

When we wake up on the morning of June 6, 2012, an event of immense significance would be underway in our solar system. In one of its rarest occurrences, the planet Venus would be seen transiting the face of the Sun. The silent unfolding of the event will not have any impact in our daily lives except for the fact that from our vantage point it would be the only opportunity for people to observe Venus crossing across the Sun last time in this century. Arguably, none of us would be alive and kicking to witness this rare appearance next time around when it occurs in the year 2117. In simple words, a transit is passage of a planet across the solar disk as seen from the Earth. It can be observed only for inferior planets, namely Mercury and Venus, whose orbits are inside the orbit of the Earth.

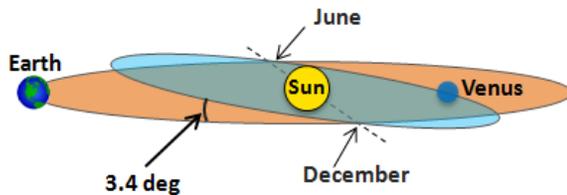


Figure 1: The TOV is rare because of a 3.4 deg tilt between the orbital planes of the Earth and the Venus.

Unlike solar or lunar eclipses, the TOV is a rare phenomenon. For the transit to occur, the Sun-Venus-Earth should be aligned in straight line. Although Venus passes between Earth and Sun roughly once in every 1.6 years (5 planetary conjunctions in 8 years), we don't observe the TOV that often. This is because Venus' orbital plane is inclined by 3.4 deg relative to Earth's orbital plane. As indicated in Figure 1, these planes intersect twice a year -once in June and then in December. For the transit to occur, Earth and Venus should be crossing

one of the nodal points simultaneously. However, for majority of the conjunctions, the Venus is seen either going above or below the solar disk as illustrated in Figure 1. The TOV occurs in pair of 8 years period separated by a long gap of 105.5 or 121.5 years as shown in Figure 2. Meaning, the cycle follows a pattern which repeats after 121.5yrs-8yrs-105.5yrs-8yrs. Since the invention of the telescope in 1608 only 3 pairs of TOV, i.e., 1631-1639, 1761-1769 and 1874-1882 have been observed. The first transit of the 4-th pair occurred on June 8, 2004 and the second is set to take place on June 6, 2012.

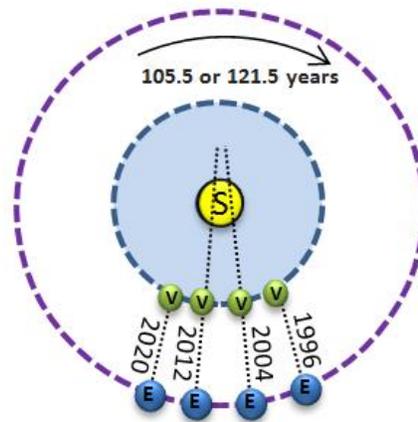


Figure 2: A favourable Earth-Venus alignment for the 2004 and 2012 pair of transits.

Historical Significance of TOV

In 17th century, Johannes Kepler gave the laws of planetary motion and derived the relative distances of planets from the Sun. To build a scaled model of the solar system, astronomers needed to know the absolute distance between Sun and Earth by some independent means. The British astronomer Edmond Halley, in 1716, proposed a way to determine the Sun-Earth distance by observing the

TOV from different locations on the Earth. The crux of his idea was that during the transit different observers will see Venus tracing out different path against the solar disk. By measuring the solar parallax angle as seen by different observers (e.g. A and B in Figure 3) and using simple trigonometric relations, the Sun-Earth distance could be determined. To carry out these measurements during the predicted TOV in 1761 and 1769, a series of observations were planned all over the world.

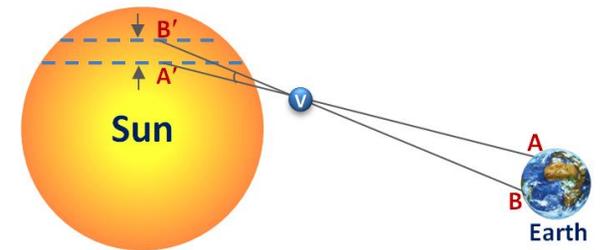


Figure 3: Venus can be seen tracing different paths on the solar disk when viewed from different locations on the Earth.

Despite several hardships, wars and long journeys to distant places, international scientific community first time collaborated in a truly global effort to settle this outstanding question in astronomy at that time. The results of over 250 measurements taken from more than 100 different sites were finally analyzed and the value of the solar parallax was nailed down to 8.794 arcsec. The measured Sun-Earth distance (also called Astronomical Unit) later became a base-line to find the distances to other stars. With improvement in technology and observing tools, the TOV continues to provide fresh opportunities to generation of researchers. For example, many ground-based telescopes and space instruments will be used for scientific observations of TOV-2012. Some of these studies are aimed at:

- better understanding of climatic conditions of the Venus' atmosphere.
- correlating the apparent diameter of the Venus during the transit with its known diameter. The comparison will help to estimate the size of exoplanets detected around other stars.
- developing reliable exoplanet detection techniques by measuring the dip in Sun's brightness (& also the presence of Sun-spots) during the TOV. The robust models will then help eliminate the false detection signals that may be arising due to the appearance of star-spots or intrinsic variability of the host star.
- inferring the composition of exoplanet atmosphere by comparing it to the spectroscopic studies of the Venus' atmosphere during the transit.
- estimating the scattering noise of the instruments and telescope optics.

Observations of TOV-2012

Extreme care must be taken while observing the transit of Venus across the Sun. Most importantly, never look directly into the Sun. The intense solar radiation may cause permanent damage to the eyes. Compared to the size of the Sun (30 arcmin), the Venus would be seen as a tiny black dot of angular diameter 1 arcmin. A safest way to view the transit is to project the Sun's magnified image from telescope or binocular onto a large screen. Solar-screen made of Mylar filter also used to look at the Sun. People in North America will be the first to see the transit of Venus on the evening of 5th June, 2012. However, for viewers in India, the transit will already be in progress when the Sun rises on the

6th June. The local transit times and Venus trajectory for various locations in India are shown in Figure 4. The transit will last over 4 hours before the 4th contact (egress exterior) occurs at about 10:22 AM.

At IIA, Bangalore and its field stations in Kavalur (T.N.), Hanle (J&K) and Kodaikonal (T.N.), we have made special arrangements for live streaming as well as public viewing of the TOV on 6th morning. If the sky is clear, we will be able to observe the planet Venus gracefully cruising across the bright Sun. Let us all join in viewing this unique celestial event and make it a great success and a memorable legacy for the future generations!

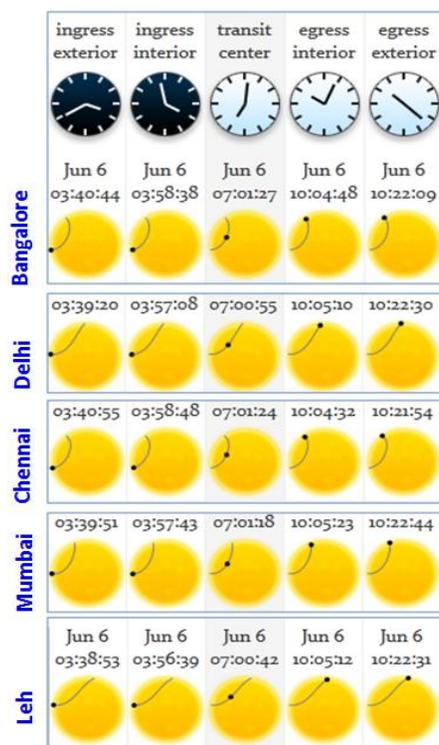
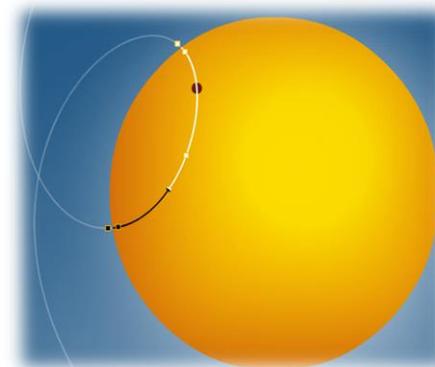


Figure 4. Local transit times and Venus trajectories during the TOV-2012 from different places in India. Source <http://transitofvenus.nl/>

–PUBLIC VIEWING OF–

Transit of Venus-2012



June 6, 2012

6:00–10:30 AM

Venue

Indian Institute of Astrophysics
Koramangala, Bangalore -560034

<http://www.iiap.res.in/>



–ALL ARE WELCOME–