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Hubble’s New Shot of Our Nearest Neighbor

(NASA/STScI) Shining brightly in this Hubble Space Telescope image is our closest stellar neighbor: Proxima Centauri.

Proxima Centauri lies in the constellation of Centaurus (the Centaur), just over four light-years from Earth. Although it looks bright through the eye of Hubble, as you might expect from the nearest star to the solar system, Proxima Centauri is not visible to the naked eye. Its average luminosity is very low, and it is quite small compared to other stars, at only about an eighth of the mass of the Sun.

However, on occasion, its brightness increases. Proxima is what is known as a "flare star," meaning that convection processes within the star's body make it prone to random and dramatic changes in brightness. The convection processes not only trigger brilliant bursts of starlight but, combined with other factors, mean that Proxima Centauri is in for a very long life. Astronomers predict that this star will remain middle-aged, or a "main sequence" star in astronomical terms, for another four trillion years, some 300 times the age of the current universe.

These observations were taken using Hubble’s Wide Field and Planetary Camera 2 (WFPC2). Proxima Centauri is actually part of a triple star system, its two companions, Alpha Centauri A and B, lie out of frame.

Although by cosmic standards it is a close neighbor, Proxima Centauri remains a point-like object even using Hubble's eagle-eyed vision, hinting at the vast scale of the universe around us. ☀
Deepest Ever Probe of the Universe

(NASA/STScI) NASA’s Great Observatories are teaming up to look deeper into the universe than ever before. With a boost from natural "zoom lenses" found in space, they should be able to uncover galaxies that are as much as 100 times fainter than what the Hubble, Spitzer, and Chandra space telescopes can typically see.

This ambitious collaborative program is called The Frontier Fields. Astronomers will spend the next three years peering at six massive clusters of galaxies. Researchers are interested not only as to what’s inside the clusters, but also what’s behind them. The gravitational fields of the clusters brighten and magnify distant background galaxies that are so faint they would otherwise be unobservable.

The clusters themselves are among the most massive assemblages of matter known. Astronomers anticipate that these observations will reveal populations of never-before-seen galaxies that existed when the universe was only a few hundred million years old. The Hubble and Spitzer data will be combined to measure the galaxies' distances and masses more accurately than either observatory could measure alone, demonstrating the synergy of these Great Observatories for such studies. The Chandra X-ray Observatory will also peer deep into the fields, imaging them at X-ray wavelengths to help determine the masses and lensing power of the clusters, as well as identify background galaxies with massive black holes.

"The idea is to use nature’s natural telescopes in combination with the Great Observatories to look much deeper than before and find the most distant and faint galaxies we can possibly see," said principal investigator Jennifer Lotz of the Space Telescope Science Institute (STScI) in Baltimore, Md.

"We want to understand when and how the first stars and galaxies formed in the universe, and each Great Observatory gives us a different piece of the puzzle. Hubble tells you which galaxies to look at and how many stars are being born in those systems. Spitzer tells you how old the galaxy is and how many stars have formed," said Peter Capak, the Spitzer principal investigator of the Frontier Fields program.

The high-resolution Hubble data from the Frontier Fields program will also be used to...
trace the distribution of dark matter within the foreground clusters. Accounting for the bulk of the universe’s mass, dark matter is the underlying, invisible scaffolding attached to galaxies. "The apparent positions of those lensed galaxies then tell you what’s happening with the cluster itself, where the dark matter is in that cluster," Lotz said. "We’ll use that information to make a better model of the cluster to better understand its lensing power."

The *Hubble* and *Spitzer* observations will be much more challenging for researchers than previous deep fields that have been studied by this powerful pair of observatories with great success. "With a deep image, you’ve got a direct image, what you see is what you get. But when we use a gravitational lens, background galaxies appear distorted and brighter," Lotz said. "In order to understand the true properties of a background galaxy, you have to understand how it is distorted and how it is magnified. This depends on the distribution of dark matter in the gravitational lens, the foreground cluster."

What’s more, the galaxies seen in previous ultra-deep fields are just the most massive at those epochs. "They are the tip of the iceberg. If you want to see the galaxies that will turn into ones like our Milky Way, you have to go much fainter," Lotz said. Without using the big natural telescopes in space, astronomers would have to wait for the *James Webb Space Telescope.* In fact, the Frontier Fields offer a sneak peek of what the *Webb* telescope will routinely see anywhere it points in space, when it is launched in 2018.

The *Hubble* Frontier Fields initiative grew out of high-level discussions at STScI concerning what important, forward-looking science *Hubble* should be doing in upcoming years. Despite several deep field surveys, astronomers realized that a lot was still to be learned about the distant universe. And, such knowledge would help in planning the observing strategy for the *Webb* telescope.

To get a better assessment of whether doing more deep field observations was scientifically interesting or urgent, STScI chartered a "Hubble Deep Field Initiative" working group, which included U.S. and European astronomers who were expert users of the Great Observatories. The astronomers also considered synergies with other observatories, such as *Spitzer, Chandra,* and the new Atacama Large Millimeter Array. STScI Director Matt Mountain allocated his director’s discretionary time to the program.

The first object to be looked at this month is called Pandora’s Cluster (Abell 2744), which has been previously observed by all three Great Observatories but not to the depth of the new observations. The giant galaxy cluster appears to be the result of a simultaneous pile-up of at least four separate, smaller galaxy clusters that took place over a span of 350 million years.

**Neutron Star Undergoes Wild Behavior Changes**

(NASA/CXC) These two images from NASA’s *Chandra X-ray Observatory* show a large change in X-ray brightness of a rapidly rotating neutron star, or pulsar, between 2006 and 2013. The neutron star, the extremely dense remnant left behind by a supernova, is in a tight orbit around a low mass star. This binary star system, IGR J18245-2452 is a member of the globular cluster M28.

As described in a press release from the European Space Agency, IGR J18245-2452 provides important information about the evolution of pulsars in binary systems. Pulses of radio waves have been observed from the neutron star as it makes a complete rotation every 3.93 milliseconds (an astonishing rate of 254 times every second), identifying it as a "millisecond pulsar."

The widely accepted model for the evolution of these objects is that matter is pulled from the companion star onto the surface of the neutron star via a disk surrounding it. During this so-called accretion phase, the system is
described as a low-mass X-ray binary because bright X-ray emission from the disk is observed. Spinning material in the disk falls onto the neutron star, increasing its rotation rate. The transfer of matter eventually slows down and the remaining material is swept away by the whirling magnetic field of the neutron star as a millisecond radio pulsar forms.

The complete evolution of a low-mass X-ray binary into a millisecond pulsar should happen over several billion years, but in the course of this evolution, the system might switch rapidly between these two states. The source IGR J18245-2452 provides the first direct evidence for such drastic changes in behavior. In observations from July 2002 to May 2013 there are periods when it acts like an X-ray binary and the radio pulses disappear, and there are times when it switches off as an X-ray binary and the radio pulses turn on.

The latest observations with both X-ray and radio telescopes show that the transitions between an X-ray binary and a radio pulsar can take place in both directions and on a time scale that is shorter than expected, maybe only a few days. They also provide powerful evidence for an evolutionary link between X-ray binaries and radio millisecond pulsars.

The X-ray observations contained data from Chandra, ESA’s XMM-Newton, the International Gamma-Ray Astrophysics Laboratory (INTEGRAL) and NASA’s Swift/XRT and the radio observations used the Australia Telescope Compact Array, the Green Bank Telescope, Parkes radio telescope and the Westerbok Synthesis Radio Telescope.

The observations of IGR J18245-2452 and their implications are described in a paper published in the September 26th, 2013 issue of *Nature*. The first author is Alessandro Papitto from the Institute of Space Sciences in Barcelona, Spain. The co-authors are C. Ferrigno and E. Bozzo from Université de Genève, Versoix, Switzerland; N. Rea from the Institute of Space Sciences in Barcelona, Spain; L. Pavan from Université de Genève, Versoix, Switzerland; L. Burderi from Università di Cagliari, Monserrato, Italy; M. Burgay from INAF-Osservatorio Astronomico di Cagliari, Capoterra, Italy; S. Campana from INAF-
An international team of astronomers has found the most distant gravitational lens yet—a galaxy that, as predicted by Albert Einstein’s general theory of relativity, deflects and intensifies the light of an even more distant object. The discovery provides a rare opportunity to directly measure the mass of a distant galaxy. The observation also poses a mystery: lenses of this kind should be exceedingly rare. Given this and other recent finds, astronomers either have been phenomenally lucky or, more likely, they have underestimated substantially the number of small, very young galaxies in the early universe.

The team is composed of Arjen van der Wel, Glenn van de Ven, Michael Maseda, and Hans-Walter Rix (Max Planck Institute for Astronomy [MPIA]), Gregory Rudnick (University of Kansas and MPIA), Andrea Grazian (INAF), Steven Finkelstein (University of Texas at Austin), David Koo and Sandra M. Faber (University of California, Santa Cruz), Henry Ferguson, Anton Koekemoer, and Norman Grogin (STScI), and Dale Kocevski (University of Kentucky).

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**Most Distant Gravitational Lens**

(NASA/STScI) An international team of astronomers has found the most distant gravitational lens yet—a galaxy that, as predicted by Albert Einstein’s general theory of relativity, deflects and intensifies the light of an even more distant object. The discovery provides a rare opportunity to directly measure the mass of a distant galaxy. The observation also poses a mystery: lenses of this kind should be exceedingly rare. Given this and other recent finds, astronomers either have been phenomenally lucky or, more likely, they have underestimated substantially the number of small, very young galaxies in the early universe.

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**Galaxy Found in Survey Has Farthest Confirmed Distance**

(NASA/STScI) A team of astronomers has discovered a galaxy that sets the current distance record for galaxies whose distance has been definitively measured by spectroscopic redshift. The galaxy is seen as it was at a time just 700 million years after the Big Bang, when the universe was only about 5 percent of its current age of 13.8 billion years. This galaxy
and dozens of others were selected for follow-up observations from the approximately 100,000 galaxies discovered in the Hubble Space Telescope CANDELS survey (Cosmic Assembly Near-infrared Deep Extragalactic Legacy Survey). The team used the Keck I Telescope in Hawaii to measure the redshift of the CANDELS galaxy, designated z8_GND_5296, at 7.51. This is the highest galaxy redshift ever confirmed. The spectral redshift of galaxies is caused by the expansion of space from the Big Bang.

Water-rich Planetary Building Blocks Found Around White Dwarf

(NASA/STScI) Astronomers using NASA’s Hubble Space Telescope have found the building blocks of solid planets that are capable of having substantial amounts of water. This rocky debris, currently orbiting a white dwarf star called GD 61, is considered a relic of a planetary system that survived the burnout of its parent star. The finding suggests that the star system, located about 150 light-years away and at the end of its life, had the potential to contain Earth-like exoplanets, the researchers say.

"These water-rich building blocks, and the terrestrial planets they assemble, may in fact be common. A system cannot create things as big as asteroids and avoid building planets, and GD 61 had the ingredients to deliver lots of water to their surfaces," according to Jay Farihi of the University of Cambridge, UK. Though it's hard to predict exactly what types of planets there might have been, Farihi emphasized that, "Our results demonstrate that there was definitely potential for habitable planets in this exoplanetary system. The system almost certainly had (and possibly still has) planets, and it had the ingredients to deliver lots of water to their surfaces."

The new research findings are reported recently in the journal Science.

Observations made with Hubble's Cosmic Origins Spectrograph (COS) allowed the team, led by Farihi, to do a robust chemical analysis of the debris falling into GD 61. The discovery complements other leading astronomical observations that measure the size and density of planets, but not their actual composition, say researchers.

"The only feasible way to see what a distant planet is made of is to take it apart, and nature does this for us using the strong gravitational tidal forces of white dwarf stars," said Farihi. "This technique allows us to look at the chemistry that builds rocky planets, and is a completely independent method from other types of exoplanet observations."

The white dwarf GD 61 is a relic of a star that once burned hotter and brighter than our Sun. The star exhausted its fuel in just 1.5 billion years. (Our Sun will last roughly ten times as long.)

NASA's Far Ultraviolet Space Explorer first found an abundance of oxygen in the dwarf's atmosphere in 2008. Eventually astronomers realized that this was the telltale signature of material falling into the star and polluting its atmosphere. White dwarfs typically have pure
The Astronomy Store

The CSN Planetarium
open 5 pm to 9 pm Friday & 3 pm to 9 pm Saturday

The Astronomy Store features items for sale that are of interest to the patrons of The Planetarium. We carry a wide variety of novelties, toys and observing aids with a space or astronomical theme. When patrons obtain their tickets to planetarium shows, they can also purchase a variety of astronomically oriented items. Friends of The Planetarium receive a 10% discount.

The only way to obtain a more precise measurement of the amount of oxygen in the debris around GD 61 requires observations in the ultraviolet, which can only be carried out above Earth's atmosphere. The team used COS aboard Hubble to obtain the required data. The COS observations were then analyzed by Detlev Koester of the University of Kiel, Germany, using a computer model of the white dwarf atmosphere to derive the elemental abundances.

Combing their results with a previous study that used the W. M. Keck Observatory on the summit of Mauna Kea, Hawaii, the team also detected magnesium, silicon, and iron, which, together with oxygen, are the main components of rocks. By counting the number of these elements relative to oxygen the researchers were able to predict how much oxygen should be in the atmosphere of the white dwarf. They found significantly more oxygen than should have been carried by rocky minerals alone. "The oxygen excess can be carried by either water or carbon monoxide or dioxide. In this star there is virtually no carbon, indicating there must have been substantial water," said Boris Gänsicke of the University of Warwick, in Coventry, UK. He added that the small amount of carbon seen in the white dwarf rules out comets as the source of water. Comets are rich in both water and carbon compounds.

In their Hubble survey the team observed nearly 100 white dwarfs. Analysis is still ongoing, but the team estimates that at least 20% of the dwarfs show ongoing accretion of planetary debris, and it could possibly be as high as 50%.

How do the asteroids fall into the stellar remnant? The best model at present is based on how Jupiter perturbs members of our main asteroid belt. The Kirkwood Gaps in the asteroid belt represent areas where asteroids lose energy to Jupiter and sometimes fall into the Sun.

Infrared observations using the Spitzer telescope show that Sun-like stars that are similar to the parent...
star of GD 61 have inner debris belts analogous to our main asteroid belt. And, interestingly, these systems appear to have a gap just outside their inner belts that may be caused by one or more planets, say the investigators. "It looks like a pattern of a planet next to an asteroid belt whose members get thrown into the star may be a common feature of solar systems," said Farihi.

Earth is essentially a "dry" planet, with only 0.02 percent of its mass as surface water. So oceans came long after it had formed, most likely when water-rich asteroids in the solar system crashed into our planet.

The new discovery shows that the same water "delivery system" could have occurred in this distant, dying star's solar system, as this latest evidence points to it containing a similar type of water-rich asteroid that would have first brought water to Earth.

Six billion years from now an alien astronomer measuring similar abundances in the atmosphere of our burned-out Sun may reach the same conclusion that terrestrial planets once circled our parent star. Though the progenitor star was different from our Sun, nevertheless, "it's a look into our future," said Gänsicke.

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**Hubble Sees Asteroid Spout Six Comet-like Tails**

(NASA/STScI) Astronomers using NASA's *Hubble Space Telescope* have identified what they can only describe as a never-before-seen "weird and freakish object" in the asteroid belt that looks like a rotating lawn sprinkler.

Normal asteroids should appear simply as tiny points of light. But this asteroid, designated P/2013 P5, has six comet-like tails of dust radiating from it like spokes on a wheel.

Because nothing like this has ever been seen before, astronomers are scratching their heads to find an adequate explanation for its out-of-this-world appearance.

"We were literally dumbfounded when we saw it," said lead investigator David Jewitt of the University of California at Los Angeles. "Even more amazing, its tail structures change dramatically in just 13 days as it belches out dust. That also caught us by surprise. It's hard to believe we're looking at an asteroid."

One interpretation is that the asteroid's rotation rate increased to the point where its surface started flying apart, ejecting dust in episodic eruptions starting last spring. The team rules out a recent asteroid impact scenario because a lot of dust would be blasted into space all at once, whereas P5 has ejected dust for at least five months.

The asteroid was discovered as an unusually fuzzy-looking object with the Pan-STARRS survey telescope in Hawaii. The multiple tails were discovered in *Hubble* images taken on Sept. 10, 2013.

When *Hubble* returned to the asteroid on Sept. 23, its appearance had totally changed. It looked as if the entire structure had swung around. "We were completely knocked out," Jewitt said.

Careful modeling by team member Jessica Agarwal of the Max Planck Institute for Solar System Research, showed that the tails could have been formed by a series of impulsive dust-ejection events. She calculated that the first ejection event occurred on April 15 and the last one on Sept. 4. The rest sequentially erupted on July 18, July 24, Aug. 8, and Aug. 26. Radiation pressure from the Sun smears out the dust into streamers.
The asteroid could possibly have been spun up if the pressure of sunlight exerted a torque on the body. If the asteroid’s spin rate became fast enough, Jewitt said, the asteroid's weak gravity would no longer be able to hold it together. Dust might avalanche downslope towards the equator, and maybe shatter and fall off, eventually drifting into space to make a tail. So far, only a small fraction of the main mass, perhaps 100 to 1,000 tons of dust, has been lost. The 700-foot-radius nucleus is thousands of times more massive.

Follow-on observations may show if the dust leaves the asteroid in the equatorial plane, and this would be pretty strong evidence for a rotational breakup. Astronomers will also try to measure the asteroid’s true spin rate.

Jewitt’s interpretation implies that rotational breakup must be a common phenomenon in the asteroid belt; it may even be the main way in which small asteroids die. "In astronomy, where you find one, you eventually find a whole bunch more," Jewitt said. "This is just an amazing object to us, and almost certainly the first of many more to come."

The paper from Jewitt’s team appeared online in the Nov. 7 issue of The Astrophysical Journal Letters.

Jewitt said that the orbit of the asteroid could make it a member of the Flora asteroid family. This means that it is probably a piece from an asteroid collision that occurred roughly 200 million years ago. The resulting collision fragments are still following similar orbits. Meteorites from these bodies show evidence of having been heated to as much as 1,500°F. This means the asteroid is likely made of metamorphic rocks and so is not capable of holding ices as comets do. ☛
The Day the Earth Smiled

(NASA/JPL) On July 19, 2013, in an event celebrated the world over, NASA's Cassini spacecraft slipped into Saturn's shadow and turned to image the planet, seven of its moons, its inner rings, and, in the background, our home planet, Earth.

With the sun’s powerful and potentially damaging rays eclipsed by Saturn itself, Cassini’s onboard cameras were able to take advantage of this unique viewing geometry. They acquired a panoramic mosaic of the Saturn system that allows scientists to see details in the rings and throughout the system as they are backlighted by the sun. This mosaic is special as it marks the third time our home planet was imaged from the outer solar system; the second time it was imaged by Cassini from Saturn’s orbit; and the first time ever that inhabitants of Earth were made aware in advance that their photo would be taken from such a great distance.

With both Cassini’s wide-angle and narrow-angle cameras aimed at Saturn, Cassini was able to capture 323 images in just over four hours. This final mosaic uses 141 of those wide-angle images. Images taken using the red, green and blue spectral filters of the wide-angle camera were combined and mosaicked together to create this natural-color view.

This image spans about 404,880 miles across. The outermost ring shown here is Saturn’s E ring, the core of which is situated about 149,000 miles from Saturn. The geysers erupting from the south polar terrain of the moon Enceladus supply the fine icy particles that comprise the E ring; diffraction by sunlight gives the ring its blue color. Enceladus (313 miles across) and the extended plume formed by its jets are visible, embedded in the E ring on the left side of the mosaic.

In the lower right of the mosaic, in between the bright blue E ring and the faint but defined G ring, is the pale blue dot of our planet, Earth. Earth’s twin, Venus, appears as a bright white dot in the upper left quadrant of the mosaic, also between the G and E rings. Mars also appears as a faint red dot embedded in the outer edge of the E ring, above and to the left of Venus. For ease of visibility, Earth, Venus, Mars, Enceladus, Epimetheus and Pandora were all brightened by a factor of eight and a half relative to Saturn. Tethys was brightened by a factor of four.

Some ring features, such as full rings traced out by tiny moons, do not appear in this version of the mosaic because they require extreme computer enhancement, which would adversely affect the rest of the mosaic.

This view looks toward the unlit side of the rings from about 17° below the ring plane. This mosaic was made from pictures taken over a span of more than four hours. Thus, due to spacecraft motion, these objects were not in these specific places over the entire duration of the imaging campaign. Venus appears far from Earth, as does Mars, because they were on the opposite side of the sun from Earth.
Month in History

January

1: Ceres, the first asteroid was discovered by Giuseppe Piazzi from his observatory in Sicily in 1801.
2: The Soviet Union launched Luna 1 on this date in 1959. It became the first vehicle to fly by the moon to an orbit about the sun.
4: Sputnik 1, the first artificial satellite of the earth, reentered the earth’s atmosphere on this date in 1958 and was destroyed.
4: The 150 foot solar observatory at Mount Wilson, California, began publishing daily sunspot drawings in 1917. This continued until September 16, 2004.
5: The trans-Neptunian object Eris is discovered in 2005 igniting the debate on the planetary status of Pluto. Both became categorized as dwarf planets.
7: Galileo, using a telescope to view Jupiter for the first time, saw three of the four major moons of that giant planet.
9: Thomas Henderson, the first Astronomer Royal of Scotland, published the first accurate determination for the distance to Alpha Centauri in 1839.
10: American scientists became the first to bounce a radar signal off of another celestial body when they detected the reflected return signal beamed towards the moon three seconds earlier on this date in 1946.
11: William Herschel discovered the first moon of Uranus in 1787, six years after he discovered the planet. This moon was later named Titania.
13: Galileo discovered the fourth of Jupiter’s major moon in 1610, just six days after his discovery of the other three major moons.
13: An editorial in the New York Times on this day in 1920 ridiculed a monograph by Robert Goddard which proposed that rockets could be used to reach the moon.
14: The Soviet Union became the first country to successfully dock two manned spacecraft in 1969.
17: Captain James Cook became the first western navigator to cross the Antarctic Circle in 1773.
18: Captain James Cook became the first Westerner to reach the Sandwich Islands in 1778. The island chain is now known as the Hawaiian Islands.
21: Pluto crossed the orbit of Neptune in 1979 making Neptune the farthest planet from the sun. This condition remained until Pluto again crossed the orbit of Neptune outbound in 1999.
24: Voyager 2 became the first craft to fly by Uranus returning photographs in 1986.
24: The United States launched Discovery on the 100th manned space mission in 1985.
27: A fire aboard the Apollo 1 spacecraft destroyed the vehicle during a preflight test in 1967. The crew of Virgil “Gus” Grissom, Edwin White and Roger Chafee were killed.
28: An explosion 73 seconds into the flight of the space shuttle Challenger destroyed the craft in 1986 killing the crew of seven.
31: Explorer 1, the first artificial satellite of the earth launched by the United States achieved orbit on this day in 1958. Data from by this satellite led to the discovery of the Van Allen radiation belt.

Take a Field Trip to a Planetarium

Shows available for all grade levels are offered Monday thru Friday at both the Fleischmann Planetarium and the CSN Planetarium. For information, call 702-651-4505 in Las Vegas or 775-784-4812 in Reno.
### Sky Calendar

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

#### The Planets

**Mercury.** Mercury is visible late in the month in the evening sky setting shortly after the sun. Superior conjunction on the far side of the sun occurred on December 28. Greatest eastern elongation (18°) occurs on January 31.

**Venus.** Venus is too close in direction to the sun to be seen until late in the month. It passes between the earth and sun (inferior conjunction) on January 11. By the end of the month it will be visible in the morning sky rising shortly before the sun.

**Mars.** Mars, in Virgo, is rising a bit before midnight. The waning gibbous moon rises shortly before Mars on the night of January 21.

**Jupiter.** Jupiter, in Gemini, is rising at about sunset. Opposition (directly opposite the sun) occur on January 5. The nearly full moon is rising to the right of Jupiter on the evening of January 14.

**Saturn.** Saturn, in Libra, is rising about five hours before the sun.

**Uranus.** Uranus, at the Pisces/Cetus border, is high in the southwest in the early evening. The waxing crescent moon is to the right of Uranus on the evening of January 6.

**Neptune.** Neptune, in Aquarius, is low in the southwest at sunset. Look for the waxing crescent moon above Neptune on the evening of January 4.

#### 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>Dwarf Planets. (At mid-month - 15th)</th>
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<tbody>
<tr>
<td>Planet</td>
</tr>
<tr>
<td>Pluto</td>
</tr>
<tr>
<td>Ceres</td>
</tr>
<tr>
<td>Eris</td>
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<tr>
<td>MakeMake</td>
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<tr>
<td>Haumea</td>
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</tbody>
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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. Dwarf planets beyond the orbit of Neptune can also be referred to as Plutoids. Eris ("EE-ris"), MakeMake (mah-keh-mah-keh) and Haumea, like most Plutoids, require a professional sized telescope. Transit times and altitudes (from Las Vegas) are when the object is at its highest in the southern sky. Each will appear slightly lower in the sky from Reno.

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<table>
<thead>
<tr>
<th>New Moon</th>
<th>Jan. 1</th>
<th>3:14 am pst</th>
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</thead>
<tbody>
<tr>
<td>First quarter</td>
<td>Jan. 7</td>
<td>7:39 pm</td>
</tr>
<tr>
<td>Full Moon</td>
<td>Jan. 15</td>
<td>8:52 pm</td>
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<tr>
<td>Last quarter</td>
<td>Jan. 23</td>
<td>9:19 pm</td>
</tr>
<tr>
<td>New Moon</td>
<td>Jan. 30</td>
<td>1:39 pm</td>
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<tr>
<td>Perigee</td>
<td>Jan. 1</td>
<td>1:01 pm pst</td>
</tr>
<tr>
<td>Apogee</td>
<td>Jan. 15</td>
<td>7:54 pm</td>
</tr>
<tr>
<td>Perigee</td>
<td>Jan. 30</td>
<td>1:59 am</td>
</tr>
</tbody>
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### Perihelion

This year the earth is closest to the sun on January 4 at 4:00 am pst. The distance from the center of the sun to the center of the earth
is 147,104,850 km or 91,406,720 miles.

The average distance between the center of the earth and the center of the sun is called the astronomical unit (AU). The official value of the AU is 149,597,870 kilometers or 92,955,810 miles.

Because the orbit of the earth is slightly elliptical, the distance varies by about ±1.7%. On July 3, the earth will be farthest from the sun.  

**Meteor Shower**

The Quadrantid meteor shower will reach its peak on the night of January 3/4, 2014, in the early morning before dawn. This is normally one of the better showers during the year, typically producing over 60 meteors per hour and occasionally reaching over 200 per hour. The moon is near new moon phase on that date and will not interfere with this shower as it sets by 8 pm January 3.

While meteors from this shower can be seen anywhere in the sky, the paths that they take can be traced back across the sky to a point near the intersection of the constellations of Draco, Boötes and Hercules. This is called the radiant point for the shower. The shower takes its name from the now obsolete constellation in that region once called Quadrans Muralis (the Mural Quadrant).

Meteors from this shower can be seen for about a week on either side of the night of the maximum. However, this stream has a very small, dense, central region that produces most of the visible meteors. Before and after the night of January 3/4, expect less than 20 meteors per hour.

On the night of the peak, depending on the exact path of the earth through the stream and the time of passage, you may observe anywhere from 40 to 200 meteors per hour. Since the stream appears to have little dust, most of the shower meteors are bright and excellent objects for photography.

While most showers are best after midnight, the radiant for this shower is already above the horizon by 9:00 pm. Since the moon will have set by then, best viewing will begin at 9 pm and last through the night. In some years the Quadrantids are among the best meteor showers of the season, this year may be better than average.

Meteor showers are the result of the debris from comets. Most showers are associated with known comets. This old shower has no known comet associated with it. The comet that originated this stream probably ceased being a visible object over 500 years ago. Comet debris spreads out along the comet’s orbit. If that orbit crosses the orbit of the earth, then a meteor shower will occur on the date the earth travels through the stream.
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