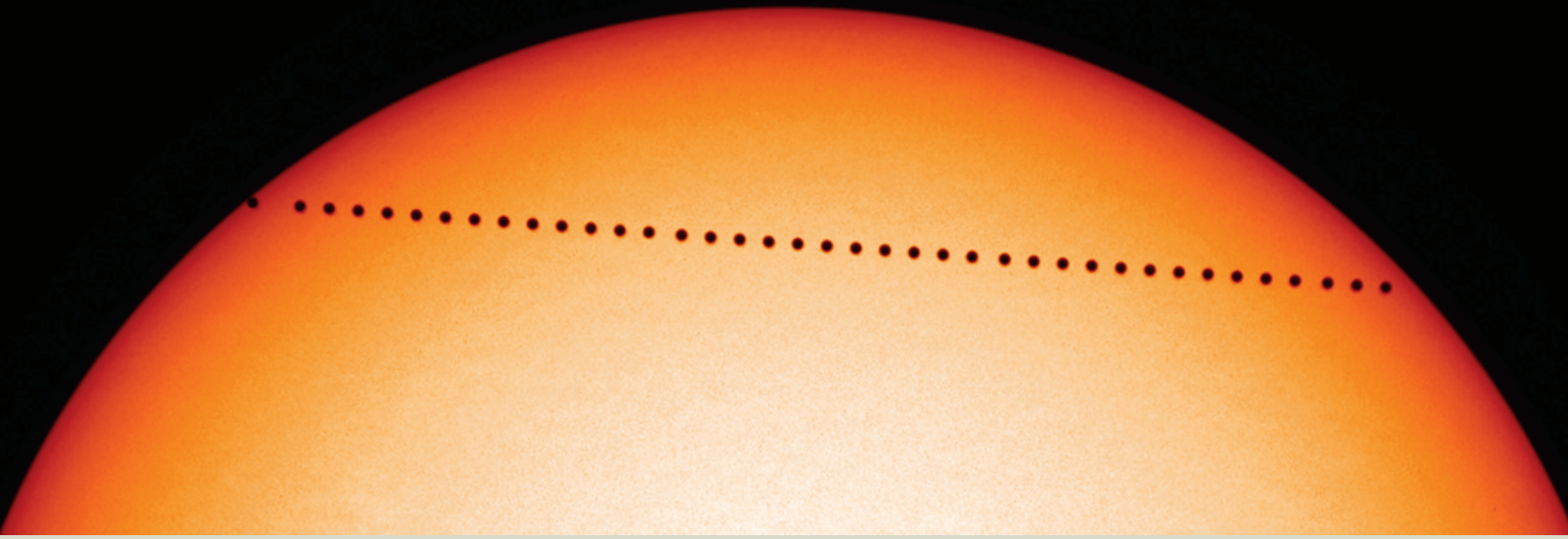
Mercury Transit Viewer's Guide

Simulation Curriculum

the publishers of Starry Night

May 09, 2016

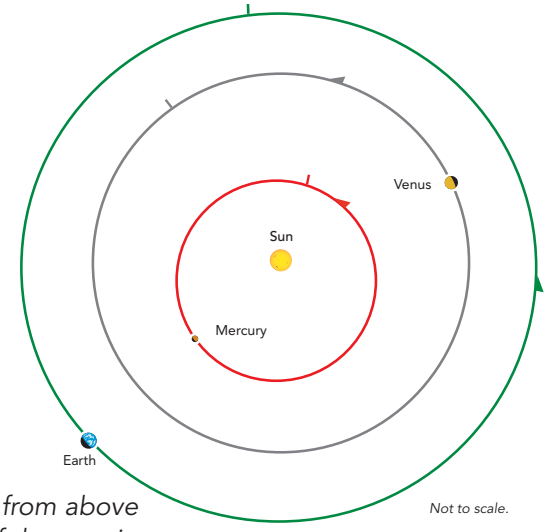


http://sohowww.nascom.nasa.gov/hotshots/2003_05_07

On May 09, 2016, amateur astronomers with small telescopes and solar filters will be able to observe Mercury's tiny silhouette moving slowly across the face of the Sun. Astronomers call this event a "transit".

Rare Opportunity

A transit occurs when one of the inner planets, Mercury or Venus, passes between the Earth and the Sun. Most of the time the inner planets pass either above or below the Sun. There are only certain points in these planets' orbits, called nodes, when they are in the plane of the Earth's orbit. For Venus, these nodes occur in June and December. For Mercury, they occur in May and November. Transits can occur only in those months.



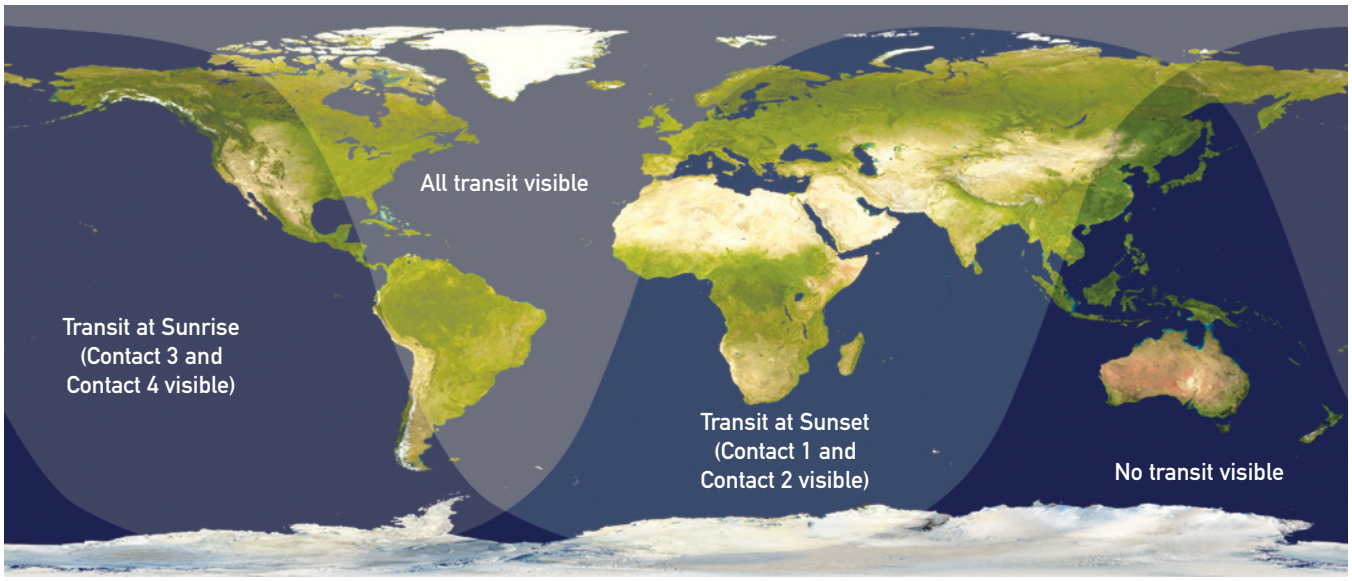
The solar system from above on the day of the transit.

Not to scale.

Because Mercury orbits the Sun much more rapidly than Venus, it's in the right place for a transit far more often. Transits of Mercury occur 13 times a century or roughly once every 7.4 years, whereas transits of Venus occur less than twice a century, or roughly once every 62.5 years. In fact, transits of Venus usually occur in pairs 8 years apart, separated by a gap of 125 years. The most recent pair of Venus transits occurred on June 08, 2004 and June 2012. The next transit of Venus will not occur until 2117. Mercury transits also occur in clumps. The last one was 9.5 years ago on November 8, 2006, and the next one will not be until 3.5 years from now, on November 11, 2019.

This year's transit lasts more than seven hours, and visible nearly everywhere on Earth except for Australia, New Zealand, Indonesia, the Philippines, and a small area of eastern Asia. Observers in eastern North America will be able to see the whole transit, while the transit will already have begun as the sun rises in the western half of the continent.

The transit begins just after 7 a.m. EDT and ends just before 3 p.m. On the west coast it begins at sunrise and ends around 11:30 PDT.



Map shows where on Earth the Mercury Transit will be visible and not visible.

Choose an Observing Location

The one imponderable in observing a transit is of course the weather. Unlike a solar eclipse, where observers are restricted to a narrow band, transits are visible over a wide area. In case of inclement weather, you should be prepared to travel; the Clear Sky Chart will be a useful guide to where to go:

http://cleardarksky.com/csk/

Start with the clear sky chart closest to your chosen location. If it shows poor weather prospects, check the clocks farther away, within 100 km (60 miles) and 200 km (120 miles) radius. If you can see a clear patch, hop in your car and drive!

Check the Sun's setting point a day or two beforehand, to verify that trees or buildings do not block your view.

Mercury is the innermost of the four terrestrial planets, which include Venus, Earth and Mars. Mercury zips around the Sun once every 88 days, lapping the Earth every 116 days. Since its orbital inclination is tilted at 7 degrees relative to the Earth, only once every 23 times does its passing between the Sun and the Earth make for a transit. The most recent was in November 8, 2006; the next will be May 9, 2016.

A Small Telescope is Needed

Venus in transit is large enough to be visible with the naked eye with a suitable solar filter. Being able to see Venus as an intense black spot on the face of the Sun without any optical aid is one of the observing highlights in the life of many amateur astronomers. Mercury is both smaller in absolute diameter (4,879 km vs. 12,104 km) and farther away (0.613 au vs. 0.277 au).

According to Starry Night, Mercury will be 12 arcseconds in diameter on May 09, as compared to the Sun's diameter of 32 arcminutes, a ratio of about 1 to 160. By comparison, Venus' diameter during the transit of June 08, 2004 was 58 arcseconds, a ratio of 1 to 33. You would think with Mercury being 1/6 the diameter of Venus, and Venus being visible to the naked eye, that you'd only need 6x to see Mercury, but in reality you need much more magnification than that, at least 30x, with 50x to 100x being optimum. Even at that magnification, Mercury seems a very tiny dot against the huge face of the Sun.

Just about any telescope capable of magnifying at least 30 times should give a good view of the transit.

Astronomical unit (AU)

The average distance from the Earth to the Sun, or 149,597,870 kilometers (92,955,807 miles).

Arcminute

A unit of angular measure equal to 1/60 of a degree, where the sky from the zenith to the horizon is 90 degrees. For example, the Moon has an apparent diameter of about 30 arcminutes.

Arcsecond

A unit of angular measure equal 1/60 of an arcminute – or 1/360 of a degree. For example, the apparent diameter of Jupiter is about 45 arcseconds.

Safe Viewing

NEVER LOOK DIRECTLY AT THE SUN. Permanent eye damage can result. Instead, proper telescope filters or protective glasses from reputable astronomy dealers should be used.

For serious transit observing, a telescope with a full-aperture solar filter is much better. Such filters are attached on that side of the telescope that is facing the Sun, not the side facing your eye. This will cause most of the sunlight to be filtered out before entering your telescope.

The transit should be watched only with an appropriate solar filter – a solar filter that is sold by a reputable outlet of astronomical equipment. If your telescope comes with a filter that screws into the eyepiece, discard it immediately! Such filters have been known to crack under the intense heat of the Sun's magnified image.

Lastly, never look at the Sun directly through your telescope, even through your smaller, finder scope. It is strongly advisable to cover the finder scope before the transit, so as to avoid looking through it accidentally.

The best and safest type of filter is a metal-coated glass or plastic filter.

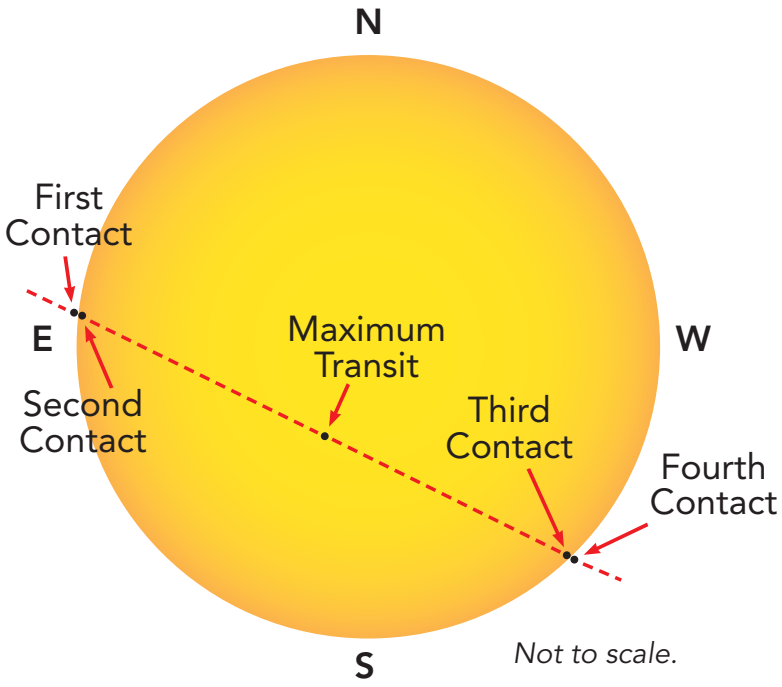
These filters are available in many different sizes suitable for any telescope. They fit snugly over the front of the telescope and reflect away 99.99% of the Sun's light and heat, allowing only a safe 0.01% through. The Sun appears as a white circle set in a perfectly black sky, because no sky light is able to penetrate the filter.

Taking photographs of the transit is easily done with almost any camera because the Sun's image through the filter is quite bright. A camera adapter will ensure a firm connection between camera and telescope.

Unacceptable filters to view the Mercury transit include sunglasses, color film negatives, black-and-white film that contains no silver, photographic neutral-density filters, and polarizing filters. Although these materials have very low visible-light transmittance levels, they transmit an unacceptably high level of near-infrared radiation that can cause a thermal retinal burn. The fact that the Sun appears dim, or that you feel no discomfort when looking at the Sun through the filter, is no guarantee that your eyes are safe.

What Will Happen

The transit will appear simultaneously all over the world, so its time is predicted using Universal Time (UT). Here are the predicted times for the events given in Universal Time and then converted to local time zones across North America. First contact is when the edge of Mercury first touches the edge of the Sun. Second contact is when the disk of Mercury is entirely in front of the Sun and moving inwards. Third contact is when Mercury touches the edge of the Sun as it begins to pass off the Sun. Fourth contact is when Mercury is completely off the Sun. Event times that are shaded will typically occur before sunrise in the regions indicated.



Time Zone	1st Contact	2nd Contact	Maximum	3rd Contact	4th Contact
UT	11:12	11:16	14:57	18:39	18:42
AST	08:12 am	08:16 am	11:57 am	03:39 pm	03:42 pm
EST	07:12 am	07:16 am	10:57 am	02:39 pm	02:42 pm
CST	06:12 am	06:16 am	09:57 am	01:39 pm	01:42 pm
MST	05:12 am	05:16 am	08:57 am	12:39 pm	12:42 pm
PST	04:12 am	04:16 am	07:57 am	11:39 am	11:42 am

Sunrise will occur roughly around 6 am local time. Here are the specific times of sunset for some major centers in the various time zones:

Time Zone	City	Sunrise
ADT	Halifax NS	06:53 am
EDT	New York NY	05:44 am
CDT	Chicago IL	06:36 am
MDT	Denver CO	05:51 am
PDT	Los Angeles CA	05:56 am

Tip: You can find the time of sunset for your location by setting the date in Starry Night (www.starrynight.com) to May 09, 2016, moving your mouse pointer over the Sun, and reading the time of sunset from the HUD (heads-up display).

What to Look For

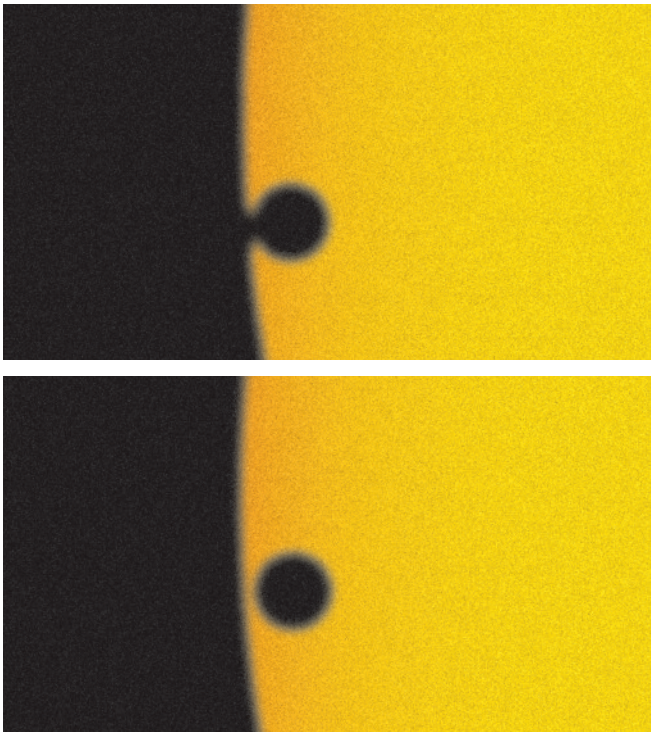
It will be interesting to compare your own times of the four contacts with the predicted times above. First contact is usually observed a little late, because you can't actually see Mercury on the Sun's disk until the exact time of first contact is past. Timings of second and third contact are complicated by something called the "Black Drop."

The "black drop" will occur just as Mercury gets fully in front of the Sun's disk at second contact, and again just before third contact about seven hours later. Mercury's black disk will appear to remain linked to the edge of the Sun for a moment, stretching into an apparent pear shape.

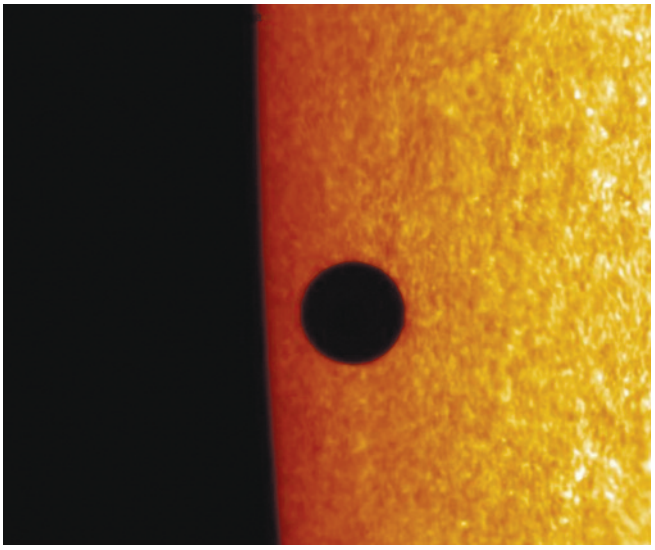
There are two causes for the black drop: The Sun is less bright at its visible edge, and there is a natural blurring effect in telescopes.

Fourth contact occurs when the disk of Mercury finally leaves the Sun.

As Mercury moves across the face of the Sun, it may pass close to sunspots or other surface features on the Sun, creating interesting "photo opportunities." The view of the Sun through a telescope with a Hydrogen Alpha filter, such as the Coronado PST, will be very dramatic, and contact times may differ significantly from times obtained with normal white light filters because we're looking at a different layer in the Sun's atmosphere.



The "black drop" effect



Mercury nears the limb of the Sun just prior to the end of the May 7, 2003 transit in this image taken by a Hydrogen-Alpha telescope on the Canary Islands, off the coast of Africa.

Share the view!

One of the nicest things about a transit of Mercury, as opposed to, say, a solar eclipse, is that it takes a long time to happen, so there's plenty of opportunity for "sidewalk astronomy" – sharing the view through your telescope with the public. It might be worth setting your telescope up in a public place, such as a park or a mall parking lot, and invite passers-by to have a look. Who knows, you may spark the interest of a new amateur astronomer!