# What is Transit?

*B S Shylaja*

**The event of Venus passing in front of the Sun is called the transit. This is equivalent to an eclipse with the Moon replaced by the planet Venus. In this article, the rarity and importance of the event and the historical explorations are discussed.**

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Planets, we know, are in eternal motion. This provides a good opportunity of one coming in the light path of another. The simplest example is that of Moon, which gets into the shadow of Earth occasionally. This phenomenon is familiar to us as lunar eclipse, when the full Moon becomes almost invisible. The same Moon casts its shadow on the Earth giving us the awe-inspiring experience of the total solar eclipse.

Any object placed between the Earth and the Sun is bound to cast a shadow on the Earth. Other than the Moon only two planets fulfill this requirement – they are Mercury and Venus, moving in orbits inside that of the Earth. Such events, when one of these comes exactly between Earth and Sun, are called transits.

Johannes Kepler, credited with the discovery of planetary orbits, undertook the task of studying the possibility of such events. He found that the transits of Mercury are quite frequent, about a dozen in a century. On the other hand, the transits of Venus were rare, barely one in a century. In fact, there was not even one in the last century.

Kepler predicted the future transits of Mercury and Venus. The immediate one was on 24th October 1631. He did not live to see the event. But astronomers all over Europe observed it. One of them was the famous mathematician Pierre Gassendi. He pondered on the idea of developing this technique to measure the distances of planets and diameter of Mercury. His suggestions attracted great attention and led to the first observation of the transit of Venus.

**Keywords**
Transit of Venus.

Two young school boys Jeremiah Horrocks and William Crabtree had a fascination for astronomy. Even after the school days they maintained the interest and corresponded on the celestial events. Impressed by the transit of Mercury, Horrocks continued the calculations on his own and found that there was an opportunity to see the transit of Venus in 1639. He wrote to Crabtree, "*The reason I am writing you now is to inform you of the extraordinary conjunction of Venus and Sun on November 24*th*, at which time Venus will pass in front of the Sun, which has never happened in the past nor will happen again in this century. I beseech you, therefore, with all my strength, to attend to it diligently with a telescope and make whatever observations you can, especially about diameter of Venus*". The two friends observed the event with great enthusiasm. Horrocks wrote, "*Venus at other times so lovely, is here obscured in melancholy gloom*". They exchanged their joy in their letters, which survived a war and fire and were discovered almost two hundred years later. Thus theirs is the first ever recorded documentation of the transit of Venus. The observations of Crabtree are immortalised in a painting by Maddax Brown in Manchester.

We may now try to understand why the transit events are so rare. In their eternal motion around the Sun, planet Venus overtakes the Earth once every twenty two months. However at that time it need not be aligned with the Sun. As seen from the Earth, it may

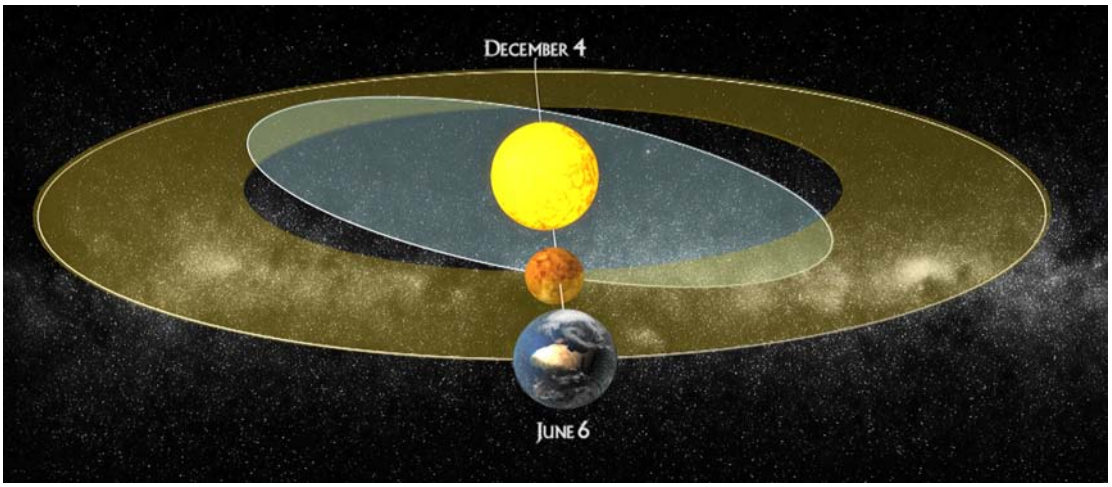


**Figure 1.** Every conjunction when Earth, Venus and Sun are almost in line cannot be a transit because the planes of orbits are inclined to each other by about 3 degrees. They intersect along a line called the line of nodes. Earth passes through this line in June and December and if Venus also is on the same line on that day, the transit occurs.

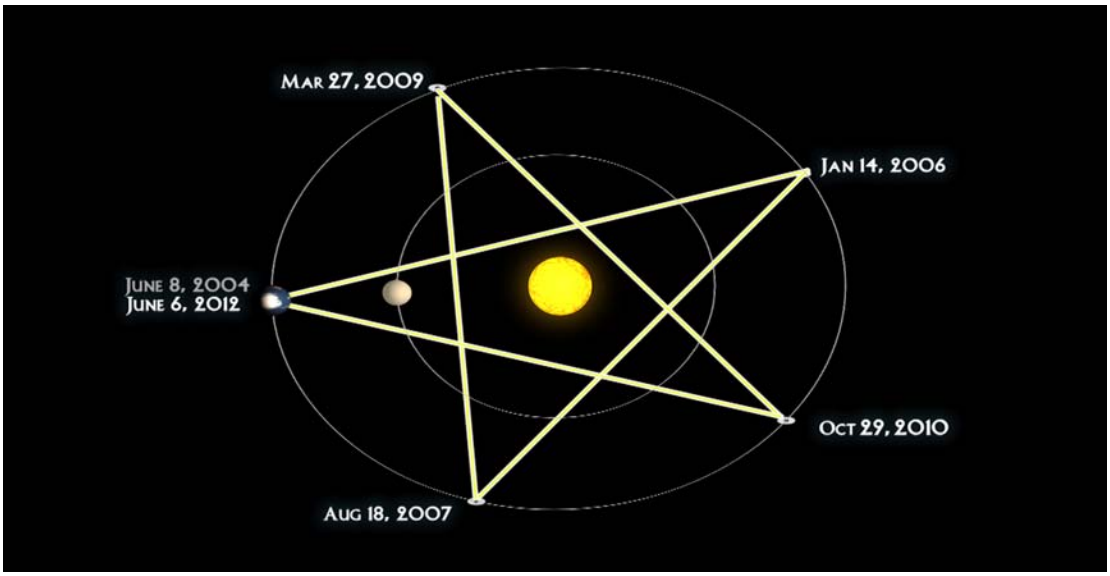


**Figure 2.** There are five synodic cycles within 8 years bringing back Venus and Earth to the line of nodes; thus the transits occur as a pair 8 years apart. The figure formed by joining these conjunctions is called a pentacle and has attracted a good number of artists.

be above or below the Sun. The orbital planes of Venus and Earth are different. Hence the two planets will be in line with the Sun only when Venus is exactly on specified points which can be either in June or in December. The June events can recur in an interval of 243 years; so can the December events. Moreover, they occur in pairs separated by eight years. Thus the first pair occurred in 1632 and 1639 in the month of December; the next events of December occurred in 1874 and 1882. The June events occurred in 1761 and 1769 and are scheduled again for 2004 and 2012.

They occur in pairs separated by either 105.5 years or 122.5 years depending on the nodes (southern or northern). Thus the sequence is

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|---|---|---|---|
| 1631 | 1761 | 1874 | 2001 |
| 1639 | 1768 | 1882 | 2012 |

The events of 1761 and 1769 were greatly publicized by Edmund Halley of the comet fame. He requested for an international campaign because that was the only technique to derive the Earth–Sun distance very precisely. He wrote, *"I recommend it therefore again and again to those curious astronomers who,*

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*when I am dead, will have an opportunity to observe … I wish them all imaginable success*". He emphasized the need for observations from all over the globe. The event was received with great enthusiasm. About two hundred astronomers sailed to different parts of the globe well in advance. One of the most successful observers was Captain James Cook who observed it from Tahiti islands. The location retains its name as Venus point even today.

Cook observed that Venus appeared like a perfect circle on the disc of the Sun. It had a halo surrounding it; he rightly guessed that this is because of the atmosphere of Venus.

One of the most unfortunate observers was le Gentil of France. He was the chairman of the French Academy of Sciences. He set out to Pondicherry with the idea of observing the transit of Venus. Rough seas and the ongoing Anglo-French war delayed his journey and he had to be content watching it from the sea. Determined to see the next one slated after 8 years, he wandered between Madagaskar and Manila studying nature. Unfortunately the second one also was clouded out. His bout of bad luck did not end there. His return journey was delayed and turned out be very unpleasant with repeated attacks of fever. When finally he reached home, there was another shock in store for him. His long absence of eleven years led to rumours of his death. Another person had been appointed as the chairman. Even his property had been

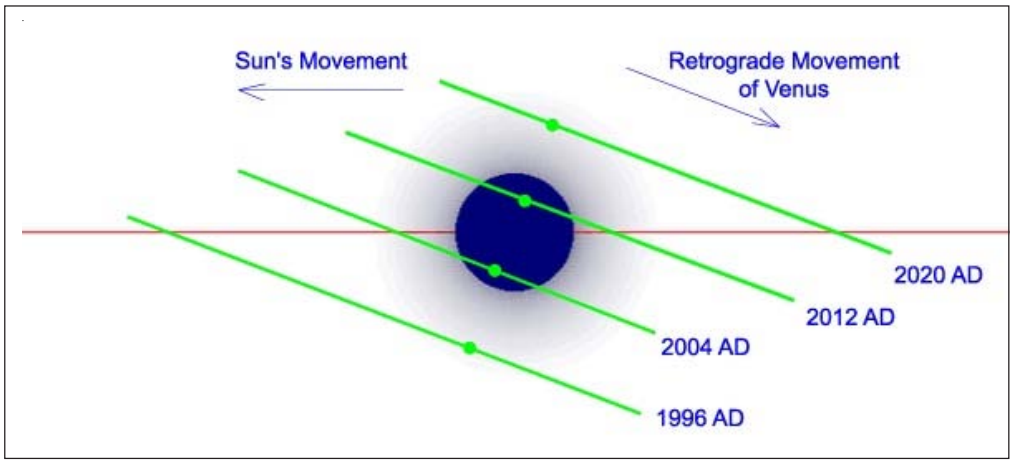


**Figure 3.** In the year 2020, Venus will pass above the disk of the Sun. Hence there will be no transit.

distributed among his relatives. He sued the relatives; but what he got at the end of it left him poor and disturbed.

The only positive note in this sad tale of ill luck is the plant he carried all the way. He presented this colourful flowering plant to his colleague astronomer Hortense Lapute. The species is today known as Hortensia reminding us of the sad tale of le Gentil.

As soon as the results of the transit observations were analysed its importance was realised by all astronomers. The next pair of events in 1874 and 1882 was eagerly awaited. Photography, which had just then been discovered, served as a boon. Over 1700 photographs were taken from all over the globe. The Sun–Earth distance was measured very precisely.

The transit of 1874 was observed from India. The observation was also carried out by Chandrashekhara Samanth in Orissa; he is perhaps the last of the few people who knew traditional Indian Astronomy. Others made observations from Vishakhapatnam (Narasingarao). Reverend Hirst observed from Madras Observatory. He saw something strange – Venus looked like a fruit (pear) before it assumed the shape of a dark perfect circle. Many others also had seen this, which has remained a puzzle. It is termed the 'black drop effect'.

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There were expeditions to India by many Europeans. Ragoonatacharry, who was employed in Madras Observatory, wrote three monographs in English, Urdu and Kannada to educate the local astronomers about the importance of the event [1]. In South Africa, three women, Mary Lyon, Abbie Park Ferguson and Miss (later Dr) Anna E. Bliss recorded the events with a small telescope from their backyard. These timings are as useful as those recorded by the professional teams. The famous mathematician and astronomer Sir Simmons Newcomb led an expedition. As part of the requirements of the instrument two pillars were erected in Wellington. "*I leave the pillars here*" he wrote, "*so that the next events may be recorded here, when I am no more*".

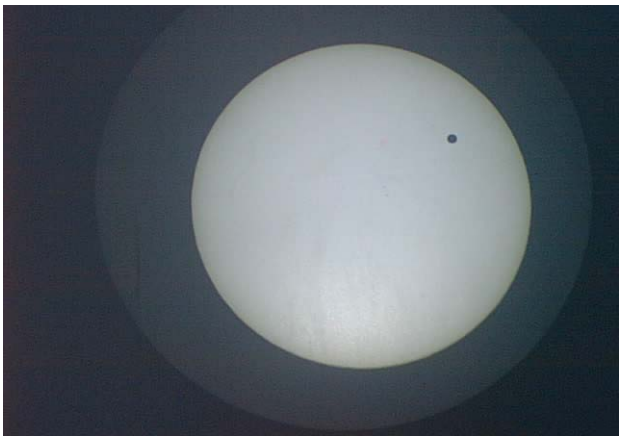

**Figure 4.** Transit of Venus photographed from Jawaharlal Nehru Planetarium, Bangalore on June 8, 2004.

In the eternal race of planets, Venus races always ahead of Earth. When it overtakes us, we feel as though temporarily it is going back analogous to the feeling we get while travelling in a crowded street. This phenomenon known as retrograde motion is very clearly depicted during the transit.

In the eternal race of planets, Venus races always ahead of Earth. When it overtakes us, we feel as though temporarily it is going back analogous to the feeling we get while travelling in a crowded street. We can observe this by noting the position of Venus with reference to the background stars. This phenomenon known as retrograde motion is very clearly depicted during the transit. It also marks the transition of the planet slipping from evening to morning sky. This is one of the easiest methods of demonstrating the meaning of retrograde motion, which remains a mystery to laypersons.

The transit of Venus offers a great opportunity to repeat the humble attempts made centuries ago for achieving accuracy in the determination of AU and asserting the presence of water in the atmosphere of Venus. Historically, it is important as it led to the precise estimates of distances to all solar system bodies. Today many sophisticated methods are in use. Still the charm of observing the transit remains as a special celestial spectacle.

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## Suggested Reading

**[1]** **B S Shylaja, Chintamani Ragoonathachari and contemporary Indian astronomy, *Current Science*, Vol.96, No.9, pp.1271–1273, 2009.**

**[2]** **http://eclipse.gsfc.nasa.gov/OH/transit04.html**

**[3]** ***Resonance*, May 2004 has articles involving classroom activities.**