National Aeronautics and Space Administration

Shadows of the Sun

The Transit of Venus/ June 5-6, 2012

First contact:
22:09:29 UT
18:09:29 EDT

transit path

Last contact:
04:49:27 UT
00:49:27 EDT

- Visible to the (protected) naked eye
- Crosses in front of the Sun for 6 hrs., 40 mins.
- Important event in astronomical history
- Will not occur again until 2117

Venus
(not to scale)

www.nasa.gov

Shadows of the Sun

Sun-Earth Day Events 2012

On June 5, 2012 at sunset on the East Coast of North America and earlier for other parts of the U.S., you will see the planet Venus as it moves across the face of the sun. The last time this event occurred was on June 8, 2004 when it was watched by millions of people across the world. For over 100 years the main quest of astronomers was to pin down the distance between Earth and Sun (the Astronomical Unit), which would give them a key to the size of the solar system. Careful studies of the transit of Venus became the gold mine they would harvest to reveal this measure. This event will not occur again until 2117.

Transit of Venus, 2004, with some clouds

The other major solar events in 2012 will be an annular solar eclipse on May 20, visible from parts of the western half of the U.S. (see path here: http://eclipse.gsfc.nasa.gov/SEplot/SEplot2001/SE2012May20A.GIF), and a total solar eclipse on Nov. 13 that will be visible from the South Pacific, where relatively few people will see it. In an annular solar eclipse the moon will not quite cover the disk of the sun. (See further information in the next column of this poster.)

Annular eclipse

Our new Sun-Earth Day web site this year featuring the theme "Shadows of the Sun" is exploding with fascinating resources for students and teachers, as NASA hosts its 2012 'Big Event' for Sun-Earth Day. We have highlights of our upcoming programs, background resources, sample activities, and registration information!

http://sunearthday.nasa.gov

Educational programs will include:

- A NASA/CONNECT TV program about how the transit of Venus set the scale of the Solar System
- Student lab experiment on calculating the Astronomical Unit with transit observations
- Multi-curricular resources in science, math, history, literature, arts, music and research on planets around other stars
- A webcast of the entire transit from Hawaii and web chats and interviews with scientists
- Online archives of transit images taken by amateur and professional telescopes from across the globe
- Library of Congress materials and other historical documents from past transits

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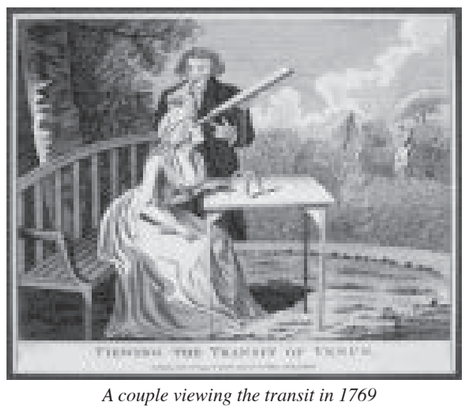
Scan this symbol to get the Space Weather Media Viewer app (Droid)

Scan this symbol to get the Space Weather Media Viewer app (iTunes)

The Venus Transit's Discovery and History

On June 5, 2012, you will see the planet Venus as it moves across the face of the mid-day Sun in Hawaii. This astronomical oddity has played a very important role over the last few centuries in giving scientists a way to understand the size of the solar system.

There is some evidence that the ancient Babylonians saw and recorded on a tablet something about Venus and the Sun in the 16th Century B.C., but the record is not clear. It is fair to say though that Galileo Galilee with his telescope, in 1610, was the first human to actually see Venus as more than just a bright point of light in the sky. Johannes Kepler, meanwhile, was shaking up the world with his meticulous use of astronomical data assembled by Tycho Brahe. He predicted that Venus would pass in front of the Sun on December 6, 1631, but unfortunately the transit was not visible from Europe at all.


A couple viewing the transit in 1769

The first recorded sighting of this transit was by British cleric, Jeremiah Horrocks, and his friend William Crabtree, on December 4, 1639—only because Horrocks had mathematically predicted it, using better data than Kepler did.

Scientists discovered they could use the transit to figure out the size of the solar system! How do we know that the actual distance from Sun to Earth is 93 million miles and not, say, 153 million or 23 million? In 1663, mathematician Rev. James Gregory suggested that a more accurate calculation of the Earth-Sun distance could be made during the transit of Venus. It turned out to be harder than anticipated, but during subsequent transits, the focus on Venus led to an even more exciting discovery.

During the transit of June 5, 1761, observed by 176 scientists from all over the world, Russian astronomer Mikhail Lomonosov (1711-1765) discovered a very strange thing. Instead of the very black disk of Venus sliding into the Sun's bright edge, it actually grew a brief, beautiful halo of light all around its dark edge. This is exactly what you would expect to see if Venus had an atmosphere!

Etching of Captain Cook's ship that observed the 1769 transit in Tahiti

In 1769 many international expeditions planned observations. The most famous expedition was led by Capt. James Cook, who set up an observation post in Tahiti with his ship, the Endeavour. The expedition astronomers, with help from a detachment of Royal Marines, set up an observatory on a high point of ground above the bay (still known as "Point Venus") and made many transit measurements. They later discovered New Zealand, got stuck on the Great Barrier Reef for several weeks, and explored many of the then unknown coasts of Australia. Cook and his crew completed their trip around the Earth and reached England safely and in triumph. The expedition established Cook's fame as a mariner and explorer.

The next transit, on December 6, 1882, made the front pages of every national and international newspaper!

Kids viewing the transit in 1882

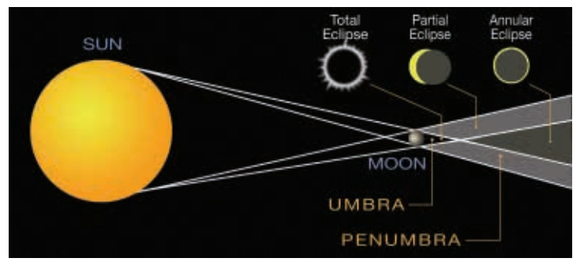
Thousands of photographs were taken with improved calibrations. Only a few astronomers were trusted to carry out the complex calculations from the resulting data. In 1896, Simon Newcomb's value, a distance from Earth to Sun of 92,702,000 plus or minus 53,700 miles, was adopted by the international scientific community. Today most textbooks report the Astronomical Unit (or AU) as "93 million miles."

The Venus transit has continued to yield fascinating new information for scientists and the public. Take this unique opportunity to make your own observations and calculations.

Kids viewing the transit in 2004

Eclipses

The shadow from the Moon creates a path of darkness that is at most 170 miles miles wide. The Moon orbits Earth once every 29 days with respect to the Sun. During this period, the Moon undergoes all its familiar phases: new, first quarter, full, last quarter and back to new. During the new phase, the Moon passes between the Sun and Earth so the Moon's side illuminated by sunlight is turned away from Earth. This means that we cannot see the Moon in the new phase.



Geometry of and types of eclipses

The Moon's orbit is tilted slightly compared to Earth's orbit around the Sun. As a consequence, the Moon usually passes a little above or below the Sun at most new moons. On rare occasions, the Sun, Moon and Earth line up at new moon phase so that some portion of the Moon's shadow falls onto Earth's surface. The Sun is 400 times wider than the moon, but it is also 400 times farther away, so they coincidentally appear to be almost exactly the same size in our sky. So, at that time, the Moon is seen to pass across the Sun and we experience an eclipse of the Sun.

The shadow from the Moon creates a path of darkness that is at most 170 miles miles wide. Outside the path of either a total or annular eclipse, the Moon's penumbra produces a broad band about 4000 miles wide where a partial eclipse can be seen.

How often do eclipses occur? There will be 36 solar eclipses from 2001-2025 of which 15 will be total eclipses on some part of Earth's surface – a little less than the average of about one a year. The common myth that eclipses don't occur very often has evolved because seeing a total eclipse from a specific point on the surface of Earth is not common. Most people think that solar eclipses are quite rare but there are actually two to five eclipses every year. They only seem rare because each eclipse can only be seen from a small part of Earth. The next total solar eclipse visible in North America will occur in 2017.

Every total eclipse begins with a partial eclipse in which the Moon gradually covers more and more of the Sun's disk. It usually takes about an hour for the Moon to completely cover the Sun before the start of the total phase or totality. During most of this time, the Sun and sky remain remarkably bright so that you would never know an eclipse was happening.

Total solar eclipse, with careful processing

In the last minutes before totality, events occur at an accelerated pace. The sky in the direction of the Moon's shadow grows dark like an approaching thunderstorm. Sunlight shining through tree leaves reveals a series of crescent shapes on the ground below. Shadows take on an odd sharpness and daylight appears weak and grey.

In the final seconds, the Moon's dark shadow rises above the horizon like a curtain rushing towards you. The Sun's remaining crescent breaks up into a series of brilliant points along one rim of the Moon. These Baily's beads are caused by sunlight shining through deep valleys along the edge of the Moon. The last flash of light as the Sun disappears behind the Moon gives the appearance of a diamond. At the same instant, the Sun's ghostly white corona encircles the Moon forming the so-called diamond ring effect.

As totality begins, the solar corona (extended outer atmosphere of the Sun) blazes into view. The corona is a million times fainter than the surface of the Sun. It is only visible when a total eclipse blocks the Sun's brilliant disk from view. The sky is now an eerie twilight that is dark enough to see the planets and the brighter stars. Animals often behave as if night has fallen and the temperature can drop 15 degrees F.

The period of totality rarely lasts more than a few minutes. The Moon's disk begins to uncover the Sun as totality ends. Baily's beads and the diamond ring are seen once again as the corona fades from view and daylight returns.

A total eclipse is the most spectacular and awe-inspiring sight in all of Nature. Once seen it will never be forgotten. If you ever have an opportunity to observe a total solar eclipse, don't miss it!

Safe Solar Viewing

The transit of Venus is a rare and striking phenomenon you won't want to miss— but you must carefully follow safety procedures. Don't let the requisite warnings scare you away from witnessing this singular spectacle! You can experience the transit of Venus safely, but it is vital that you protect your eyes at all times with the proper solar filters. No matter what recommended technique you use, do not stare continuously at the Sun. Take breaks and give your eyes a rest! Do not use sunglasses: they don't offer your eyes sufficient protection. See the NASA site at http://eclipse.gsfc.nasa.gov/SEhelp/safety2.html for definitive advice on safe solar viewing!

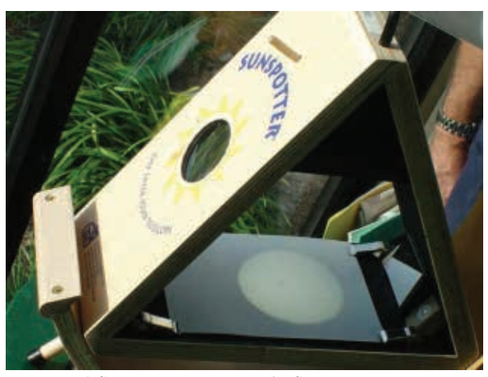
Viewing with Protection -- Experts suggests that one widely available filter for safe solar viewing is number 14 welder's glass. It is imperative that the welding hood houses a #14 or darker filter. Do not view through any welding glass if you do not know or cannot discern its shade number. Be advised that arc welders typically use glass with a shade much less than the necessary #14. A welding glass that permits you to see the landscape is not safe. Inexpensive Eclipse Shades have special safety filters that appear similar to sunglasses, but these filters permit safe viewing. Eclipse shades are available through retailers listed at http://www.mreclipse.com/Totality/TotalityApC.html under "Solar Filters."

Telescopes with Solar Filters -- The transit of Venus is best viewed directly when magnified, which demands a telescope with a solar filter. A filtered, magnified view will clearly show the planet Venus and sunspots (http://www.skyandtelescope.com/observing/objects/sun/Solar_Filter_Safety.html). Never look through a telescope without a solar filter on the large end of the scope. And never use small solar filters that attach to the eyepiece (as found in some older, cheaper telescopes.) See "Solar Filters" as cited above for retailers.

Pinhole projectors -- These are a safe, indirect viewing technique for observing an image of the Sun. While popular for viewing solar eclipses, pinhole projectors suffer from the same shortcomings as unmagnified views when Venus approaches the edges of the Sun. Small features like the halo around Venus will not likely be discernible. Pinhole projectors and other projection techniques are at http://solar-center.stanford.edu/observe/.

Related projection methods -- One viewing technique is to project an image of the Sun onto a white surface with a projecting telescope. http://www.skyandtelescope.com/observing/objects/sun/Solar_Projection.html and http://www.astrosociety.org/education/publications/tnl/05/stars2.html. Others follow:

- The Exploratorium demonstrates how to view a planet in transit safely by projecting the image with binoculars. http://www.exploratorium.edu/transit/how.html.
- The Sunspotter telescope viewer (recommended for younger viewers) is commercially available from Edmund Scientific at http://www.scientificsonline.com/sunspotter.html



A Sunspotter projecting the Sun onto paper

Other helpful links:

Viewing the Sun Safely (article)
http://www.skyandtelescope.com/observing/objects/sun/Viewing_the_Sun_Safely.html

How to Observe the Sun, by Lee MacDonald (book)
http://www.amazon.com/How-Observe-Sun-Safely-Macdonald/dp/1852335270

Safe Sunwatching Techniques from NASA's spaceweather.com
http://spaceweather.com/sunspots/doityourself.html

Video clip on safe solar viewing:
http://cse.ssl.berkeley.edu/cms/LearningResources/ViewingtheSunSafely/tabid/269/Default.aspx

Check out these links

Space Weather Media Viewer -- presents the Sun and surrounding corona in real time
http://sunearthday.nasa.gov/spaceweather/#

Space Weather Action Center -- students make their own space weather predictions and produce multimedia reports
http://sunearthday.nasa.gov/swac/

Space Math@NASA -- Transit Math topic guide
http://spacemath.gsfc.nasa.gov/books.html

Solar Dynamics Observatory -- shows near real-time clips of the Sun in many wavelengths of light
http://sdo.gsfc.nasa.gov/

Scan this symbol to get to the Sun-Earth Day home page

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