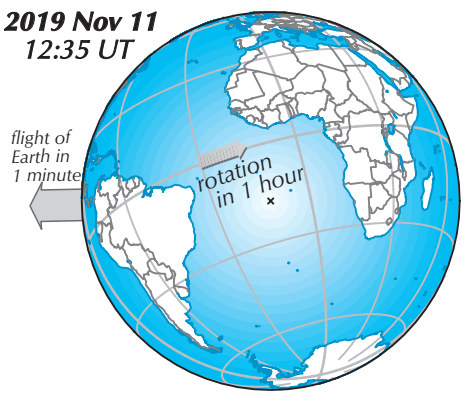
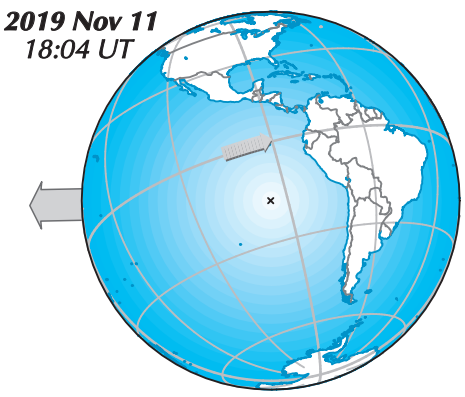
TRANSIT OF MERCURY

On 2019 November 11, Mercury will pass across the face of the Sun for about 5¾ hours; a fairly rare event, observable from the lands around the Atlantic, though it begins before sunrise for most of North America and ends after sunset for Europe. The previous Mercury transit was 2016 May 9, the next will be 2032 Nov. 13.

The henisphere from which the beginning of the transit can be seen; i.e., the Earth as seen from Sun and Mercury. They are on the dawn horizon for eastern North America, at the zenith for the southern Atlantic, setting for Finland and Afghanistan.

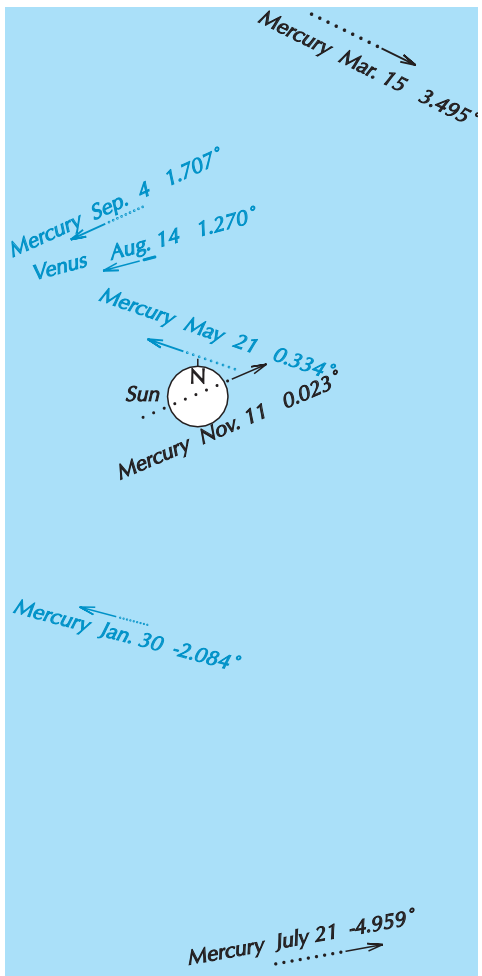


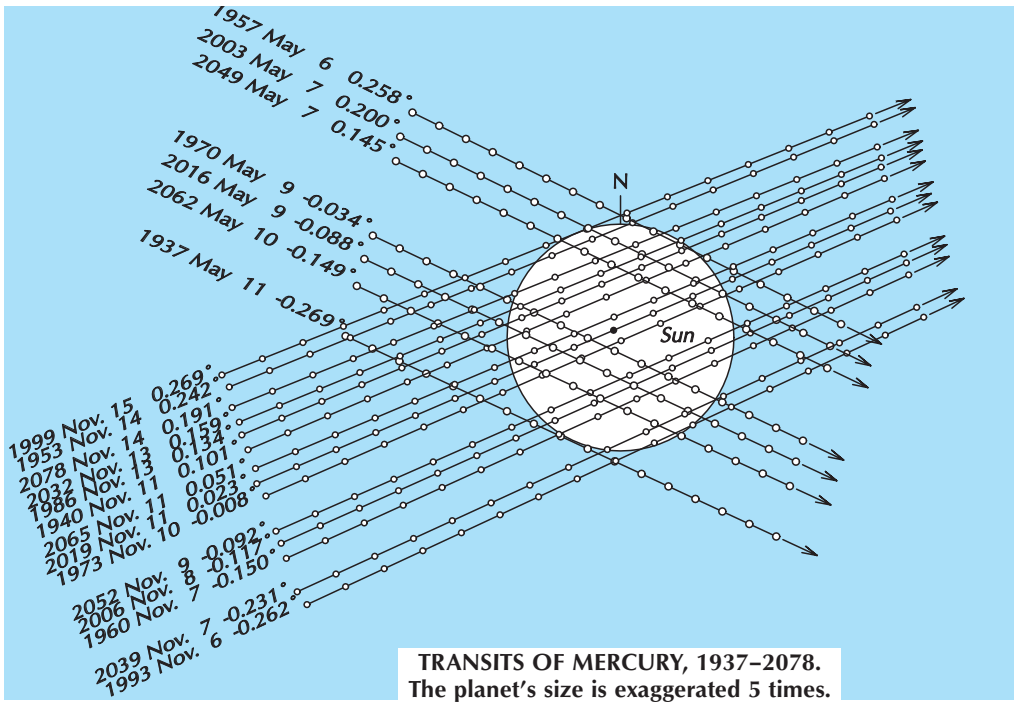
—and at the end of the transit. Sun and Mercury are rising for eastern and southern Alaska, the mid Pacific, the water west of New Zealand; overhead for the eastern Pacific' setting for southern Greenland and the west coast of northern Africa.



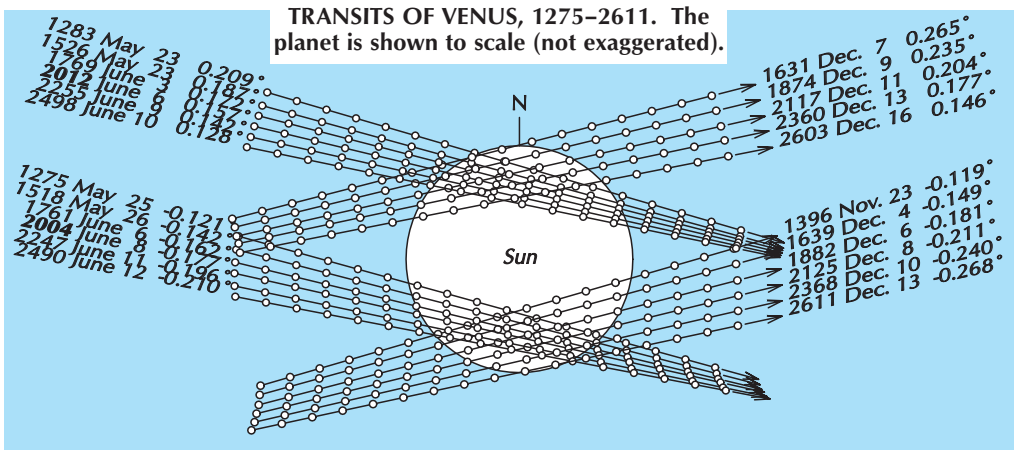
In charts below, the planets are shown at 1-hour intervals. Moving right (west) they are at inferior conjunction (in front of the Sun); moving left (east), they are at superior conjunction beyond the Sun, appearing to more slowly because at greater distance. Celestial north is up. The figure given with each date is the closest angular distance (in degrees) from the center of the Sun to the center of the planet. The scale is in relation to the size of the Sun, so is not perfectoy constant, since the Sun's angular radius of about 0.27° varies slightly at different times of year.

Mercury at all of its conjunctions with the Sun this year. Its size is exaggerated by 5.





TRANSITS OF MERCURY, 1937–2078. The planet's size is exaggerated 5 times.



TRANSITS OF VENUS, 1275–2611. The planet is shown to scale (not exaggerated).

Transits of Mercury happen 13 or 14 times per century, and only in May or November. The reason is that, for Mercury to be seen between us and the Sun, it must be near one of the two nodes of its orbit (the two points where it crosses the plane of Earth's orbit); and these are oriented toward the May and November parts of Earth's orbit. If, when Mercury passes a node, Earth happens to be near the same longitude of its orbit, we see a transit.

This year, Mercury reaches ascending node at Nov. 11, 14*h* Universal Time, and inferior conjunction only an hour later. It is at perihelion 4.6 days later, on Nov. 16.

Since the ascending node is near the perihelion of the orbit, Mercury during a November transit is relatively near to the Sun and far from us, so it appears smaller. Near perihelion it travels faster, crossing the Sun in a shorter time (less than 6 hours for a central November transit, as against nearly 8 hours for a central May one). Because farther from us, it appears angularly nearer to the ecliptic plane, so is less likely to miss the Sun; so there are almost twice as many November as May transits. (The gradual changes in Mercury's orbit are relatively rapid, so all this will differ slightly a century hence.)

The orbit is inclined to the ecliptic at only 7°. So why do we see the planet cross the Sun at about 25°? Partly because the diagrams have equatorial (not ecliptic) north at the top, and the November part of the ecliptic slopes southeast. And, though Mercury is overtaking us, we too are moving forward, making Mercury appear to move forward more slowly and therefore drop more sharply.

Like eclipses of the Sun and Moon, transits show intricate patterns. Look at the diagram of Mercury's transits over a span of time. There is a perpetual succession of interlaced series that run northward in steps of 13 years:

1993 Nov. 6——1.70 hours duration
2006 Nov. 8——4.97
2019 Nov. 11——5.48
2032 Nov. 13——4.44
2045 Nov. 16——(misses, no transit, end of series)

1960 Nov. 7——4.63 hours duration
1973 Nov. 10——5.50
1986 Nov. 13——4.80
1999 Nov. 15——0.86
2012 Nov. 17——(misses, no transit, end of series)

The same transits form series running *southward* in 33-year steps:

1861-1894-1927-1960-1993
1999-2032-2065-2098-2131

And the same for the May transits, except that they shift more rapidly across the Sun and so the series are shorter (usually 2 members). There is a periodicity of even more similar transits 46 years apart: 1993-2039-2085, or 2006-2052-2098 (and many more into the future).

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All this is because of harmonies in the orbital periods of Earth and Mercury. While Earth goes around the Sun 13 times, Mercury goes around 54, roughly. While Earth goes around 33 times, Mercury goes around 137 times, more exactly. While Earth goes around 46 times, Mercury goes around 191 times, more exactly still. So they return to almost the same positions.

The surface result is an apparently irregular pattern in which the years from transit to transit are either 3½ (Nov.-May or May-Nov.) or 9½ (Nov.-May) or 6 or 7 or 13 (all Nov.-Nov.). A May transit is always followed in 3½ years by a November one.

Here is the timetable for the transit of this November 11.

12h 35m 27s UT: 1st contact: Mercury touches Sun's limb (edge)
12h 37m 09s: 2nd contact: Mercury all inside the limb
15h 19m 48s: Mercury's center nearest (76″) to Sun's center
18h 02m 33s: 3rd contact: Mercury again touches the limb
18h 04m 15s: 4th contact: Mercury all outside the limb

Subtract 4 hours to get Eastern summer time, 7 for Pacific time.

These figures apply to the transit as seen from the center of the Earth. For places west of that, the times will be slightly earlier. For places south of it, Mercury's track lies slightly farther south, so the transit lasts slightly longer.

Most of Alaska does no see the transit. It begins before sunrise for the eastern Pacific and most of North America. The whole of it is seen by the eastern U.S.A. and eastern Canada, the southern tip of Greenland, southeastern Mexico, the Caribbean, Central America, all of South America, the west coast of north Africa, most of the Atlantic, most of Antarctica. The transit ends after sunset for most of Europe and Africa and the Middle East.

Mercury at the time is 0.676 a.u. from us and 0.314 a.u. from the Sun. The Sun, 1,392,000 kilometers in diameter, appears 1949″ wide; Mercury, 4,900 km in diameter, appears 9.9" wide——197 times smaller! Too small to be detected by the naked eye, if the naked eye was unwise enough to try. At mid transit this black spot is 632″ in from the Sun's edge, 319″ from its center.

DON'T BE BLINDED: don't try to observe without knowledge of safe techniques. Never look at the Sun through binoculars! Make a pinhole in cardboard, through which an image of the Sun can fall onto a white surface.

If you have a proper solar filter and a time source accurate to 1 second, it is of scientific value to time all four contacts. The next two Mercury transits will all also be November ones: 2032 Nov. 13, 2039 Nov. 7.

Transits of the much larger Venus are 10 times rarer (because it is farther from the Sun and orbits more slowly). They happen in May-June at Venus's descending node or Nov.-Dec. at the ascending node; usually in pairs 8 years apart; and at a rate of 13 or 14 in 1000 years. The last pairs were 1874 Dec. 9 and 1882 Dec. 6, 2004 June 8 and 2012 June 6. The next will not be till 2117 Dec. 11 and 2125 Dec. 8.

The last year with transits of both Mercury and Venus was 1769. when James Cook's famous expedition observed them both——Venus from Tahiti, Mercury from New Zealand. The next will be 2611.