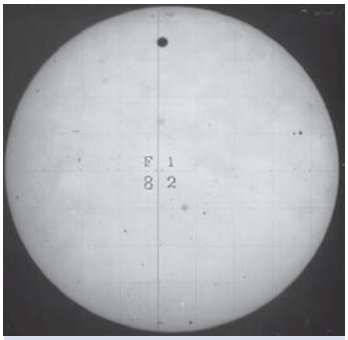
Observing the transit of Venus

A transit of the planet Venus across the brilliant face of the Sun is one of the rarest of all astronomical phenomena. Such transits occur in pairs just eight years apart, but following the second transit of a pair, the next will not occur again for more than a century. Transits of Venus can only occur in June or December, and just five such events have been observed since the invention of the telescope. One was seen in the 17th century, two in the 18th, two in the 19th, and none at all in the 20th century. Indeed, there can be no person alive today who has observed a transit of Venus, the last pair having taken place in December 1874 and 1882.



The last transit of Venus to be observed. A photograph of the 1882 December 6 transit taken on a glass-plate negative by one of the US Naval Observatory expeditions. *(Image courtesy US Naval Observatory Library.)*

The orbit of Venus is inclined at an angle of 3.4° with respect to Earth's orbit, and it intersects the ecliptic plane at two points, the ascending and descending nodes, which are in line with the Sun as seen from the Earth during early December and early June, respectively. If Venus happens to pass through inferior conjunction at these times, a transit will occur. Although Venus' orbital period is only 224.7 days, its synodic period (conjunction to conjunction) is 583.9 days. Due to its orbital inclination, most inferior conjunctions of Venus do not result in a transit because the planet passes too far above or below the ecliptic plane and does not cross the solar disk.

Transits of Venus currently recur at intervals of 8, 105.5, 8 and 121.5 years, so the circumstances of transits repeat themselves after a period of 243 years. A pair of June (descending node) transits will be followed by a pair of December (ascending node) transits after an interval of 105.5 years, and then there will be an interval of 121.5 years before the next pair of June transits. The last pair of Venus transits occurred on 1874 December 9 and 1882 December 6. Now, after an interval of 121.5 years, another transit of Venus is due, and will occur on Tuesday June 8 this year. A second will take place just 8 years later, on 2012 June 6, and then there will be no more until 2117 December 11, an interval of 105.5 years. Consequently, these two forthcoming Venus transits will be the only chances for people alive today to witness one of the rarest of all astronomical events. The phenomenon is no longer regarded as important, as it used to be in the days when it provided the best means of measuring the distance between the Earth and the Sun, but it will certainly be very interesting to watch.

The principal events taking place during a transit of Venus are known as 'contacts'. The event begins with contact I, which is the instant when the planet's disk just touches the outer edge of the Sun's limb. The entire disk of Venus is first seen in silhouette against the Sun at contact II. Contacts I and II define the phase called ingress. During a period of just over six hours, Venus' silhouetted disk gradually crosses the solar disk. At contact III, the planet reaches the opposite limb of the Sun. The transit ends at contact IV when the planet's disk again just touches the outer edge of the Sun's limb. Contacts III and IV are known as egress.

Geocentric times and position angles for the 2004 June 8 transit are as follows:

	Time (UT) *h m*	*PA*
Ingress, Contact I (exterior contact)	05 13.5	116°
Ingress, Contact II (interior contact)	05 32.8	119°
Egress, Contact III (interior contact)	11 06.5	213°
Egress, Contact IV (exterior contact)	11 25.9	216°

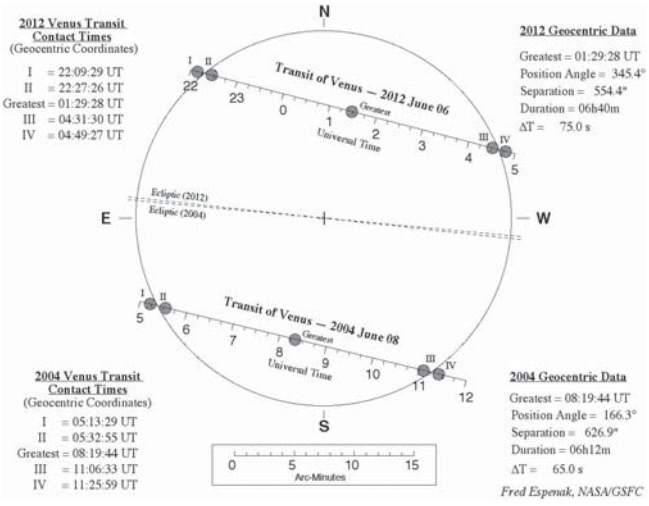
For observers in the United Kingdom, the ingress times will be about 6–7 minutes later, and egress times about 2 minutes earlier than those given above. Don't forget that British Summer Time (which is one hour ahead of these times) will be in force in the United Kingdom in June.

In the 17th century, the famous astronomer Edmond Halley realised that transits of Venus could be used to measure the average distance between Earth and the Sun – a fundamental unit in the sizing of the cosmos. In practice what had to be done was to accurately time the transit from ingress to egress, using synchronised clocks, from many locations widely separated on the Earth's surface. However, such timings proved more difficult than expected. As Venus passes on to the Sun, it seems to draw a strip of blackness after it. By the time this strip disappears the transit has already begun, so that ingress cannot be timed accurately. The same problem occurs at egress. Although transits of Venus are no longer used for such measurements, many observers will want to witness, for themselves, this so-called 'black drop' effect (which is due partly to atmospheric seeing and diffraction within the telescope), because of its historical importance.

During the forthcoming transit, Venus' apparent diameter will be almost 58 arcseconds, so the silhouetted disk of the planet will be around 1/33rd of the solar diameter and it should be possible to see it without optical magnification (but using solar filter protection) as it crosses the Sun.

As always, observers must take the very greatest care. The visual and photographic requirements for observing a transit are identical to those for solar viewing. Do not stare at the Sun without using a solar filter that is safe for direct viewing; check it for scuffs, scratches or pinholes, and if you are in any doubt about the effectiveness of the filter then don't use it. Those wishing to use solar filters suitable for direct viewing, must follow the TRANSIT OF VENUS SAFETY CODE, distributed with this issue of the *Journal*.

On no account look directly through a telescope unless it is fitted with a suitable solar filter that covers the telescope's full aperture and fits securely over the front end of the instrument. (Many small telescopes used to come supplied with a dark filter that fitted over the eyepiece. These are very dangerous, as they can crack under the magnified and focused heat of the Sun without warning. If you have one of these filters please throw it away.) Much the best method for anyone who is unsure of the suitability of their equipment is to use a small telescope



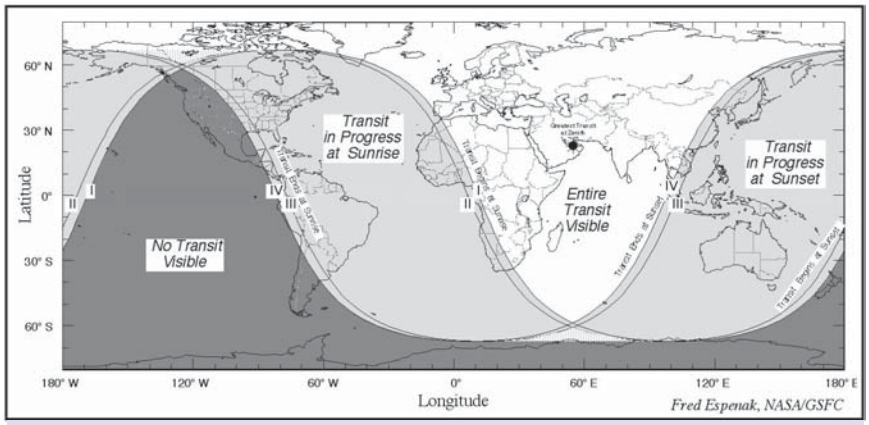
The path of Venus across the Sun's disk on 2004 June 8 and 2012 June 6. *Fred Espenak/NASA GSFC.*

(or pair of binoculars) to project a magnified image of the Sun onto a white cardboard screen. Aim the instrument at the Sun using the shadow of the telescope tube on the card: never look through the main telescope or its smaller finder 'scope to do this.

White light observations of contacts I and IV are not technically possible since Venus is only visible after contact I and before contact IV. However, if a hydrogen-alpha filter is used, the planet will be visible against either the chromosphere or any prominences before and after contacts I and IV, respectively. Contacts II and III are the two instants when the planet appears internally tangent to the Sun. However, just before contact II, the so-called 'Black Drop' effect is seen, when the transiting planet seems to be attached to the Sun's limb by a thin strip or thread of blackness. When the thread breaks and the planet is completely surrounded by sunlight, this marks the true instant of contact II. Contact III occurs in exactly the reverse order. Atmospheric seeing makes it difficult to measure contact timings with a precision better than several seconds.

Given the rarity of such events, many people will wish to see the 2004 June 8 transit of Venus. Clouds are always a potential menace on these occasions, and some enthusiasts will travel to locations where clouds are highly unlikely at this time of the year. The ingress only is visible from Australasia and the extreme eastern part of Asia. The entire transit (all four contacts) is visible throughout Europe except the extreme south-western Iberian Peninsula; Africa except western parts; the Middle East; Asia except extreme eastern parts; most of the Indian Ocean and the northern part of Greenland – so there are plenty of places to choose from. From the UK, the entire transit will be visible – weather permitting, of course. Only the egress can be seen from the remainder of the Americas, except the western part of North America and southern South America.

Let us hope for clear skies on the morning of 2004 June 8, because the next Venus transit – on 2012 June 6 – will be visible in its entirety only from the central and western Pacific Ocean, Japan, the eastern parts of Russia and China, and north-eastern Australia. From the UK, the transit will be in progress at sunrise and only the final phases of the event may be seen. Then it will be a long wait once again – until 2117 December 11.



World visibility of the transit of Venus on 2004 June 8. *Fred Espenak/NASA GSFC.*

John W. Mason

For more information on the transit of Venus, and links to details of local events throughout the country, visit this website:

http://www.transitofvenus2004.org.uk/

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