A PLANET IS BORN

See page 18 inside
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It is through their efforts that the McCarthy Observatory has established itself as a significant educational and recreational resource within the western Connecticut community.

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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 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,

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

Distance: 13556.53 m
Elevation (GLD100)

Min: -2222 Max: -2023

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

Kies Pi Lava Dome

Photo: Bill Cloutier

http://www.mccarthyobservatory.org
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 crystallize, 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-
Administration has added $1.6 billion in funding to NASA's 2020 budget. The funding will be used to accelerate 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.

**MARSJA**

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 composed of a basaltic fiber that can be processed from natural materials found on Mars and renewable bioplastic (polylactic acid, or PLA) derived from plants.
that could be grown on Mars. The 3-D printed structure ranked high in overall strength and its plastic component effective as a shield for ionizing cosmic radiation. PLA is also stable, with a low expansion coefficient, which works well with the basalt fiber, yielding a non-toxic, low conductivity building material. Together, they form an effective insulator against the harsh Martian environment.

### 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 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 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.
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.

Summertime Sights

The constellation Sagittarius (the Archer) graces the southern summer evening sky. The center of our Milky Way galaxy lies in the direction of Sagittarius.

Credit: Japan Aerospace Exploration Agency

Credit: NASA/JPL-Caltech/Space Science Institute
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.

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)
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.

**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 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.

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, was 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.

### 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

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

### 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:

<table>
<thead>
<tr>
<th>Date</th>
<th>Transit Time</th>
<th>Date</th>
<th>Transit Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>May 31st</td>
<td>11:06 pm</td>
<td>17th</td>
<td>10:05 pm</td>
</tr>
<tr>
<td>June 3rd</td>
<td>8:35 pm</td>
<td>19th</td>
<td>11:43 pm</td>
</tr>
<tr>
<td>5th</td>
<td>10:13 pm</td>
<td>22nd</td>
<td>9:12 pm</td>
</tr>
<tr>
<td>7th</td>
<td>11:51 pm</td>
<td>24th</td>
<td>10:50 pm</td>
</tr>
<tr>
<td>10th</td>
<td>9:20 pm</td>
<td>27th</td>
<td>8:20 pm</td>
</tr>
<tr>
<td>12th</td>
<td>10:58 pm</td>
<td>29th</td>
<td>9:58 pm</td>
</tr>
<tr>
<td>15th</td>
<td>8:27 pm</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**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)

<table>
<thead>
<tr>
<th></th>
<th>Sunrise</th>
<th>Sunset</th>
</tr>
</thead>
<tbody>
<tr>
<td>June 1 (EDT)</td>
<td>05:22</td>
<td>20:21 pm</td>
</tr>
<tr>
<td>June 15</td>
<td>05:19</td>
<td>20:32 pm</td>
</tr>
</tbody>
</table>

### Astronomical and Historical Events

1\textsuperscript{st} Amor Asteroid 3551 Verenia closest approach to Earth (1.389 AU)
1\textsuperscript{st} Plutino 470308 (2007 JH43) at Opposition (39.548 AU)
1\textsuperscript{st} History: final landing of Space Shuttle Endeavour (STS-134) (2011)
1\textsuperscript{st} 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)
2\textsuperscript{nd} History: launch of the Mars Express spacecraft and ill-fated Beagle 2 lander (2003)
2\textsuperscript{nd} History: launch of the Space Shuttle Discovery (STS-91); ninth and final Mir docking (1998)
2\textsuperscript{nd} History: launch of Soviet Venus orbiter Venera 15; side-looking radar provided high resolution mapping of surface in tandem with Venera 16 (1983)
2\textsuperscript{nd} History: Surveyor 1 lands on the Moon (1966)
2\textsuperscript{nd} History: Gemini 5, Gemini 11, Apollo 12 and Skylab 2 astronaut Pete Conrad born (1930)
2\textsuperscript{nd} History: discovery of Comet Donati by Italian astronomer Giovanni Battista Donati; brightest comet of the 19th century and first comet to be photographed (1858)
3\textsuperscript{rd} New Moon
3\textsuperscript{rd} History: discovery of two rings around the centaur asteroid 10199 Chariklo, the smallest known object to have rings (2013)
3\textsuperscript{rd} History: launch of Gemini 4; Ed White becomes first American to walk in space (1965)
3\textsuperscript{rd} History: launch of Gemini 9 with astronauts Thomas Stafford and Eugene Cernan (1966)
3\textsuperscript{rd} History: dedication of the 200-inch Hale Telescope at Palomar Mountain (1948)
4\textsuperscript{th} Aten Asteroid 2014 JU15 near-Earth flyby (0.100 AU)
4\textsuperscript{th} 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)
4\textsuperscript{th} History: maiden flight of SpaceX's Falcon 9 rocket; launched from Cape Canaveral, Florida (2010)
## Astronomical and Historical Events (continued)

<table>
<thead>
<tr>
<th>Day</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>6th</td>
<td>Aten Asteroid 2014 MF18 near-Earth flyby (0.022 AU)</td>
</tr>
<tr>
<td>6th</td>
<td>Kuiper Belt Object 278361 (2007 JJ43) at Opposition (39.923 AU)</td>
</tr>
<tr>
<td>6th</td>
<td>History: launch of Soviet Venus orbiter Venera 16; side-looking radar provided high resolution mapping of surface in tandem with Venera 15 (1983)</td>
</tr>
<tr>
<td>7th</td>
<td>Moon at perigee (closest distance from Earth)</td>
</tr>
<tr>
<td>7th</td>
<td>Comet C/2018 R3 (Lemmon) Perihelion (1.291 AU)</td>
</tr>
<tr>
<td>7th</td>
<td>Apollo Asteroid 2017 BM93 near-Earth flyby (0.086 AU)</td>
</tr>
<tr>
<td>7th</td>
<td>Second Saturday Stars/Open House at the McCarthy Observatory 8:00 to 10:00 pm</td>
</tr>
<tr>
<td>7th</td>
<td>Amor Asteroid 189011 Ogmios closest approach to Earth (0.697 AU)</td>
</tr>
<tr>
<td>7th</td>
<td>History: New Horizons spacecraft, on its way to Pluto, crosses the orbit of Saturn (2008)</td>
</tr>
<tr>
<td>7th</td>
<td>History: discovery of Nova Aquila; a supernova explosion from the collapse of a white dwarf (1918)</td>
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<tr>
<td>7th</td>
<td>History: launch of Soviet Venus orbiter/lander Venera 9; transmitted the first black and white images of the surface of Venus (1975)</td>
</tr>
<tr>
<td>8th</td>
<td>History: Giovanni Cassini born, observer of Mars, Jupiter and Saturn (1625)</td>
</tr>
<tr>
<td>8th</td>
<td>Apollo Asteroid 2017 XY2 near-Earth flyby (0.074 AU)</td>
</tr>
<tr>
<td>8th</td>
<td>Kuiper Belt Object 2010 KZ39 at Opposition (44.988 AU)</td>
</tr>
<tr>
<td>8th</td>
<td>History: dedication of the Kathleen Fischer Sundial at the McCarthy Observatory (2012)</td>
</tr>
<tr>
<td>8th</td>
<td>History: launch of Soviet Venus orbiter Venera 10; Soviet Venus orbiter/lander (1975)</td>
</tr>
<tr>
<td>8th</td>
<td>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)</td>
</tr>
<tr>
<td>8th</td>
<td>History: launch of Venera 4, Soviet Venus lander; first to enter atmosphere of another planet (1967)</td>
</tr>
<tr>
<td>8th</td>
<td>Comet 209P/LINEAR Perihelion (0.968 AU)</td>
</tr>
<tr>
<td>8th</td>
<td>Kuiper Belt Object 174567 Varda at Opposition (45.633 AU)</td>
</tr>
<tr>
<td>8th</td>
<td>History: return of the sample capsule from the Hayabusa (MUSES-C) spacecraft (2010)</td>
</tr>
<tr>
<td>8th</td>
<td>Apollo Asteroid 1866 Sisyphus closest approach to Earth (0.450 AU)</td>
</tr>
<tr>
<td>8th</td>
<td>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)</td>
</tr>
<tr>
<td>8th</td>
<td>History: first radar astrometry for an asteroid from Goldstone and Haystack antennae observations of the asteroid 1566 Icarus (1968)</td>
</tr>
<tr>
<td>8th</td>
<td>History: launch of Mariner 5; Venus flyby mission (1967)</td>
</tr>
<tr>
<td>8th</td>
<td>History: launch of Venera 10; Soviet Venus orbiter/lander (1975)</td>
</tr>
<tr>
<td>9th</td>
<td>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)</td>
</tr>
<tr>
<td>9th</td>
<td>Apollo Asteroid 2017 XZ1 near-Earth flyby (0.076 AU)</td>
</tr>
<tr>
<td>9th</td>
<td>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)</td>
</tr>
</tbody>
</table>
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)


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: 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 AU to 50 AU) with a vast population of small bodies orbiting the Sun.

• Opposition: Celestial bodies on opposite sides of the sky, typically as viewed from Earth.

• Plutino: An asteroid-sized body that orbits the Sun in a 2:3 resonance with Neptune.

• Trojan: Asteroids orbiting in the 4th and 5th Lagrange points (leading and trailing) of major planets in the Solar System.

References on Distances

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

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

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.

Image Credits

Front page design and graphic calendar: Allan Ostergren
All other non-credited photos were taken by the author: Bill Cloutier
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 stationery, 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.

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### Phases of the Moon

<table>
<thead>
<tr>
<th>Sunday</th>
<th>Monday</th>
<th>Tuesday</th>
<th>Wednesday</th>
<th>Thursday</th>
<th>Friday</th>
<th>Saturday</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>June 3</strong></td>
<td><strong>June 10</strong></td>
<td><strong>June 17</strong></td>
<td><strong>June 24</strong></td>
<td><strong>June 30</strong></td>
<td><strong>July 1</strong></td>
<td><strong>July 2</strong></td>
</tr>
</tbody>
</table>

**Launch of Soviet Venus Orbiter, Venera 15 to map surface of Venus, in tandem with Venera 16 (1983)**

**Launch of Venera 16, the first Soviet Venus lander, (1966)**

**Launch of Soviet Venus orbiter/Venus lander missions to map Venusian landscape (1983)**

**Launch of NASA's OSIRIS-REx spacecraft to study Bennu (2019)**

**Launch of Lunar Express spacecraft and ill-fated Beagle 2 lander (2003)**

### Celestial Events

- **June 3**: New Moon
- **June 10**: 200-inch Hale Telescope dedication (1948)
- **June 17**: Venera 15 to map surface of Venus, in tandem with Venera 16 (1983)
- **June 30**: Moon at perigee (closest distance to Earth)

### Historical Events

- **June 6**: Venera 16 - last of Soviet Venus orbiter/lander missions to map Venusian landscape (1983)
- **June 9**: “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)
- **June 11**: Maiden flight of Space X Falcon 9 rocket (2010)
- **June 12**: Launch of Venera 4, Soviet Venus lander, first to enter orbit of another planet (1960)
- **June 13**: 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)
- **June 14**: Launch of Venus Express spacecraft Vega 1 on its way to Comet Halley - dropped off lander and a balloon to study middle cloud layers (1985)
- **June 15**: 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)
- **June 16**: Liu Yang becomes the first Chinese woman in space (2012)
- **June 17**: Discovery of the Dhofar 378 Mars meteorite (2000)
- **June 19**: Sally Ride, first U.S. woman in space (1983)
- **June 20**: Discovery of Nova 1670 in Vulpeculae by Pere Dom (1670)
- **June 21**: Summer Solstice - 05:04 UT (1:04 AM EDT)
- **June 22**: Discovery of Pluto's largest moon Charon by James Christy (1978)
- **June 23**: Moon at Apogee (farthest from Earth)
- **June 24**: Countess of Haddington, founder of the Royal Greenwich Observatory (1675)
- **June 25**: Launch of Venera 9, first Soviet Venus orbiter/lander missions to map Venusian landscape (1983)
- **June 26**: Charles Messier born, famed comet hunter (1730)
- **June 27**: Shuttles 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)
- **June 28**: Nakhal meteor fall in Egypt - A piece of Mars object fabled to have hit dog (1911)
- **June 29**: American space station docks with Russian space station MIR to form the largest man-made satellite ever to orbit the Earth (1995)
- **June 30**: Tunguska explosion event (1908)