and discoveries that are still being made almost two years after the mission ended. The spacecraft left Earth in 1997 from the Cape Canaveral Air Force Station. Seven years later and after flybys of Venus (2), Earth and Jupiter, Cassini-Huygens arrived at Saturn in June 2004.

The spacecraft's instruments transmitted 635 gigabytes of data throughout its mission, included 453,048 images of the planet, rings and moons. Six named moons were discovered, two oceans (on Titan and Enceladus), 3 seas and hundreds of small lakes (on Titan). The data produced by the mission produced over 4,000 science papers. More than 5,000 people worked on some portion of the project.



Saturn from the Cassini-Huygens spacecraft. The giant hexagon-shaped jet stream around the planet's north pole is visible in this natural-color image. Image credit: NASA/JPL-Caltech/Space Science Institute

Summer Solstice

On the morning of June 21st the Sun will rise over a prehistoric structure on the Salisbury Plain in southern England as it has for the last 4,000 years. For those individuals standing within the 100-foot diameter circle of 30 sandstone or sarsen-stones (weighing up to 50 tons each), the Sun will appear over a large naturally shaped stone (Heel Stone) located outside and to the northeast of the circle. The alignment signals the start of the longest day, midsummer, or the summer solstice.

The photo shows the current state of the stone circle. Many of



Stonehenge
Photo: Bill Cloutier

the original stones are missing or damaged. Over time, they were taken to build houses and roads, chipped away by visitors and taken as souvenirs. What remains represents the last in a progressive sequence of monuments erected at the site between 3,000 and 1,600 B.C. The Heel Stone is adjacent to the access road to the site. The ancient people who constructed this monument left no written record of their accomplishments or the intended use of the stone circle. Its purpose has been widely debated and many groups have attempted to claim ownership. However, archeologists have clearly shown that the construction of Stonehenge predates the appearance of most modern cultures in Britain.

<http://www.mccarthyobservatory.org>

In the 1960s, Gerald Hawkins, an astronomer at the Smithsonian Astrophysical Observatory, found that each significant stone aligns with at least one other to point to an extreme position of the sun or moon ("Stonehenge Decoded," Doubleday & Company). That Stonehenge is an astronomical observatory or celestial calendar is intriguing, as the precision and architectural refinement by which it was constructed certainly suggests a significant purpose for this megalithic monument.

June History Women in Space

On June 16, 1963, Valentina Tereshkova became the first woman in space. Shortly after Yuri Gagarin's flight, the Soviets began a search for suitable female candidates for spaceflight. With few female pilots, the majority of the candidates were women parachutists (Valentina had joined an amateur parachuting club at the age of 18). Control of the Vostok spacecraft was completely automatic, so piloting experience was not required. However, since the Vostok was not designed to return its occupant safely to Earth, the cosmonaut was required to eject from the spacecraft after re-entry and parachute to the landing site.

The selection of Valentina Tereshkova for the flight was made by Premier Khrushchev. In addition to experience and fitness, qualifications included being an ideal Soviet citizen and model Communist Party member. On June 16th, Valentina rode Vostok 6 into orbit with the call sign "Chaika" (Seagull). The mission



was not without incident and included space-sickness, leg cramps and other discomforts from being strapped into the capsule for three days. More importantly, the capsule ended up in the wrong orientation and, had it not been corrected, would not have allowed her to return to Earth.

Valentina's three days in space was more flight time than all the American astronauts combined (at that time). After fulfilling her duties to her country, Tereshkova retired to a small house on the outskirts of Star City. The house is topped with a seagull weathervane, the call sign of her flight.

Twenty years later, on June 18th, Sally Ride became the first American woman in space. Launched aboard the space shuttle Challenger, Sally served as the mission specialist of the five-person crew.



An Extraordinary Feat

If you have ever seen a Gemini space capsule (there is one on display at the Air and Space Museum in Washington, D.C.) it is difficult to comprehend how two people could have spent any length of time inside its cramped interior (Frank Borman and Jim Lovell spent 14 days orbiting the Earth in Gemini 7). The reentry module, where the two astronauts sat, is approximately 11 feet long with a maximum diameter of 7½ feet and filled with instrumentation, life support systems and controls.

On June 3, 1965, Gemini 4 lifted off on a four-day mission. The highlight of the mission was to be a spacewalk by Ed White. NASA was very concerned with "putting guys in vacuums with nothing between them but that little



old lady from Worcester, Massachusetts [the seamstress at the David Clark Company], and her glue pot and that suit." However, the Soviets had challenged the United States with a spacewalk by Cosmonaut Alexei Leonov in March during a Voskhod II mission, and the United States did not want to appear to be falling behind its adversary.

After struggling with a faulty hatch, Ed White finally exited the spacecraft as it passed over the Pacific Ocean. Using a gun powered by compressed oxygen, he was able to maneuver outside the capsule, just avoiding the flaming thrusters of the Gemini capsule. After a 23 minute spacewalk, Jim McDivitt struggled to get the six-foot-tall Ed White back inside the capsule and close the balky door.

Unfortunately, after making history as the first American to walk in space, Ed White died during a launch pad test of the Apollo 1 spacecraft, when the pure oxygen atmosphere exploded, killing all three astronauts inside.



Ed White, left, and Jim McDivitt

Jupiter and its Moons

Jupiter reaches Opposition in early June when it lies directly opposite the Sun. The gas giant is well placed in the evening sky, rising 30 minutes after sunset at the beginning of the month. On June 1st, Jupiter will reach its maximum altitude around 1:30 am, and almost two hours earlier by month's end. As the Earth moves ahead of Jupiter on its inside orbit, Jupiter will diminish slightly in brightness and apparent size. As one

of the brightest star-like objects in the night sky, Jupiter can be found in the constellation Ophiuchus, just to the east of Scorpius.

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. On nights of good visibility, the following events should be discernible through a moderately-sized telescope:

Jovian Moon Transits

Date	Moon	Transit Begins	Transit Ends
4 th	Ganymede	7:35 pm	9:55 pm
4 th	Io	8:29 pm	10:42 pm
7 th	Europa	6:55 pm	9:22 pm
11 th	Io	10:24 pm	12:36 am (12 th)
11 th	Ganymede	11:33 pm	1:54 am (12 th)
14 th	Europa	9:30 pm	11:57 pm
19 th	Io	12:18 am	2:30 am
20 th	Io	6:47 pm	8:59 pm
22 nd	Europa	12:40 am	2:32 am
27 th	Io	8:41 pm	10:53 pm

Red Spot Transits

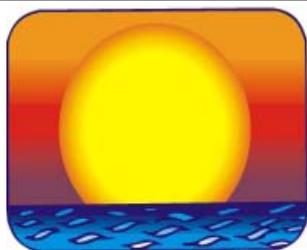
The Red Spot is a large cyclone in the upper Jovian atmosphere. The rapid rotation of this gas giant (10 hours) may be responsible for the longevity of this storm, which has been observed for over 300 years. The Red Spot will cross the center line of the planetary disk on the following evenings during the hours between 8 pm to midnight local time:

Date	Transit Time	Date	Transit Time
May 31 st	11:06 pm	17 th	10:05 pm
June 3 rd	8:35 pm	19 th	11:43 pm
5 th	10:13 pm	22 nd	9:12 pm
7 th	11:51 pm	24 th	10:50 pm
10 th	9:20 pm	27 th	8:20 pm
12 th	10:58 pm	29 th	9:58 pm
15 th	8:27 pm		

Summer Nights

For the more adventurous and sleep deprived individuals, the summer sky sparkles as twilight deepens and the summer Milky Way rises. The Milky Way is heralded by the three stars of the summer triangle Vega, Deneb and Altair. Appearing like a gossamer stream of stars, it flows across the night sky, emptying into the constellation Sagittarius. In our light-polluted skies, it may be easier to see on nights when the Moon is absent (in the weeks preceding and following the New Moon on the 3rd).

High in the June sky is the constellation Hercules. Shaped like a keystone or trapezoid, Hercules is home to one of the finest globular star clusters in the northern hemisphere. The Great Hercules Cluster (M13) is a collection of several hundred thousand suns located near the galactic core of the Milky Way Galaxy at a distance of approximately 25,000 light years. Hercules rises in the evening after the constellation Boötes with its bright star Arcturus and before the constellation Lyra with its bright star Vega. The cluster can be found on the side of the keystone asterism facing Boötes.



Sunrise and Sunset (from New Milford, CT)

<u>Sun</u>	<u>Sunrise</u>	<u>Sunset</u>
June 1 (EDT)	05:22	20:21 pm
June 15	05:19	20:32 pm

Astronomical and Historical Events

- 1st Amor Asteroid 3551 Verenia closest approach to Earth (1.389 AU)
- 1st Plutino 470308 (2007 JH43) at Opposition (39.548 AU)
- 1st History: final landing of Space Shuttle Endeavour (STS-134) (2011)
- 1st History: launch of the ROSAT (Röntgen) X-ray observatory; cooperative program between Germany, the United States, and United Kingdom; among its many discoveries was the detection of X-ray emissions from Comet Hyakutake (1990)
- 2nd History: launch of the Mars Express spacecraft and ill-fated Beagle 2 lander (2003)
- 2nd History: launch of the Space Shuttle Discovery (STS-91); ninth and final Mir docking (1998)
- 2nd History: launch of Soviet Venus orbiter Venera 15; side-looking radar provided high resolution mapping of surface in tandem with Venera 16 (1983)
- 2nd History: Surveyor 1 lands on the Moon (1966)
- 2nd History: Gemini 5, Gemini 11, Apollo 12 and Skylab 2 astronaut Pete Conrad born (1930)
- 2nd History: discovery of Comet Donati by Italian astronomer Giovanni Battista Donati; brightest comet of the 19th century and first comet to be photographed (1858)
- 3rd New Moon
- 3rd History: discovery of two rings around the centaur asteroid 10199 Chariklo, the smallest known object to have rings (2013)
- 3rd History: launch of Gemini 4; Ed White becomes first American to walk in space (1965)
- 3rd History: launch of Gemini 9 with astronauts Thomas Stafford and Eugene Cernan (1966)
- 3rd History: dedication of the 200-inch Hale Telescope at Palomar Mountain (1948)
- 4th Aten Asteroid 2014 JU15 near-Earth flyby (0.100 AU)
- 4th History: discovery of Classical Kuiper Belt Object 50000 Quaoar by Mike Brown and Chad Trujillo from images acquired at the Samuel Oschin Telescope at Palomar Observatory (2002)
- 4th History: maiden flight of SpaceX's Falcon 9 rocket; launched from Cape Canaveral, Florida (2010)

Astronomical and Historical Events (continued)

- 6th Aten Asteroid 2014 MF18 near-Earth flyby (0.022 AU)
- 6th Kuiper Belt Object 278361 (2007 JJ43) at Opposition (39.923 AU)
- 6th History: launch of Soviet Venus orbiter Venera 16; side-looking radar provided high resolution mapping of surface in tandem with Venera 15 (1983)
- 7th Moon at perigee (closest distance from Earth)
- 7th Comet C/2018 R3 (Lemmon) Perihelion (1.291 AU)
- 7th Apollo Asteroid 2017 BM93 near-Earth flyby (0.086 AU)
- 8th Second Saturday Stars/Open House at the McCarthy Observatory 8:00 to 10:00 pm
- 8th Amor Asteroid 189011 Ogmios closest approach to Earth (0.697 AU)
- 8th History: New Horizons spacecraft, on its way to Pluto, crosses the orbit of Saturn (2008)
- 8th History: discovery of Nova Aquila; a supernova explosion from the collapse of a white dwarf (1918)
- 8th History: launch of Soviet Venus orbiter/lander Venera 9; transmitted the first black and white images of the surface of Venus (1975)
- 8th History: Giovanni Cassini born, observer of Mars, Jupiter and Saturn (1625)
- 9th Apollo Asteroid 2017 XY2 near-Earth flyby (0.074 AU)
- 9th Kuiper Belt Object 2010 KZ39 at Opposition (44.988 AU)
- 9th History: dedication of the Kathleen Fischer Sundial at the McCarthy Observatory (2012)
- 10th First Quarter Moon
- 10th Jupiter at Opposition, rising with the setting Sun and visible all night
- 10th Amor Asteroid 452307 Manawydan closest approach to Earth (1.399 AU)
- 10th History: launch of Mars Exploration Rover A (Spirit) in 2003
- 10th History: launch of Explorer 49, Moon orbiter and radio astronomy explorer (1973)
- 11th History: flyby of Venus by Soviet spacecraft Vega 1 on its way to Comet Halley; dropped off lander and a balloon to study middle cloud layers (1985)
- 12th Apollo Asteroid 2011 TC4 near-Earth flyby (0.085 AU)
- 12th History: launch of Venera 4, Soviet Venus lander; first to enter atmosphere of another planet (1967)
- 13th COMET 209P/LINEAR PERIHELION (0.968 AU)
- 13th Kuiper Belt Object 174567 Varda at Opposition (45.633 AU)
- 13th History: return of the sample capsule from the Hayabusa (MUSES-C) spacecraft (2010)
- 14th Apollo Asteroid 1866 Sisyphus closest approach to Earth (0.450 AU)
- 14th History: launch of a V-2 rocket carrying a rhesus monkey (Albert II) - monkey survived flight and successfully transmitted biomedical data, but died on impact when parachutes failed to open (1949)
- 14th History: first radar astrometry for an asteroid from Goldstone and Haystack antennae observations of the asteroid 1566 Icarus (1968)
- 14th History: launch of Mariner 5; Venus flyby mission (1967)
- 14th History: launch of Venera 10; Soviet Venus orbiter/lander (1975)
- 15th History: flyby of Venus by Soviet spacecraft Vega 2 on its way to Comet Halley; dropped off lander and a balloon to study middle cloud layers (1985)
- 16th Apollo Asteroid 2017 XZ1 near-Earth flyby (0.076 AU)
- 16th History: Liu Yang becomes the first Chinese woman in space aboard a Shenzhou-9 spacecraft, joining two other crew members on a thirteen-day mission to the orbiting Tiangong 1 laboratory module (2012)

Astronomical and Historical Events (continued)

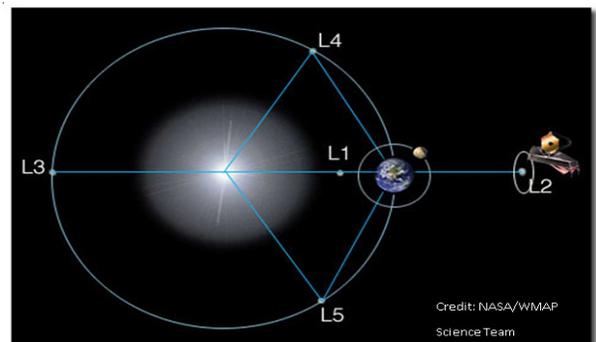
- 16th History: Valentina Tereshkova; first woman in space aboard Soviet Vostok 6 (1963)
- 17th Full Moon (Strawberry Moon)
- 18th History: launch of the Lunar Reconnaissance Orbiter (LRO) and Lunar CRater Observation and Sensing Satellite (LCROSS) to the Moon (2009)
- 18th History: Sally Ride becomes the first American woman in space aboard the Space Shuttle Challenger (1983)
- 19th Aten Asteroid 2014 MV18 near-Earth flyby (0.078 AU)
- 19th Aten Asteroid 2014 OL339 closest approach to Earth (0.293 AU)
- 19th Amor Asteroid 5869 Tanith closest approach to Earth (1.409 AU)
- 19th Plutino 28978 Ixion at Opposition (38.212 AU)
- 19th History: discovery of the potentially hazardous asteroid (PHA) 99942 Apophis - on April 13, 2029, the asteroid will pass within 19,000 miles (31,000 km) of the Earth (2004)
- 19th History: flyby of Earth by the ill-fated Nozomi spacecraft on its way to Mars (2003)
- 20th History: successful landing of the Viking 1 spacecraft on Mars' Chryse Planitia (Plains of Gold) (1976)
- 20th History: discovery of Nova 1670 in Vulpeculae (1670)
- 21st Summer Solstice, 15:54 UT (11:54 am EDT)
- 21st Aten Asteroid 2010 RX30 near-Earth flyby (0.094 AU)
- 21st Apollo Asteroid 11500 Tomaiyowit closest approach to Earth (0.187 AU)
- 21st Amor Asteroid 3553 Mera closest approach to Earth (1.227 AU)
- 21st History: SpaceShipOne makes first privately funded human spaceflight (2004)
- 22nd Scheduled launch of SpaceX's Falcon Heavy from the Kennedy Space Center on its second commercial flight
- 22nd Apollo Asteroid 2016 WQ3 near-Earth flyby (0.079 AU)
- 22nd Atira Asteroid 418265 (2008 EA32) closest approach to Earth (0.589 AU)
- 22nd Apollo Asteroid 11066 Sigurd closest approach to Earth (1.161 AU)
- 22nd History: launch of Soviet space station Salyut 5 (1976)
- 22nd History: founding of the Royal Greenwich Observatory (1675)
- 22nd History: discovery of Pluto's largest moon Charon by Jim Christy (1978)
- 23rd Moon at apogee (furthest distance from Earth)
- 23rd Mercury at its Greatest Eastern Elongation - apparent separation from the Sun in the western sky shortly after sunset (25°)
- 23rd Apollo Asteroid 2063 Bacchus closest approach to Earth (1.574 AU)
- 23rd Centaur Object 5145 Pholus at Opposition (27.282 AU)
- 24th Aten Asteroid 441987 (2010 NY65) near-Earth flyby (0.020 AU)
- 24th Amor Asteroid 2011 HT near-Earth flyby (0.074 AU)
- 24th Kuiper Belt Object 50000 Quaoar at Opposition (41.849 AU)
- 24th History: launch of the Salyut 3 Soviet space station (1974)
- 24th History: Fred Hoyle born; British astronomer and proponent of nucleosynthesis (1915)
- 24th History: Sir William Huggins makes first photographic spectrum of a comet (1881)
- 24th Last Quarter Moon
- 24th History: Rupert Wildt born, German-American astronomer and first to hypothesize that the CO₂ in the Venusian atmosphere was responsible for the trapped heat (1905)

Astronomical and Historical Events (continued)

- 25th History: Hermann Oberth born, father of modern rocketry and space travel (1894)
- 26th Atira Asteroid 2010 XB11 closest approach to Earth (0.716 AU)
- 26th Apollo Asteroid 4769 Castalia closest approach to Earth (1.511 AU)
- 26th History: Charles Messier born, famed comet hunter (1730)
- 27th Asteroid 3530 Hammel closest approach to Earth (1.117 AU)
- 27th Aten Asteroid 2008 KV2 near-Earth flyby (0.045 AU)
- 27th History: discovery of the Mars meteorite SAU 060, a small 42.28 g partially crusted grey-greenish stone found near Sayh al Uhaymir in Oman (2001)
- 27th History: flyby of the asteroid Mathilde by the NEAR spacecraft (1997)
- 27th History: Space Shuttle Atlantis (STS-71) first docking with the Russian space station Mir (1995)
- 27th History: launch of SEASAT, the first Earth-orbiting satellite designed for remote sensing of the Earth's oceans (1978)
- 27th History: Alexis Bouvard born, French astronomer, director of Paris Observatory, postulated existence of eighth planet from discrepancies in his astronomical tables for Saturn and Uranus. Neptune was subsequently discovered by John Couch Adams and Urbain Le Verrier after his death where he had predicted (1767)
- 28th Amor Asteroid 2016 NN15 near-Earth flyby (0.025 AU)
- 28th Apollo Asteroid 2013 WR45 near-Earth flyby (0.092 AU)
- 28th History: discovery of Pluto's moon Kerberos by Mark Showalter, et al., using the Hubble Space Telescope (2011)
- 28th History: Nakhla meteorite fall in Egypt (Mars meteorite), a piece of which was claimed to have vaporized a dog; first direct evidence of aqueous processes on Mars (1911)
- 29th Apollo Asteroid 3361 Orpheus closest approach to Earth (1.343 AU)
- 29th History: George Ellery Hale born, founding father of the Mt. Wilson Observatory (1868)
- 30th History: the Cassini-Huygens spacecraft enters orbit around Saturn (2004)
- 30th History: discovery of Haumea's moon Namaka, the smaller, inner moon of the dwarf planet, by Mike Brown, Chad Trujillo, David Rabinowitz, et al. (2005)
- 30th History: crew of Soyuz 11 dies upon return from the Salyut space station when capsule depressurizes (1971)
- 30th History: Tunguska Explosion Event (1908)

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).



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 ($1/2^\circ$), less than the width of your little finger at arm's length which covers approximately one degree (1°); three fingers span approximately five degrees (5°)
- 1 astronomical unit (AU) is the distance from the Sun to the Earth or approximately 93 million miles

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

International Space Station and Iridium Satellites

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

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Front page design and graphic calendar: Allan Ostergren

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

Front Page Graphic

When stargazers view a solar eclipse, they typically use a device called a coronagraph to block the sun's intense glare and reveal its surrounding plasma, or corona. Recently, this technique is being adapted and expanded in the search for planets in emerging star systems.

Astronomers at the Max Planck Institute in Heidelberg, Germany have been studying images of PDS 70, a dwarf star in the Taurus Molecular Cloud, 370 light-years from Earth and approximately 10 million years old. The images are gathered from the ESO's Very Large Telescope (VLT) in the mountains of southern Chile, using the Spectro-Polarimetric High-contrast Exoplanet REsearch (VLT-SPHERE)—an adaptive optics system and coronagraphic facility at the complex.

The coronagraph is the black circle at the center of the image, and the protoplanet (PDS 70b) is the bright circle below at right. But getting to this final detail involves a complex process of taking successive images, filtering out the elements that remain stationary, and leaving those that appear to have moved, indicating a rotating object.

Analysis of the protoplanet indicates a surface temperature of 1,000 degrees celsius (1,832 degrees fahrenheit), a mass several times that of Jupiter and a distance from its star similar to the orbit of Uranus. But it will need to bulk-up and get in shape in order to achieve planetary status. Its structure is typical of a transition disk, in which its components—dust, gas, planetesimals, asteroids, or other fragments of matter—are only loosely distributed.



Source: ESO/ Luis Calçada

Artist's impression of a protoplanetary disk, showing a young star at its center.

Sources: https://en.wikipedia.org/wiki/PDS_70; <https://www.eso.org/public/usa/news/eso1821/>; <https://www.universetoday.com/tag/eso-vlt/>; <https://www.universetoday.com/tag/eso-vlt/>

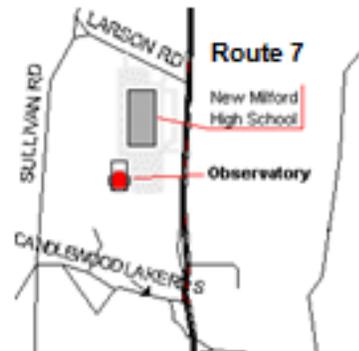
Contact Information

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



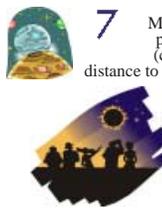
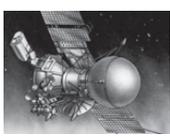
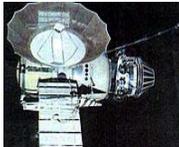
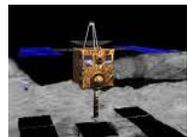
mccarthy.observatory@gmail.com



@JJMObservatory

June 2019

Celestial Calendar

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
<p align="center">Phases of the Moon</p> <div style="display: flex; justify-content: space-around;"> <div style="text-align: center;"> <p>June 3</p>  <p>New Moon</p> </div> <div style="text-align: center;"> <p>June 10</p>  <p>Waxing Crescent</p> </div> <div style="text-align: center;"> <p>June 17</p>  <p>Full Moon</p> </div> <div style="text-align: center;"> <p>June 24</p>  <p>Waning Crescent</p> </div> </div>						<p align="center">1</p>  <p>Launch of Mars Express spacecraft and ill-fated Beagle 2 lander. (2003)</p>
<p align="center">2</p> <p>Launch of Soviet Venus Orbiter, Venera 15 to map surface of Venus, in tandem with Venera 16 (1983)</p>  <p>Launch of ROSAT (Röntgen) X-ray observatory (1990)</p> 	<p align="center">3</p> <p>200-inch Hale Telescope dedication (1948)</p>  <p>Gemini 9 launch, Thomas Stafford, Eugene Cernan. (1966)</p>  <p>Launch of Gemini 4; Ed White 1st American to walk in space (1965)</p> 	<p align="center">4</p>  <p>Maiden flight of Space X Falcon 9 rocket (2010)</p>	<p align="center">5</p>  <p>Mercury-Redstone 3, or Freedom 7, first US human spaceflight, on May 5, 1961, piloted by astronaut Alan Shepard</p>	<p align="center">6</p>  <p>Venera 16 - last of Soviet Venus orbiter/lander missions to map Venusian landscape (1983)</p>	<p align="center">7</p>  <p>Moon at perigee (closest distance to Earth)</p> <p>“Three flames ate the sun, and big stars were seen.” - etching on Chinese oracle bones indicating ancient solar eclipse, with three coronal streamers and stars visible in the darkened sky. (1302 BC)</p>	<p align="center">8</p>  <p>Giovanni Cassini born, observer of Mars, Jupiter and Saturn (1625)</p>  <p>Launch of Venera 9, - 1st black/white images of surface of Venus (1975)</p> <p align="right">2nd Saturday Stars Open House McCarthy Observatory</p> 
<p align="center">9</p> <p>Dedication of the Kathleen Fischer Sundial at the McCarthy Observatory (2012)</p>  <p>Johann Gottfried Galle, German astronomer, born - first to view planet Neptune, using calculations of Urbain Le Verrier 1846. (1812)</p> 	<p align="center">10</p> <p>Launch of Explorer 49 - moon orbiter and radio astronomy explorer (1973)</p>  <p>Launch of Mars Exploration Rover A Spirit (2003)</p> 	<p align="center">11</p>  <p>Flyby of Venus by Soviet spacecraft Vega 1 on its way to Comet Halley - dropped off lander and a balloon to study middle cloud layers (1985)</p>	<p align="center">12</p>  <p>Launch of Venera 4, Soviet Venus lander, first to enter orbit of another planet (1967)</p>	<p align="center">13</p>  <p>Return of sample capsule from the Hayabusa (MUSES-C) spacecraft, taken from near-Earth asteroid Itokawa (2010)</p>	<p align="center">14</p>  <p>Launch of Mariner 5, Venus flyby mission (1967)</p> <p>Launch of Venera 10, Soviet Venus orbiter/lander (1975)</p>	<p align="center">15</p>  <p>flyby of Venus by Soviet spacecraft Vega 2 on its way to Comet Halley; dropped off lander and a balloon to study middle cloud layers (1985)</p>
<p align="center">16</p>  <p>Liu Yang becomes the first Chinese woman in space (2012)</p> <p>Valentina Tereshkova, 1st woman in space (1963)</p> 	<p align="center">17</p>  <p>Discovery of the Dhofar 378 Mars meteorite (2000)</p>	<p align="center">18</p>  <p>Sally Ride, 1st U.S. woman in space (1983)</p> <p>Launch of Lunar Reconnaissance Orbiter and LCROSS satellite to Moon (2009)</p> 	<p align="center">19</p>  <p>Flyby of Earth by the ill-fated Nozomi spacecraft on its way to Mars (2003)</p>	<p align="center">20</p>  <p>Discovery of Nova 1670 in Vulpeculae by Pere Dom Voiture Anhelme, a Carthusian monk in Dijon, France (1670)</p>	<p align="center">21</p> <p>Summer Solstice 05:04 UT (1:04 AM EDT)</p>  <p>Yáng Liwei, a Chinese major general, military pilot and a CNSA astronaut; was first man sent into space by the Chinese space program and his mission, Shenzhou 5, made China the third country to independently send people into space (1965)</p> 	<p align="center">22</p>  <p>Royal Greenwich Observatory founded (1675)</p> <p>Discovery of Pluto's largest moon Charon by Jim Christy (1978)</p>  <p>Launch of Soviet space station Salyut 5 (1976)</p> 
<p align="center">23</p> <p>Moon at Apogee (farthest from earth)</p> <p>Fred Hoyle born, British astronomer and proponent of nucleosynthesis (1915)</p>  <p>Sir William Huggins makes 1st photographic spectrum of a comet (1881)</p> 	<p align="center">24</p>  <p>Rupert Wildt born, German astronomer (1905)</p> <p>Hermann Oberth born, father of modern rocketry and space travel (1894)</p> 	<p align="center">25</p>  <p>Charles Messier born, famed comet hunter (1730)</p> <p>German astronomer Walter Baade discovers near-earth asteroid 1566 Icarus inside orbit of Mercury, which became the subject of asteroid-busting "project Icarus." (1949)</p> 	<p align="center">26</p>  <p>Alexis Bouvard born, postulated existence of 8th planet, later identified as Neptune (1767)</p> <p>launch of SEASAT 1, first Earth-orbiting satellite designed for remote sensing of oceans (1978)</p>  <p>Flyby of the asteroid Mathilde by the NEAR spacecraft (1997)</p> 	<p align="center">27</p>  <p>Nakhl meteor fall in Egypt - A piece of Mars object fabled to have hit dog (1911)</p>	<p align="center">28</p> <p>Shuttle Atlantis docks with Russian space station Mir to form the largest man-made satellite ever to orbit the Earth - the second time ships from two countries had linked up in space (1995)</p> 	<p align="center">29</p>  <p>American space station docks with Russian space station Mir to form the largest man-made satellite ever to orbit the Earth. (1995)</p> <p>George Ellery Hale born, founding father of the Mt. Wilson Observatory (1868)</p> 
<p align="center">30</p> <p>Tunguska explosion event (1908)</p> 						