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MESSENGER at Mercury

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Internal Heat Drives Jupiter’s Storms

(NASA/STScI) Detailed analysis of two continent-sized storms that erupted in Jupiter’s atmosphere in March 2007 shows that Jupiter’s internal heat plays a significant role in generating atmospheric disturbances. Understanding this outbreak could be the key to unlock the mysteries buried in the deep Jovian atmosphere, say astronomers.

Understanding these phenomena is important for Earth’s meteorology where storms are present everywhere and jet streams dominate the atmospheric circulation. Jupiter is a natural laboratory where atmospheric scientists study the nature and interplay of the intense jets and severe atmospheric phenomena.

An international team coordinated by Agustin Sánchez-Lavega from the Universidad del País Vasco in Spain presented its findings about this event in the January 24 issue of the journal Nature.

The team monitored the new eruption of cloud activity and its evolution with an unprecedented resolution using NASA’s Hubble Space Telescope, the NASA Infrared Telescope Facility in Hawaii, and telescopes in the Canary Islands (Spain). A network of smaller telescopes around the world also supported these observations.

According to the analysis, the bright plumes were storm systems triggered in Jupiter’s deep water clouds that moved upward in the atmosphere vigorously and injected a fresh mixture of ammonia ice and water about 20 miles (30 kilometers) above the visible clouds. The storms moved in the peak of a jet stream in Jupiter’s atmosphere at 375 miles per hour (600 kilometers per hour). Models of the disturbance indicate that the jet stream extends deep in the buried atmosphere of Jupiter, more than 60 miles (approximately 100 kilometers) below the cloud tops where most sunlight is absorbed. 

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Editor: Dr. Dale Etheridge, CSN Planetarium Director • Graphic Design: Denise MacRae
Circulation Manager: Pam Maher
**MESSENGER at Mercury**

(NASA/JPL) On January 14, 2008, MESSENGER became the first spacecraft in over three decades to visit Mercury, snapping images of a large portion of Mercury’s surface previously unseen by spacecraft. As the spacecraft proceeds on its journey, the science team continues to study the 1213 images returned from the mission’s historic first flyby. The probe’s trajectory will bring it to a second Mercury flyby on October 6, 2008.

This first scene (here and cover) was imaged by MESSENGER’s Narrow Angle Camera (NAC) on the Mercury Dual Imaging System (MDIS) during the spacecraft’s flyby. The scene is part of a mosaic that covers a portion of the hemisphere not viewed by Mariner 10 during any of its three flybys (1974-1975). The surface of Mercury is revealed at a resolution of about 250 meters/pixel (820 feet/pixel). For this image, the Sun is illuminating the scene from the top and north is to the left.

The outer diameter of the large double ring crater at the center of the scene is about 260 km (about 160 miles). The crater appears to be filled with smooth plains material that may be volcanic in nature. Multiple chains of smaller secondary craters are also seen extending radially outward from the double ring crater. Double or multiple rings form in craters with very large diameters, often referred to as impact basins. On Mercury, double ring basins begin to form when the crater diameter exceeds about 200 km (about 125 miles); at such an onset diameter the inner rings are typically low, partial, or discontinuous. The transition diameter at which craters begin to form rings is not the same on all bodies and, although it depends primarily on the surface gravity of the planet or moon, the transition diameter can also reveal important information about the physical characteristics of surface materials. Studying impact craters, such as this one, in the more than 1200 images returned from this flyby will provide clues to the physical properties of Mercury’s surface and its geological history.

As MESSENGER sped by Mercury on January 14, the Narrow Angle Camera (NAC) of the Mercury Dual Imaging System (MDIS) captured this next image before its closest approach with the planet. The scene is near Mercury’s terminator (the line between the sunlit day side and dark night side of the planet), where shadows are long and height differences accentuated, revealing rising crater walls that tower over the floors below. The large crater
situated on the right side in the bottom half of the image is Sullivan crater, a structure about 135 kilometers (84 miles) in diameter also seen during the Mariner 10 mission. An influential American architect, Louis Sullivan and his work are often associated with the rise of modern skyscrapers, and this crater named in his honor finds a fitting home in Mercury’s ancient geological architecture.

**MESSENGER**’s Narrow Angle Camera (NAC) of the Mercury Dual Imaging System (MDIS) captured this final image (above). The Sun is illuminating this region at a low angle, accentuating the modest ridges and other low topography on these nearly flat plains. Low ridges trend from the top-center of the image to the left edge (white arrows). The ghostly remains of craters are visible, filled to their rims by what may have been volcanic lavas (red arrows). The faint remnant of an inner ring within the large crater in the bottom half of this picture can be seen (blue arrow); the area interior to this ring was also flooded, possibly by lava, nearly to the point of disappearance. Clusters of secondary craters on the floor of the large crater and elsewhere (yellow arrows) formed when clumps of material were ejected from large impacts beyond the view of this image, which is about 350 kilometers (220 miles) across.

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**Titan’s Surface Organics Surpass Oil Reserves on Earth**

(NASA/JPL) Saturn’s orange moon Titan has hundreds of times more liquid hydrocarbons than all the known oil and natural gas reserves on Earth, according to new data from NASA’s **Cassini** spacecraft. The hydrocarbons rain from the sky, collecting in vast deposits that form lakes and dunes.

The new findings from the study led by Ralph Lorenz, **Cassini** radar team member from the Johns Hopkins University Applied Physics Laboratory, Laurel, Md., were reported in the January 29 issue of the *Geophysical Research Letters*.

"Titan is just covered in carbon-bearing material, it’s a giant factory of organic chemicals," said Lorenz. "This vast carbon inventory is an important window into the geology and climate history of Titan."

At a balmy -179° C (-290° F), Titan is a far cry from Earth. Instead of water, liquid hydrocarbons in the form of methane and ethane are present on the moon’s surface, and tholins probably make up its dunes. The term "tholins" was coined by Carl Sagan in 1979 to
describe the complex organic molecules at the heart of prebiotic chemistry.

_Cassini_ has mapped about 20 percent of Titan's surface with radar. Several hundred lakes and seas have been observed, with each of several dozen estimated to contain more hydrocarbon liquid than Earth's oil and gas reserves. The dark dunes that run along the equator contain a volume of organics several hundred times larger than Earth's coal reserves.

The question of how much liquid is on the surface is an important one because methane is a strong greenhouse gas on Titan as well as on Earth, but there is much more of it on Titan. If all the observed liquid on Titan is methane, it would only last a few million years, because as methane escapes into Titan's atmosphere, it breaks down and escapes into space. If the methane were to run out, Titan could become much colder. Scientists believe that methane might be supplied to the atmosphere by venting from the interior in cryovolcanic eruptions. If so, the amount of methane, and the temperature on Titan, may have fluctuated dramatically in Titan's past.

"We are carbon-based life, and understanding how far along the chain of complexity towards life that chemistry can go in an environment like Titan will be important in understanding the origins of life throughout the universe," added Lorenz.

The Cassini-Huygens mission is a cooperative project of NASA, the European Space Agency and the Italian Space Agency. JPL, a division of the California Institute of Technology in Pasadena, manages the Cassini-Huygens mission for NASA's Science Mission Directorate, Washington.
Youngest and Brightest Galaxy in the Early Universe

(NASA/STScI) NASA’s Hubble and Spitzer space telescopes, with a boost from a natural "zoom lens," have uncovered what may be one of the youngest and brightest galaxies ever seen in the middle of the cosmic "dark ages," just 700 million years after the beginning of our universe.

The detailed images from Hubble's Near Infrared Camera and Multi-Object Spectrometer (NICMOS) reveal an infant galaxy, dubbed A1689-zD1, undergoing a firestorm of star birth during the dark ages, a time shortly after the Big Bang but before the first stars reheated the cold, dark universe. Images from NASA’s Spitzer Space Telescope’s Infrared Array Camera provided strong additional evidence that it was a young star-forming galaxy in the dark ages.

"We certainly were surprised to find such a bright young galaxy 12.8 billion years in the past," said astronomer Garth Illingworth of the University of California, Santa Cruz, and a member of the research team. "This is the most detailed look to date at an object so far back in time."

"The Hubble images yield insight into the galaxy’s structure that we cannot get with any other telescope," added astronomer Rychard Bouwens of the University of California, Santa Cruz, one of the co-discoverers of this galaxy.

The new images should offer insights into the formative years of galaxy birth and evolution and yield information on the types of objects that may have contributed to ending the dark ages. The faraway galaxy also is an ideal target for Hubble’s successor, the James Webb Space Telescope (JWST), scheduled to launch in 2013.

During its lifetime, the Hubble telescope has peered ever farther back in time, viewing galaxies at successively younger stages of evolution. These snapshots have helped astronomers create a scrapbook of galaxies from infancy to adulthood. The new Hubble and Spitzer images of A1689-zD1 show a time when galaxies were in their infancy.

Current theory holds that the dark ages began about 400,000 years after the Big Bang, as matter in the expanding universe cooled and formed clouds of cold hydrogen. These cold clouds pervaded the universe like a thick fog.

At some point during this era, stars and galaxies started to form. Their collective light reheated the foggy, cold hydrogen, ending the dark ages about a billion years after the Big Bang.

"This galaxy presumably is one of the many galaxies that helped end the dark ages," said astronomer Larry Bradley of Johns Hopkins University in Baltimore, Md., and leader of the study. "Astronomers are fairly certain that high-energy objects such as quasars did not provide enough energy to end the dark ages of the universe. But many young star-forming galaxies may have produced enough energy to end it."

The galaxy is so far away it did not appear in images taken with Hubble’s Advanced
Camera for Surveys, because its light is stretched to invisible infrared wavelengths by the universe's expansion. It took Hubble's NICMOS, Spitzer, and a trick of nature called gravitational lensing to see the faraway galaxy.

The astronomers used a relatively nearby massive cluster of galaxies known as Abell 1689, roughly 2.2 billion light-years away, to magnify the light from the more distant galaxy directly behind it. This natural telescope is called a gravitational lens.

Though the diffuse light of the faraway object is nearly impossible to see, gravitational lensing has increased its brightness by nearly 10 times, making it bright enough for Hubble and Spitzer to detect. A telltale sign of the lensing is the smearing of the images of galaxies behind Abell 1689 into arcs by the gravitational warping of space by the intervening galaxy cluster.

The images reveal bright, dense clumps of hundreds of millions of massive stars in a compact region about 2,000 light-years across, which is only a fraction of the width of our Milky Way Galaxy. This type of galaxy is not uncommon in the early universe, when the bulk of star formation was taking place, Bradley and Illingworth said.

Spitzer's images show that the galaxy's mass is typical to that of galaxies in the early universe. Its mass is equivalent to several billions of stars like our Sun, or just a tiny fraction of the mass of the Milky Way.

"This observation confirms previous Hubble studies that star birth happens in very tiny regions compared with the size of the final galaxy," Illingworth said.

Even with the increased magnification from the gravitational lens, Hubble's sharp "eye" can only see knots of the brightest, heftiest stars in the galaxy. The telescope cannot pinpoint fainter, lower-mass stars, individual stars, or the material surrounding the star-birthing region. To see those things, astronomers will need the infrared capabilities of NASA's JWST. The planned infrared observatory will have a mirror about seven times the area of Hubble's primary mirror and will collect more light from faint galaxies. JWST also will be able to view even more remote galaxies whose light has been stretched deep into infrared wavelengths that are out of the reach of NICMOS.

"This galaxy will certainly be one of the first objects that will be observed by JWST," said team member Holland Ford of Johns Hopkins University. "This galaxy is so bright that JWST will see its detailed structure. This object is a pathfinder for JWST for deciphering what is happening in young galaxies."

The astronomers noted that the faraway galaxy also would be an ideal target for the Atacama Large Millimeter Array (ALMA), which, when completed in 2012, will be the most powerful radio telescope in the world. "ALMA and JWST working together would be an ideal combination to really understand this galaxy," Illingworth said, noting that "JWST's images and ALMA's measurement of the gas motions will provide revolutionary insights into the very youngest galaxies."
The astronomers will conduct follow-up observations with infrared spectroscopy to confirm the galaxy’s distance using the Keck telescope atop Mauna Kea in Hawaii.

The results will be published in the *Astrophysical Journal.*

**Mars Rovers Sharpen Questions About Livable Conditions**

(NASA/JPL) Like salt used as a preservative, high concentrations of dissolved minerals in the wet, early-Mars environment known from discoveries by NASA’s *Opportunity* rover may have thwarted any microbes from developing or surviving.

"Not all water is fit to drink," said Andrew Knoll, a member of the rover science team who is a biologist at Harvard University, Cambridge, Mass.

*Opportunity* and its twin, *Spirit,* began their fifth year on Mars in January, far surpassing their prime missions of three months. Recently, at a meeting of the American Association for the Advancement of Science in Boston, scientists and engineers discussed new observations by the rovers, recent analysis of some earlier discoveries, and perspectives on which lessons from these rovers’ successes apply to upcoming missions to Mars.

"The engineering efforts that have enabled the rovers’ longevity have tremendously magnified the science return," said Steve Squyres of Cornell University, Ithaca, N.Y., principal investigator for the rovers’ science payload. "All of *Spirit*’s most important findings, such as evidence for hot springs or steam vents, came after the prime mission."

*Opportunity* spent recent months examining a bright band of rocks around the inner wall of a crater. Scientists previously hypothesized this material might preserve a record of the ground surface from just before the impact that excavated the crater. Inspection suggests that, instead, it was at the top of an underground water table, Squyres reported.

Experiments with simulated Martian conditions and computer modeling are helping researchers refine earlier assessments of whether...
the long-ago conditions in the Meridiani area studied by Opportunity would have been hospitable to microbes. Chances look slimmer. "At first, we focused on acidity, because the environment would have been very acidic," Knoll said. "Now, we also appreciate the high salinity of the water when it left behind the minerals Opportunity found. This tightens the noose on the possibility of life."

Conditions may have been more hospitable earlier, with water less briny, but later conditions at Meridiani and elsewhere on the surface of Mars appear to have been less hospitable, Knoll said. "Life at the Martian surface would have been very challenging for the last 4 billion years. The best hopes for a story of life on Mars are at environments we haven’t studied yet, older ones, subsurface ones," he said.

NASA’s current rovers and orbiters at Mars pursue the agency’s "follow the water" theme for Mars exploration. They decipher the roles and fate of water on a planet whose most striking difference from Earth is a scarcity of water. "Our next missions, Phoenix and Mars Science Laboratory, mark a transition from water to habitability, assessing whether sites where there’s been water have had conditions suited to life," said Charles Elachi, director of NASA’s Jet Propulsion Laboratory, Pasadena, Calif. "Where conditions were habitable, later missions may look for evidence of life."

Elachi cited the achievements of Spirit and Opportunity. "They have worked 16 times longer than planned, driven 20 times farther than planned, and, most important, found diverse geological records of the effects of water in ancient Martian environments," he said. "We must not let these successes lull us into thinking this type of exploration is easy. Fifty years into the Space Age, we are still in the golden age of robotic exploration of our solar system, when each mission is unprecedented in some way as we push the limits of what is possible. Each mission presents new challenges."

The Phoenix lander, on course to reach Mars on May 25, will assess habitability of a shallow subsurface environment of icy soil farther north than any earlier mission has landed. It revives technology from missions launched before Spirit and Opportunity. The following mission, the Mars Science Laboratory rover, will incorporate many lessons from the current rovers, said that project's manager, Richard Cook of JPL. "The next rover will be much bigger to carry the instruments necessary for meeting its goals, but it would be laughable to consider doing Mars Science Laboratory without the experience gained from doing the Mars Exploration Rovers," he said.

The Mars Science Laboratory rover will weigh about four times as much as Spirit or Opportunity. "There’s no way we could use an airbag landing," said JPL’s Rob Manning, chief engineer for the future rover. Instead, a rocket-powered hovering stage will lower it to the surface on a tether. Lessons from Spirit and Opportunity will come into play when it starts driving, though. "With the current rovers, we’ve learned we can trust the autonomous navigation technology to a level we never expected, so now we can include that as a capability in our mission design for Mars Science Laboratory," Manning said.

Jet Propulsion Laboratory (JPL), a division of the California Institute of Technology, Pasadena, built and manages the rovers for NASA’s Science Mission Directorate.
Two Studies of Next Generation Astronomy

(NASA/STScI) Two astronomers at the Space Telescope Science Institute (STScI) in Baltimore, Md., Dr. Marc Postman and Dr. Ken Sembach, have been selected among 19 science teams to conduct year-long studies of new concepts for NASA’s next generation of major observatories. The studies will help the agency make decisions about how it explores the heavens in the future, following the Astronomy and Astrophysics Decadal Survey.

Postman’s group will study the feasibility of building the Advanced Technology Large-Aperture Space Telescope (ATLAS Telescope), which will have more than 40 times the sensitivity of the Hubble Space Telescope. The telescope would have a primary mirror that could be as large as 16 meters in diameter, and could be carried aboard NASA’s planned Ares V heavy-lift launch vehicle. The telescope would be located 1 million miles away at a gravitational balancing point in space called L2, where the James Webb Space Telescope will be perched when it is launched in 2013.

"The ATLAS telescope will revolutionize astronomy. It will enable us to definitively answer the question: 'Are there life-bearing Earth-like planets in our Galaxy?' Postman said. "It will allow us to map the dark matter around galaxies in unprecedented detail, giving us fundamentally new insights into how structure in the universe develops over time. And it will allow us to detect individual Sun-like stars in galaxies as far away as 30 million light-years, allowing us to reconstruct the assembly histories of 20 times as many galaxies as we can do with current telescopes. The primary goal of our study is to identify a path to developing the key technologies that we need to bring us to a state-of-the-art that, in ten years from now, will allow us to build a telescope much more powerful than Hubble but at similar cost."

Ken Sembach’s team will study the feasibility of building a Space Telescope that could have more than 100 times the sensitivity of the Hubble Space Telescope. The telescope would be located at a station 6.5 million miles from Earth, where it would be perched when it is launched in 2017.

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For information, call 702-651-4505 in Las Vegas or 775-784-4812 in Reno.
of adding ultraviolet spectrographs to large space telescopes. This novel instrumentation will bolster observational cosmology by examining the "cosmic web" in much greater detail than is possible with Hubble or the Far Ultraviolet Spectroscopic Explorer. This web is made up of great filaments of dark matter which interacts with the evolution of stars and galaxies. Observations of the cosmic web will provide fundamental tests of cosmological theory.

"Our goal is to reduce the cost of future NASA missions by producing novel instrument designs and a roadmap for investments in enabling technologies at ultraviolet wavelengths," Sembach said. "We expect that such investments will revolutionize studies of the filamentary cosmic web of tenuous gas that surrounds and connects galaxies."

Every 10 years, astronomers and physicists from across the U.S. work with the National Academy of Sciences to define the future research directions for the fields of astronomy and astrophysics. The science teams’ work is part of an effort to ensure that technical and cost input is accurate for this upcoming Astronomy and Astrophysics Decadal Survey. The survey produces directions that guide federal agencies such as NASA and the National Science Foundation in planning their programs over the coming decade.

"Astrophysics is truly in a golden age, revolutionizing our knowledge of topics as diverse and compelling as the origin and evolution of the universe, the physics of black holes and the distribution and habitability of planetary systems across our galaxy," said Alan Stern, associate administrator for the Science Mission Directorate at NASA Headquarters, Washington. "The exciting new astrophysics mission concept studies we are funding will seed preparations for astronomical space missions and paradigm-shifting discoveries across the early 21st century. Today, NASA’s Science Mission Directorate is setting sail on a whole new chapter in continued U.S. leadership in astrophysics."

The concept studies total approximately $12 million in fiscal years 2008 and 2009, ranging in cost from $250,000 to $1 million.

"The number, range, and quality of the proposals submitted indicate very powerfully the level of enthusiasm in the community for addressing frontier astrophysics research and employing the very latest technologies," said Jon Morse, division director for Astrophysics, NASA Headquarters. "This early investment directed toward the decadal study will pay off in the coming years."

The studies’ results are expected in March 2009. Concepts that rank highly in the decadal survey may result in missions that would launch after the suite of missions in development, such as the Gamma-ray Large Area Space Telescope, scheduled to launch in May, the Kepler mission, scheduled to launch in 2009, and the James Webb Space Telescope, scheduled to launch in 2013.

Postman is a senior astronomer at STScI and head of the Institute’s Community Missions Office, which provides science operations support for a number of additional missions and projects including the data management center for the Kepler Mission and the data archive center for all of NASA’s optical/ultraviolet missions.

Sembach is currently the STScI’s Hubble Project Scientist, a position in which he is deeply involved in the scientific, operational, and managerial aspects of the Hubble Space Telescope.
Month in History

April

1: The first US weather satellite, *Tiros I*, was launched this day in 1960.
3: *Luna 10*, launched by the USSR, became the first craft to orbit the moon in 1966.
6: The *Long Duration Exposure Facility* (LDEF) launched aboard shuttle flight STS-41C in 1984 to study the effect exposure various materials to the space environment over extended time periods.
11: *Apollo 13* was launched on this date in 1970. Due to a failure in the Service Module, it traveled around the moon but was unable to land there.
12: Yuri Gagarin became the first person to orbit the earth aboard the *Vostok 1* in 1961. He traveled once around the earth during a 108 minute flight.
12: *Columbia*, piloted by John Young and Robert Crippen, became the first reusable spacecraft to orbit the earth in 1981. The two day mission was on the 20th anniversary of Gagarin’s first space flight.
14: Christiaan Huygens, the first to recognize the true nature of Saturn’s rings (in 1655), was born this date in 1629.
16: Wilbur Wright, co-inventor of the first practical heavier-than-air craft, was born in 1867.
18: *Salyut 1*, the first space station was launched on a Proton booster by the USSR in 1971.
20: The first flight by a “rocket belt” occurred on this date in 1961.
23: The first manned docking with a space station occurred on this date in 1971 (see April 18 above). Cosmonauts Shatalov, Yeliseyev and Rukavishnikov rode *Soyuz 10* to rendezvous with the new space station. While they docked with the station 15½ hours into the mission, they did not enter the station. After being docked for over 5 hours, the cosmonauts separated from the *Salyut 1* and returned to earth after less than two days in space.
24: Jeanne Baret became the first woman to circumnavigate the earth in 1769.
24: Vladimir Komarov became the first person to die in space in the *Soyuz 1* accident in 1967. The parachute tangled on reentry and the vehicle crashed to the ground.
24: China became the fifth nation to launch an artificial satellite in 1970.
25: In 1990 the crew of the Space Shuttle *Discovery* (STS-31) deployed the *Hubble Space Telescope*.
26: *Ariel 1*, built in the UK became the first international satellite when launched by a US booster in 1962.

Give a Star

A popular service of The CSN Planetarium lets you dedicate a star to a loved one. For a donation of $35, we will provide an attractive certificate that proclaims your dedication of the star of your choice to any other person. The certificate will have a chart of the constellation containing the star and complete information about the star. A donation of $100 will give you an exclusive dedication. Call 651-4138 or 651-4505 for further information.
Sky Calendar

All times are Pacific Daylight Time. Rise and set times are for the astronomical horizon at Las Vegas or Reno as noted.

The Planets

Mercury. Mercury is too close in direction to the sun to be easily observed. Superior conjunction on the far side of the sun occurs on April 16. Look for it in the evening sky in May.

Venus. Venus is too close in direction to the sun to be easily observed. It will reappear in the evening sky this Fall. Superior conjunction on the far side of the sun occurs on June 8.

Mars. Look for the red planet in the southwest in the early evening as it passes through Gemini. The nearly first quarter moon passes near Mars on the evening of April 11.

Jupiter. Jupiter, in Sagittarius, is in the southeast before sunrise. At mid-month it rises at about 2:00 am. On the morning of April 27, the waning crescent moon will be just below Jupiter in the early morning sky.

Saturn. Saturn, in the constellation of Leo, is near the bright star Regulus. Look for the waxing gibbous moon near Regulus and Saturn on April 15.

Uranus. Uranus is in the constellation of Aquarius where it is too close in direction to the sun to be seen. Conjunction on the far side of the sun occurred on March 8. Look for it in the early morning sky at the beginning of May.

Neptune. Neptune, in Capricornus, is visible in the early morning sky rising just before the sun. On the morning of April 2, Neptune will rise just above the waning crescent moon.

Dwarf Planets. (At mid-month - 15th)

<table>
<thead>
<tr>
<th>Planet</th>
<th>Constellation</th>
<th>Transit</th>
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<tbody>
<tr>
<td>Pluto</td>
<td>Sagittarius</td>
<td>5:09 am (37°)</td>
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<tr>
<td>Ceres</td>
<td>Taurus</td>
<td>3:22 pm (75°)</td>
</tr>
<tr>
<td>Eris</td>
<td>Cetus</td>
<td>12:42 pm (49°)</td>
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All Dwarf Planets require a telescope. Ceres is visible through most amateur telescopes. Pluto usually requires a telescope of at least 12" diameter. Eris ("EE-ris", formerly 2003 UB313), like most Trans-Neptunian objects, requires a professional sized telescope. Transit time and altitude (from Las Vegas) are when the object is at its highest in the southern sky.

The Moon

Each day the moon rises about one hour later than the day before. The New Moon (not visible) is in the direction of the sun and rises and sets with the sun. The first quarter moon rises at about noon and sets near midnight. The full moon is opposite the sun in the sky and rises at sunset and sets at sunrise. The last quarter moon rises near midnight and sets near noon. Perigee is when the moon is closest to the earth and apogee is when it is farthest. The distance varies by ±6% from the average.

<table>
<thead>
<tr>
<th>Date</th>
<th>Time</th>
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<tbody>
<tr>
<td>Last quarter</td>
<td>Mar. 29</td>
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<tr>
<td>New Moon</td>
<td>Apr. 5</td>
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<tr>
<td>First quarter</td>
<td>Apr. 12</td>
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<td>Full Moon</td>
<td>Apr. 20</td>
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<tr>
<td>Last quarter</td>
<td>Apr. 28</td>
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<tr>
<td>Apogee</td>
<td>Mar. 26</td>
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<td>Perigee</td>
<td>Apr. 7</td>
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<td>Apogee</td>
<td>Apr. 23</td>
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Terminology

When describing the positions of the planets with respect to the earth, there are several terms that are commonly used.

When a planet is in the same direction in the sky as the sun, it is said to be in conjunction. If we could see it amongst the glare of the sun, we would see it “in conjunction” with the sun in the sky. Conjunction is the worst time to try to see a planet in the sky.

For the planets Mercury and Venus, there are two possible conjunctions. Inferior conjunction occurs when the planet passes between the earth and sun. Superior conjunction occurs when the planet passes on the far side of the sun. The terms inferior and superior refer only to the relative distance from the earth.

It is possible for Mercury or Venus to pass directly in front of the sun when at inferior conjunction. Because the orbits of these planets are tilted a bit with respect to the orbit of the earth, these events are rare. This type of event is called a transit. The last transit of Mercury was last November. The next transit will be on May 9, 2016.

The last transit for the planet Venus was June 8, 2004. The next will be on June 6, 2012. There will not be another for over a century. Venus transits occur in pairs that are 8 years apart, but the pairs are separated from each other by nearly 125 years.

For the rest of the planets, there can only be one conjunction on the far side of the sun. These planets can never pass between the earth and sun.

The term opposition is used to describe the condition when the planet is opposite the sun in the sky as seen from the earth. When a planet is in opposition, it rises when the sun sets and sets when the sun rises. It is in the sky all night long. Opposition is also when a planet is closest to the earth. This provides the optimum time to view the planet.

Of the brighter planets, Mars will reach opposition this year on December 24. Mars oppositions are separated by about 26 months. Jupiter will reach conjunction on June 5. Saturn was at opposition on February 10 this year. Mercury and Venus can never be in opposition because they are always closer to the sun than the earth. These two planets oscillate back and forth with respect to the sun. They are sometimes visible in the morning sky and at other times in the evening sky.

The angle of a planet from the sun is called the elongation for the planet. The greatest elongation for Venus is about 45° (either east or west of the sun). Because of its elliptical orbit, Mercury’s greatest elongations can vary from 18° to 28°. Venus will be at its next greatest elongation in early June when it will be east of the sun in the evening sky. ☼
### Now Playing

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| **Astronaut** and **Sky Watch**  
*Saturday Matinee*  
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