Herbig-Haro 110

Fleischmann Planetarium
University of Nevada - Reno

The Planetarium
College of Southern Nevada - Las Vegas
Now Playing

Ancient Skies, Ancient Mysteries
2012: Mayan Prophecies
Secret of the Cardboard Rocket

Show Times:
Ancient Skies: 6:00 & 8:00 pm Friday & Saturday
Mayan Prophecies: 7:00 pm Friday & Saturday
Cardboard Rocket: 3:30 pm Saturday
General admission price: $6.00
Students, children & seniors: $4.00
Gift Shop: Fri.: 5 - 9 pm, Sat.: 3 - 9 pm

Seasonal Stargazing with all shows
The Student Observatory
Free observing sessions after 7:30 pm planetarium shows, weather permitting.

Solar Max in Skydome 8/70™
Tales of the Maya Skies in SciDome™
Impact Earth in SciDome™

Show Times:
Hourly from opening. Call for times and titles for additional programs.
General Admission: $7.00
Children and Seniors: $5.00
Open Monday-Thursday 12 noon - 5 pm
Friday & Saturday 10 am - 9 pm
Sunday 10 am - 5 pm
775-784-4811 Show Info.

Seasonal Stargazing with some shows
Telescope Viewing
Free observing sessions on the first Friday of each month at MacClean Observatory (Redfield Campus) starting 30 minutes after sunset. Weather permitting.

775-784-4812 Office
Dawn Leaves Vesta for Ceres

(NASA/JPL) After successfully completing nearly five months scrutinizing the giant asteroid Vesta at its lowest orbit altitude, NASA's Dawn spacecraft began its final major science data-gathering phase at Vesta on June 15, at an average altitude of 420 miles above the surface.

Over a period of six weeks, Dawn gently spiraled up from its lowest orbit, 130 miles above the surface, to the final planned science orbit, known as high-altitude mapping orbit 2. Observations obtained from this orbit will provide a companion set of data and images to those obtained during the first high-altitude mapping orbit phase, completed in October 2011. A key difference will be that the angle of sunlight hitting Vesta changed, illuminating more of its northern region. The principal science observations planned in this new orbit will be obtained with the framing camera and the visible and infrared mapping spectrometer.

Following this final science data gathering phase, Dawn then spent almost five weeks spiraling out from the giant asteroid to the point at which Vesta lost its gravitational hold on the spacecraft. That departure day was expected to be around August 26. Dawn turned to view Vesta as it left and acquired more data. Then, Dawn set its sights on the dwarf planet Ceres, and began a two-and-a-half year journey to investigate the largest body in the main asteroid belt. Dawn will enter orbit around Ceres in 2015.

Dawn's mission is managed by JPL for NASA's Science Mission Directorate in Washington. Dawn is a project of the directorate's Discovery Program, managed by NASA's Marshall Space Flight Center in Huntsville, Ala. UCLA is responsible for overall Dawn mission science. Orbital Sciences Corp. in Dulles, Va., designed and built the spacecraft. The German Aerospace Center, the Max Planck Institute for Solar System Research, the Italian Space Agency and the Italian National Astrophysical Institute are international partners on the mission team. The California Institute of Technology in Pasadena manages JPL for NASA.
Hubble Views a Cosmic Skyrocket

(NASA/STScI) Resembling a Fourth of July skyrocket, Herbig-Haro 110 is a geyser of hot gas from a newborn star that splashes up against and ricochets off the dense core of a cloud of molecular hydrogen. Although the plumes of gas look like whiffs of smoke, they are actually billions of times less dense than the smoke from a July 4 firework. This Hubble Space Telescope photo shows the integrated light from plumes, which are light-years across.

Herbig-Haro (HH) objects come in a wide array of shapes, but the basic configuration stays the same. Twin jets of heated gas, ejected in opposite directions away from a forming star, stream through interstellar space. Astronomers suspect that these outflows are fueled by gas accreting onto a young star surrounded by a disk of dust and gas. The disk is the "fuel tank," the star is the gravitational engine, and the jets are the exhaust.

When these energetic jets slam into colder gas, the collision plays out like a traffic jam on the interstate. Gas within the shock front slows to a crawl, but more gas continues to pile up as the jet keeps slamming into the shock from behind. Temperatures climb sharply, and this curving, flared region starts to glow. These "bow shocks" are so named because they resemble the waves that form at the front of a boat.

In the case of the single HH 110 jet, astronomers observe a spectacular and unusual permutation on this basic model. Careful study has repeatedly failed to find the source star driving HH 110, and there may be good reason for this: perhaps the HH 110 outflow is itself generated by another jet.

Astronomers now believe that the nearby HH 270 jet grazes an immovable obstacle, a much denser, colder cloud core, and gets diverted off at about a 60° angle. The jet goes dark and then reemerges, having reinvented itself as HH 110.

The jet shows that these energetic flows are like the erratic outbursts from a Roman candle. As fast-moving blobs of gas catch up and collide with slower blobs, new shocks arise along the jet’s interior. The light emitted from excited gas in these hot blue ridges marks the boundaries of these interior collisions. By measuring the current velocity and positions of different blobs and hot ridges along the chain within the jet, astronomers can effectively "rewind" the outflow, extrapolating the blobs back to the moment when they were emitted. This technique can be used to gain insight into the source star’s history of mass accretion.

This image is a composite of data taken with Hubble’s Advanced Camera for Surveys in 2004 and 2005 and the Wide Field Camera 3 in April 2011.
Why Is Earth So Dry?

(NASA/STScI) With large swaths of oceans, rivers that snake for hundreds of miles, and behemoth glaciers near the north and south poles, Earth doesn't seem to have a water shortage. And yet, less than one percent of our planet's mass is locked up in water, and even that may have been delivered by comets and asteroids after Earth's initial formation.

Astronomers have been puzzled by Earth's water deficiency. The standard model explaining how the solar system formed from a protoplanetary disk, a swirling disk of gas and dust surrounding our Sun, billions of years ago suggests that our planet should be a water world. Earth should have formed from icy material in a zone around the Sun where temperatures were cold enough for ices to condense out of the disk. Therefore, Earth should have formed from material rich in water. So why is our planet comparatively dry?

A new analysis of the common accretion-disk model explaining how planets form in a debris disk around our Sun uncovered a possible reason for Earth's comparative dryness. Led by Rebecca Martin and Mario Livio of the Space Telescope Science Institute in Baltimore, Md., the study found that our planet formed from rocky debris in a dry, hotter region, inside of the so-called "snow line." The snow line in our solar system currently lies in the middle of the asteroid belt, a reservoir of rubble between Mars and Jupiter; beyond this point, the Sun's light is too weak to melt the icy debris left over from the protoplanetary disk. Previous accretion-disk models suggested that the snow line was much closer to the Sun 4.5 billion years ago, when Earth formed.

"Unlike the standard accretion-disk model, the snow line in our analysis never migrates inside Earth's orbit," Livio said. "Instead, it remains farther from the Sun than the orbit of Earth, which explains why our Earth is a dry planet. In fact, our model predicts that the other innermost planets, Mercury, Venus, and Mars, are also relatively dry."

The results have been accepted for publication in the journal *Monthly Notices of the Royal Astronomical Society*.

In the conventional model, the protoplanetary disk around our Sun is fully ionized (a process where electrons are stripped off of atoms) and is funneling material onto our star, which heats up the disk. The snow line is initially far away from the star, perhaps at least one billion miles. Over time, the disk runs out of material, cools, and draws the snow line inward, past Earth's orbit, before there is sufficient time for Earth to form.

"If the snow line was inside Earth's orbit when our planet formed, then it should have been an icy body," Martin explained. "Planets such as Uranus and Neptune that formed beyond the snow line are composed of tens of percents of water. But Earth doesn't have much water, and that has always been a puzzle."

Martin and Livio's study found a problem with the standard accretion-disk model for the evolution of the snow line. "We said, wait a second, disks around young stars are not fully ionized," Livio said. "They're not standard disks because there just isn't enough heat and radiation to ionize the disk."

"Very hot objects such as white dwarfs..."
and X-ray sources release enough energy to ionize their accretion disks," Martin added. "But young stars don't have enough radiation or enough infalling material to provide the necessary energetic punch to ionize the disks."

So, if the disks aren't ionized, mechanisms that would allow material to flow through the region and fall onto the star are absent. Instead, gas and dust orbit around the star without moving inward, creating a so-called "dead zone" in the disk. The dead zone typically extends from about 0.1 astronomical unit to a few astronomical units beyond the star. (An astronomical unit is the distance between Earth and the Sun, which is roughly 93 million miles.) This zone acts like a plug, preventing matter from migrating towards the star. Material, however, piles up in the dead zone and increases its density, much like people crowding around the entrance to a concert, waiting for the gates to open.

The dense matter begins to heat up by gravitational compression. This process, in turn, heats the area outside the plug, vaporizing the icy material and turning it into dry matter. Earth forms in this hotter region, which extends to around a few astronomical units beyond the Sun, from the dry material. Martin and Livio's altered version of the standard model explains why Earth didn't wind up with an abundance of water.

Martin cautioned that the revised model is not a blueprint for how all disks around young stars behave. "Conditions within the disk will vary from star to star," Livio said, "and chance, as much as anything else, determined the precise end results for our Earth."

The discovery increases the number of known moons orbiting Pluto to five.

The Pluto team is intrigued that such a small planet can have such a complex collection of satellites. The new discovery provides additional clues for unraveling how the Pluto system formed and evolved. The favored theory is that all the moons are relics of a collision.
between Pluto and another large Kuiper belt object billions of years ago.

The new detection will help scientists navigate NASA's New Horizons spacecraft through the Pluto system in 2015, when it makes an historic and long-awaited high-speed flyby of the distant world.

The team is using Hubble's powerful vision to scour the Pluto system to uncover potential hazards to the New Horizons spacecraft. Moving past the dwarf planet at a speed of 30,000 miles per hour, New Horizons could be destroyed in a collision with even a BB-shot-size piece of orbital debris.

"The discovery of so many small moons indirectly tells us that there must be lots of small particles lurking unseen in the Pluto system," said Harold Weaver of the Johns Hopkins University Applied Physics Laboratory in Laurel, Md.

"The inventory of the Pluto system we're taking now with Hubble will help the New Horizons team design a safer trajectory for the spacecraft," added Alan Stern of the Southwest Research Institute in Boulder, Colo., the mission's principal investigator.

Pluto's largest moon, Charon, was discovered in 1978 in observations made at the United States Naval Observatory in Washington, D.C. Hubble observations in 2006 uncovered two additional small moons, Nix and Hydra. In 2011 another moon, P4, was found in Hubble data.

Provisionally designated S/2012 (134340) 1, the latest moon was detected in nine separate sets of images taken by Hubble's Wide Field Camera 3 on June 26, 27, and 29, 2012 and July 7 and 9, 2012.

In the years following the New Horizons Pluto flyby, astronomers plan to use the infrared vision of Hubble's planned successor, NASA's James Webb Space Telescope, for follow-up observations. The Webb telescope will be able to measure the surface chemistry of Pluto, its moons, and many other bodies that lie in the distant Kuiper Belt along with Pluto.

Hubble Unmasks Ghost Galaxies

(NASA/STScI) Astronomers have puzzled over why some puny, extremely faint dwarf galaxies spotted in our Milky Way galaxy's back yard contain so few stars.

These ghost-like galaxies are thought to be some of the tiniest, oldest, and most pristine galaxies in the universe. They have been discovered over the past decade by astronomers using automated computer techniques to search through the images of the Sloan Digital Sky Survey. But astronomers needed NASA's Hubble Space Telescope to help solve the mystery of these star-starved galaxies.

Hubble views of three of the small-fry galaxies reveal that their stars share the same birth date. The galaxies all started forming stars more than 13 billion years ago, and then abruptly stopped, all in the first billion years after the universe was born in the big bang.

The relic galaxies are evidence for a transitional phase in the early universe that shut down star-making factories in tiny galaxies. During this time, the first stars burned off a fog of cold hydrogen in a process called reionization.

"These galaxies are all ancient and they're all the same age, so you know something came
down like a guillotine and turned off the star formation at the same time in these galaxies," said Tom Brown of the Space Telescope Science Institute in Baltimore, Md., the study's leader. "The most likely explanation is reionization."

The reionization of the universe began in the first billion years after the big bang. During this epoch, radiation from the first stars knocked electrons off primeval hydrogen atoms, ionizing the cool hydrogen gas. This process allowed the hydrogen gas to become transparent to ultraviolet light.

Ironically, the same radiation that sparked universal reionization appears to have squelched star-making activities in dwarf galaxies, such as those in Brown's study. The small irregular galaxies were born about 100 million years before reionization began and had just started to churn out stars. Roughly 2,000 light-years wide, the galaxies are the smaller cousins of the more luminous star-making dwarf galaxies near our Milky Way. Unlike their larger relatives, the puny galaxies were not massive enough to shield themselves from the harsh ultraviolet light. What little gas they had was stripped away as the flood of ultraviolet light rushed through them. Their gas supply depleted, the galaxies could not make new stars.

The discovery could help explain the so-called "missing satellite problem," where only a few dozen dwarf galaxies have been observed around the Milky Way while computer simulations predict that thousands should exist. One possible explanation is that there has been very little, or even no star formation in the smallest of these dwarf galaxies, making them difficult to detect.

The Sloan survey recently uncovered more than a dozen of these star-starved galaxies in our Milky Way's neighborhood while scanning just a quarter of the sky. Astronomers think the rest of the sky should contain dozens more of these objects, dubbed ultra-faint dwarf galaxies. The evidence for squelched star formation in some of the smallest of these dwarfs suggests that there may be thousands more where essentially no stars formed at all.

"By measuring the star formation histories of the observed dwarfs, Hubble has confirmed earlier theoretical predictions that star formation in the smallest clumps would be shut down by reionization," said Jason Tumlinson of the Space Telescope Science Institute, a member of the research team.

Brown's results appeared in the July 1 issue of The Astrophysical Journal Letters. "These are the fossils of the earliest galaxies in the universe," Brown said. "They haven't changed in billions of years. These galaxies are unlike most nearby galaxies, which have long star-formation histories."

The stellar populations in these fossil galaxies range from a few hundred to a few thousand stars both fainter and brighter than our Sun. The galaxies may be star-deprived, but they have an abundance of dark matter, the underlying scaffolding upon which galaxies are built.

Normal dwarf galaxies near the Milky Way contain 10 times more dark matter than the ordinary matter that makes up gas and stars. In ultra-faint dwarf galaxies, dark matter outweighs ordinary matter by at least a factor of 100. "The small galaxies in our study are made up mostly of dark matter because their
hydrogen gas was ionized and the stars got turned off," Brown explained.

These mostly dark-matter islands coexisted unseen with our Milky Way for billions of years, until astronomers began finding them in the Sloan survey.

When these galaxies were uncovered, astronomers began proposing many reasons for their shortage of stars. Some believed that internal dynamics, such as a supernova blast, blew out the gas needed to create more stars. Others suggested that the galaxies simply used up what little gas they had. And a few thought that the galaxies were born during the early universe and reionization had turned off their star formation.

Then, ground-based observations of two of the newly discovered galaxies revealed tantalizing evidence that the stars were indeed ancient. So Brown decided to use Hubble's Advanced Camera for Surveys to look deep inside six of the galaxies to study the population of stars and determine when they were born. So far, Brown and his team have finished analyzing the Hubble data of three of the galaxies, named Hercules, Leo IV, and Ursa Major. The galaxies' distance from Earth ranges from 330,000 light-years to 490,000 light-years.

"Astronomers have said before that certain galaxies should be ancient, and then someone studies them hard enough and finds younger stars," Brown said. "Some of us expected to uncover younger stars and prove that the galaxies are not relics from the early universe. We were surprised to find that all the stars were ancient."

Brown measured the stars' ages by analyzing their brightness and colors. For reference, Brown compared the galaxies' stars with the stars in the ancient globular cluster M92, located 26,000 light-years away. M92 is more than 13 billion years old, one of the oldest objects...
in the universe. The analysis revealed that the galaxies' stars are as old as those in M92.

"The stars in the ultra-faint dwarf galaxies are very sparse," Brown said. "This is one reason why no one went after them with Hubble. However, we thought they were good targets for Hubble, given Hubble's ability to measure precise ages. You look at the Hubble images and there are almost no stars, but the ones we have are enough to give us the ages of these galaxies."

First-Ever Changes in an Exoplanet Atmosphere

(NASA/STScI) An international team of astronomers using data from NASA's Hubble Space Telescope has made an unparalleled observation, detecting significant changes in the atmosphere of a planet located beyond our solar system.

The scientists conclude the atmospheric variations occurred in response to a powerful eruption on the planet's host star, an event observed by NASA's Swift satellite.

"The multiwavelength coverage by Hubble and Swift has given us an unprecedented view of the interaction between a flare on an active star and the atmosphere of a giant planet," said lead researcher Alain Lecavelier des Etangs at the Paris Institute of Astrophysics (IAP), part of the French National Scientific Research Center located at Pierre and Marie Curie University in Paris.

HD 189733b periodically passes across, or transits, its parent star, and these events give astronomers an opportunity to probe its atmosphere and environment. In a previous study, a group led by Lecavelier des Etangs used Hubble to show that hydrogen gas was escaping from the planet's upper atmosphere. The finding made HD 189733b only the second known "evaporating" exoplanet at the time.

The system is just 63 light-years away, so close that its star can be seen with binoculars near the famous Dumbbell Nebula. This makes HD 189733b an ideal target for studying the processes that drive atmospheric escape.

"Astronomers have been debating the details of atmospheric evaporation for years, and studying HD 189733b is our best opportunity for understanding the process," said Vincent Bourrier, a doctoral student at IAP and a team member on the new study.

When HD 189733b transits its star, some of the star's light passes through the planet's atmosphere. This interaction imprints information on the composition and motion of the planet's atmosphere into the star's light.

In April 2010, the researchers observed a single transit using Hubble's Space Telescope Imaging Spectrograph (STIS), but they detected no trace of the planet's atmosphere. Follow-up STIS observations in September 2011 showed a surprising reversal, with striking evidence that a plume of
gas was streaming away from the exoplanet. The researchers determined that at least 1,000 tons of gas was leaving the planet’s atmosphere every second. The hydrogen atoms were racing away at speeds greater than 300,000 miles per hour. The findings will appear in an upcoming issue of the journal *Astronomy & Astrophysics*.

Because X-rays and extreme ultraviolet starlight heat the planet’s atmosphere and likely drive its escape, the team also monitored the star with *Swift’s* X-ray Telescope (XRT). On Sept. 7, 2011, just eight hours before *Hubble* was scheduled to observe the transit, *Swift* was monitoring the star when it unleashed a powerful flare. It brightened by 3.6 times in X-rays, a spike occurring atop emission levels that already were greater than the Sun’s.

"The planet's close proximity to the star means it was struck by a blast of X-rays tens of thousands of times stronger than the Earth suffers even during an X-class solar flare, the strongest category," said co-author Peter Wheatley, a physicist at the University of Warwick in England.

After accounting for the planet’s enormous size, the team notes that HD 189733b encountered about 3 million times as many X-rays as Earth receives from a solar flare at the threshold of the X class.

**Most Quasars Live on Snacks**

(NASA/STScI) Black holes in the early universe needed a few snacks rather than one giant meal to fuel their quasars and help them grow, a new study shows.

Quasars are the brilliant beacons of light that are powered by black holes feasting on captured material, and in the process, heating some of the matter to millions of degrees. The brightest quasars reside in galaxies distorted by collisions with other galaxies. These encounters send lots of gas and dust into the gravitational whirlpool of hungry black holes.

Now, however, astronomers are uncovering an underlying population of fainter quasars that thrive in normal-looking spiral galaxies. They are triggered by black holes snacking on such tasty treats as a batch of gas or the occasional small satellite galaxy.

A census of 30 quasar host galaxies conducted with two of NASA’s premier observatories, the *Hubble Space Telescope* and *Spitzer Space Telescope*, has found that 26 of the host galaxies bear no tell-tale signs of collisions with neighbors, such as distorted shapes. Only one galaxy in the sample shows evidence of an interaction with another galaxy. The galaxies

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  Star Cluster ($200) - year large credit, free admission for Friend & family.  
  Galaxy ($500) - year large credit, free admission for Friend & all guests.

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The Las Vegas Astronomical Society

The galaxies in Schawinski's study are prime targets for the James Webb Space Telescope, a large infrared observatory scheduled to launch later this decade. "To get to the heart of what kinds of events are powering the quasars in these galaxies, we need the Webb telescope. Hubble and Spitzer have been the trailblazers for finding them."
Month in History

September

1: Pioneer 11 returned the first close photographs of Saturn from a distance of 13,000 miles during its flyby mission in 1979.
2: The planned Apollo 18 and Apollo 19 missions were canceled due to budget constraints in 1970. The proposed Apollo 20 mission had been canceled earlier the same year. Some of the hardware for these missions were used in other missions and the rest was scrapped.
5: Voyager 1 was launched on its mission to the outer planets in 1977.
8: Juan Sebastian del Cano completed the first circumnavigation of the globe in 1522 on a three-year voyage begun by Ferdinand Magellan who was killed in the Philippines in 1521. Only one ship and 18 men of the original compliment of five ships and 280 men completed the voyage. This trip also discovered the need for the International Dateline as the ship’s log recorded this date as September 7.
8: Premiere of the original Star Trek, a favorite of many space enthusiasts, in 1966.
11: The International Cometary Explorer (ICE), previously known as International Sun-Earth Explorer 3 (ISEE-3), became the first craft to encounter a comet when it flew by Comet Giacobini-Zinner in 1985 on its way to Comet Halley. The environment of the comet was sampled but no pictures were returned as the craft had no camera.
14: The Soviet craft Luna 2 became the first craft to impact on another world when it crashed on the moon in 1959.
18: Voyager 1 became the first craft to return a photograph of the earth and moon together in space in 1977. It was 1 1/2 weeks out on its journey to Jupiter and Saturn.
18: Jean Foucault, who first demonstrated the rotation of the earth with a pendulum, was born in 1819.
18: Anousheh Ansari became the first Iranian to visit the International Space Station in 2006. The Iranian-American was the first female "space tourist" to visit the ISS where she spent 8 days conducting experiments on behalf of the European Space Agency.
20: Ferdinand Magellan set sail in 1519 from Spain on the journey that first circumnavigated the globe. He was searching for a southwest passage to Asia. See September 8.
23: Johann Gottfried Galle became the first person to knowingly observe the planet Neptune in 1846. Working at the Berlin Observatory, his sighting was based on a position predicted by Urbain Leverrier. Several earlier astronomers, including Galileo, had observed Neptune without recognizing it as a planet.
25: Christopher Columbus launched his second expedition to the New World in 1493.
28: The first Canadian satellite, Alouette, was launched on an American booster in 1962 from Cape Canaveral.
29: Vasco de Balboa, leading a band of 190 Spaniards, became the first European to cross the Isthmus of Panama in 1513. Balboa was the first European to observe the western ocean which, because of its apparent serenity at the time, he called the Pacific Ocean.

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 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 seen this month. Superior conjunction on the far side of the sun from the earth will occur on September 10.

Venus. Venus is visible in the morning sky rising about three hours before the sun. Look for the waning crescent moon to rise 4° to the right of Venus on the morning of September 12.

Mars. Mars, moving from Virgo into Libra early in the month, is in the southwest at sunset. It sets about three hours after the sun. Look for the waxing crescent moon above and to the left of Mars on the evening of September 19.

Jupiter. Jupiter, in Taurus near the Hyades star cluster and the bright star Aldebaran, is rising in the late evening. The last quarter moon rises just two degrees to the right of Jupiter on the evening of September 7 shortly after 11 pm.

Saturn. Saturn, in Virgo, is in the southwest after sunset. It is setting about two hours after the sun.

Uranus. Uranus, near the Cetus-Pisces border, is rising in the east in the early evening. Opposition (opposite the sun in the sky) occurs on September 29 when it will be rising at sunset.

Neptune. Neptune, in Aquarius, is rising in the east in the early evening. It is about 36° west of Uranus.

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>7:28 pm (34°)</td>
</tr>
<tr>
<td>Ceres</td>
<td>Orion</td>
<td>6:51 am (74°)</td>
</tr>
<tr>
<td>Eris</td>
<td>Cetus</td>
<td>2:44 am (50°)</td>
</tr>
<tr>
<td>MakeMake</td>
<td>Coma Berenices</td>
<td>1:42 pm (80°)</td>
</tr>
<tr>
<td>Haumea</td>
<td>Boötes</td>
<td>4:50 pm (72°)</td>
</tr>
</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.

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>Phase</th>
<th>Date</th>
<th>Time</th>
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<tbody>
<tr>
<td>Full Moon</td>
<td>Aug. 31</td>
<td>6:58 am pdt</td>
</tr>
<tr>
<td>Last quarter</td>
<td>Sep. 8</td>
<td>5:15 am</td>
</tr>
<tr>
<td>New Moon</td>
<td>Sep. 15</td>
<td>6:11 pm</td>
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<tr>
<td>First quarter</td>
<td>Sep. 22</td>
<td>12:41 pm</td>
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<tr>
<td>Full Moon</td>
<td>Sep. 29</td>
<td>8:19 pm</td>
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<tr>
<td>Perigee</td>
<td>Aug. 23</td>
<td>12:40 pm pdt</td>
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<tr>
<td>Apogee</td>
<td>Sep. 6</td>
<td>11:01 pm</td>
</tr>
<tr>
<td>Perigee</td>
<td>Sep. 18</td>
<td>7:53 pm</td>
</tr>
</tbody>
</table>

The moon will occult (pass in front of) Jupiter on Sept. 8 as seen from central and south Americas.
### The Sun

<table>
<thead>
<tr>
<th>Date</th>
<th>Sunrise</th>
<th>Sunset</th>
<th>Day</th>
</tr>
</thead>
<tbody>
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<td>6:13 am pdt</td>
<td>7:07 pm pdt</td>
<td>Sat.</td>
</tr>
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<td>Sep. 4</td>
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<td>7:03</td>
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<td>6:17</td>
<td>6:59</td>
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<td>6:37</td>
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<td>6:32</td>
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<tr>
<td>Sep. 28</td>
<td>6:34</td>
<td>6:28</td>
<td>Fri.</td>
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</table>

### The Sun

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<tr>
<th>Date</th>
<th>Sunrise</th>
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</thead>
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<tr>
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<td>7:05</td>
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<td>7:00</td>
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<td>Sep. 28</td>
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### Autumnal Equinox

The Autumnal equinox will occur at 7:49 am pdt on September 22. This is the moment that the sun, in its apparent motion around the earth, crosses the celestial equator from north to south. It marks the official beginning of Fall.

As the earth travels around the sun, the direction to the sun constantly changes with respect to the distant stars. This makes the sun appear to travel around the earth. The apparent annual path of the sun in the sky is called the ecliptic. The ecliptic is the orbit plane of the earth extended into space.

The apparent daily motion of the sky is caused by the rotation of the earth. This motion is parallel to the earth’s equator. The equator, when extended into space is called the celestial equator. Because the earth’s axis is tilted with respect to its orbit, the celestial equator is tilted 23½° to the ecliptic.

The yearly motion of the sun around the ecliptic causes the daily path of the sun to vary. When the sun is at its northernmost position with respect to the equator, the sun rises in the northeast, travels nearly overhead and sets in the northwest. Days are long and nights short. In Las Vegas, there are 14½ hours of daylight and 9½ hours of dark. In Reno, there are 15 hours of daylight and 9 hours of dark.

When the sun is at its southernmost position with respect to the equator, it rises in the southeast, passes low in the south at noon and sets in the southwest. Days are short and nights long, reversing the times from Summer.

Twice a year, the sun appears exactly on the equator. On or about March 21, the sun appears to cross the equator from south to north. On or about September 23, the sun appears to cross the equator from north to south. When it appears on the equator, the sun rises exactly in the east and sets exactly in the west. It is above the horizon for twelve hours each day and below the horizon for twelve hours everywhere on earth. Day and night are equal in length. The term *equinox* comes from the Latin and literally means “equal night”. ✨
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