A search for records of planetary transits in India prior to the colonial period

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Given the exciting and inspiring history of the first known observations of the transits of Venus, one is always left wondering about any possible inadvertent observations of such a transit earlier than the known observations based on the predictions by Johannes Kepler. Here we consider the possible attempts by earlier astronomers and non-astronomers from India.

The earliest known record of the transit was made by Jeremiah Horrocks, England, in the winter of 1639. Quite naturally, there will be a curiosity in terms of knowing how close any earlier theoretical considerations related to planetary positions and movements came towards considering possible transits of Venus and Mercury, as could be observed from the Earth, prior to the work of Kepler predicting the transit of Venus of 1631.

There seems to be no immediate indication of the existence of calculated planetary tables, accurate enough to have predicted such transits of Venus anywhere else in the world at that time. Perhaps more work is merited in terms of looking at Arab and Indian planetary tables from this period. It would be interesting to know how close they would have come towards predicting the transits of Mercury and Venus.

As shown by Rao and Venugopal[1] (hereafter BV2009), it seems that traditional Indian (Siddhantic) positional astronomy framework does have the potential for predicting transits of Venus, when applied in specific cases, after some minor corrections. However, BV2009 stress the fact that Siddhantic astronomers did not specifically consider the possibility of a planetary transit across the disk of the Sun. The conjunctions were calculated and the heliacal rising and setting of planets were accordingly observed (Sripada Bhatt, private commun., 2012). Thus whether it was a conjunction or a special case like transit was not relevant for the calculations.

In the Indian context, it is interesting to study some existing records in the form of historical stone inscriptions[2]. Here are some examples where the conjunctions and transits are cited as '*vyatipatha*', a word used to imply that the declinations of the Sun and the Moon have the same numerical value. The following inscription records will gain importance when we interpret *vyatipatha* to mean the declination of the Sun and the planet (Mercury or Venus as the case may be) as being equal.

1. 3 June AD 1000 – (EKU Vol. I, Series II, No. 17): This record cites the name of the star as Mrigashira. The Sun and Venus both were near this star Lambda Orionis. This was a conjunction – the angular separation between the two was about 34′. The date is recorded as *Saka* 922 (this is *Shalivahana Saka*), *Sarvari Samvatsara* (a cycle of 60 years) and *Jyeshta* (lunar calendar month) *bahula* 12 (the 12th day after full moon) and *Mrigashira.*
2. 21 April AD 1056 – (EKU Vol. V, No. 341): This is a possible record for transit of Mercury. The record gives *Saka* 980, *Vilambi Samvatsara* and *Vaishakha purnami* (full moon) *vyatipatha*. It has been noticed that there may be a difference of one in *Saka* count owing to differences in notations, which can be sorted out based on other details especially if an eclipse record is available in and around the same year[3]. In the present record, the word *vyatipatha* may be interpreted to mean the declination of Mercury and the Sun as being equal.
3. 21 December 1077 – (EC Vol. VII, No. 118): The record cites *vyatipatottara uttarayana Sankramana* with details of date as *Hevilambi samvatsara* and *Pushya shuddha* 3.
4. 4 October 1126 – (EKU Vol. V, Part II, No. 604): This is possibly a record of conjunction of Mercury. The date is given as *Prabhva samvatsara*, *Karthika bahula* 7.
5. 24 October 1217: This is also possibly a record of the transit of Mercury. Here the epigraphists have not been able to decide on the year since only the name of *Samvatsara Bahudhanya* is mentioned. The word eclipse creates confusion since neither 1217 or 1218 will match a lunar eclipse. The month is *Karthika* corresponding to October.
6. 2 July 1390: This inscription from Suchindram reads '*Raakaloke sakabde surapathi sachive simhayute Tulayamarudhe padminise … Aditidinayute…*'. This has been interpreted by Kielhorn as Jupiter in *Tula*, is not possible. Venkatasubbiah interprets this as Venus in *Simha*, but puts the date as 2 October 1390 (*Raakaloke* means *Saka* 1302 according to the *Katapayaadi* system). However, on this day no planet was in Tula. Therefore, it may be for the conjunction of Venus with the Sun in *Simha* (Leo) and the conjunction occurred at *Tula lagna* (when Libra was rising)[4].

The work on stone inscriptions has covered only 10% of the available 40,000 and odd records centred around Karnataka. Hence a systematic search of such inscriptions from all over India is likely to yield more records.

Going further back in time, one has only this tenuous possibility of reference to a transit in the *Chandogya Upanishad*, which is conventionally dated around 500 BC.

The following verses of the *Chandogya Upanishad*, translated by Swami Swahananda, are cited as a reference to naked eye sunspots[5]:

'*It flowed forth; It settled by the side of the Sun; Verily it is that which appears as the black form in the Sun.*'

– *Chandogya Upanishad* 3.3.3

'*It flowed forth; It settled by the side of the Sun; Verily it is that which appears as the quivering in the middle of the Sun.*'

– *Chandogya Upanishad* 3.5.3

The transit of Venus.

The transit of Venus is a rare astronomical event when the planet passes in front of the Sun. Although the event can be compared to a solar eclipse, the effect is not noticeable since the disc of Venus occupies only 1/30th the disc of the Sun. However, keen observers would have taken a note of it. After Kepler publicised the event, it attracted the attention of astronomers for a different purpose, namely the estimation of the astronomical unit. It is a rare event occurring approximately once in a century, although the 20th century did not have even one event. Thus we had the pair of 1874 and 1882 followed by the current pair of 2004 and 2012. The next ones are slated for 2117 and 2125. Apart from the rarity and historical significance, the event itself has historical and educational value.

If the description – settling by the side of the Sun, black form in the Sun, and appearing in the middle of the Sun – refers to observing something on the Sun on a particular day – would have to refer to a transit of Venus rather than a naked-eye sunspot.

The caution here, however, is due to the fact that the translations from Vedic and Upanishad material would be highly interpretation-oriented. It is likely that the translator was not aware of the possibility of a transit. In this context it is interesting to look at the ideas of Siddhantic astronomers, about the planets Mercury and Venus. Very few refer to the motion of Mercury and Venus as a special case.

One of the earliest discussions is found in the work of Lalla '*Sisyavriddhi Tantra*', as cited in the commentary by Mallikarjuna Suri[6]. The commentary gives us a clue that there had been some thoughts on the possible conjunctions with the Sun and the visibility of the planet on such occasions. The statement reads...

'*All the spheres of planets…are like the moon bright on one side facing the sun and dark on the other away from it…That half of the disc which is above the sun, which is visible to people (of the earth) is always illuminated and ...it is never dark…Venus and Mercury though moving in orbits beneath that of the sun do not appear dark like the Moon. This is because they are nearer to the sun and are always illuminated.*'

(Ch XVI verses 40–42)

This statement implies that Mercury and Venus will be visible during conjunctions since they are close to the Sun and illuminated by the Sun. We do not come across a direct reference on the discussions thereafter.

A theoretical discussion on this topic is available later in the 16th century text *Siddhanta-tattva-viveka* by Kamalakara Bhatta[7]. About 20 verses are devoted to the visibility of planets in a chapter called *Bimbadhikaara.* Kamalakara objects to the statement that Mercury and Venus have their own illumination and thus become visible even during conjunctions (transits, as a special case). His statement exactly reads as: 'I do not agree with the objection raised by certain learned people to the idea that Mercury and Venus create a hole-like appearance on the sun from whom they acquire the brightness' (verse no. 28).

This has a footnote from Pandit Sudhakar Dwivedi which elaborates the idea as:

(a) Mercury and Venus do not have their own light.
(b) Their brightness will be useless when they are near the Sun.
(c) They will look like holes on the disc of the Sun.

The arguments continue – if these two planets have their own light why do they not become visible when they are within the small angle defined as *Kaalaamsha* or (The minimum separation for which the planets do not become visible during conjunctions is technically termed *Kaalamsha*. For Venus, it is 8 units.) even their *Kaalaamsha* is large? (verse no. 29).

The disc of these planets will not be seen when they are lost in the glory of the Sun (at conjunctions). However, there is a way to see them (verse no. 34). The footnote to this explains that the planets do not have their own light and hence will not shine during conjunctions.

Kamalakara lived in the 17th century and he was a contemporary of Kepler. However, as is well known, there was no exchange of ideas between the two. The discussion here leads us to the fact that he thought about the possibility of a transit and/or discussed it with senior astronomers who had turned down the idea. He is believed to have written this in 1658 (ref. 8). This makes us wonder – did he see the transit of Venus in 1631 or that of Mercury in 1651 or had heard about them?

Kamalakara seems relatively modern in his views compared to his contemporaries – intent as he appears – to have observational or logical verifications for many fallacies or false views. Amazingly, he also seems to have had an inkling about the phases of Venus. Verse no. 27 states 'As the planet approaches the sun its size decreases and the brightness increases'. He mentions that this is something special about Venus and Mercury. Kamalakara's thoughts about the phases of Venus as also his probable observations of planetary transits raise the question of his possible usage of optical aids, though we do not have any confirmed mention of the same.

The transit of Venus in 1631 was visible as a nearly grazing transit from Varanasi and the rest of Northern India. It was not a sunrise event, but a late morning event. It seems to have needed some kind of a telescopic observation with a projected image of the Sun. So far, the first known instance of the use of a telescope in India was that by Jeremiah Shakerely, when he observed a transit of Mercury from Surat in 1651, though there is a possibility of an earlier usage[9].

The possibility of an earlier usage is being speculated upon, arising from the fact that the Mughal Emperor Jehangir had observed the solar eclipse of 19 April 1614, visible as a partial eclipse from Delhi and had made measurements of the obscuration fraction of the eclipse[10,11]. He is thought to have been presented, amongst a host of goods, different kinds of glasses/folding glasses (perhaps a telescope?) by Sir Thomas Roe, the English ambassador in his court. (Perspective glasses, as telescopes were then called, were standard gift items being requested from back home by various European travellers to far away lands.) Roe, in his dispatches back to England, laments that gifts like spyglasses and other novelties have not found favour at the Mughal court, and what he needed to court favour with the Mughal Emperor was jewels or paintings[12].

Based on these writings, it has been taken to understand that Jehangir did not show any interest in the telescope, which was received as a gift. However, given his meticulous observations as a naturalist and also his keen interest in astronomy, one is left wondering whether he did make any use of the telescope. The fact that nowhere in the *Jehangirnama* or other writings of his time, a mention is made of this, need not necessarily mean that he did not use it. Nowhere in the *Jehangirnama* is a mention of Roe himself.

However, there seems to be no specific mention of anything which may be directly connected with observing the Sun and Venus in close conjunction of the transit kind, in the memoirs of the Mughal emperors all of whom – and Humayun in particular – had a keen interest in positional astronomy, even if that interest came from an interest in astrology.

But, there is a glancing reference to the Sun and Venus a few years after 1631, which is intriguing. This comes in the context of the famous Peacock Throne made under orders of the Mughal Emperor Shah Jahan, perhaps around 1634. The *Padshahnama*, a biography of Shah Jahan written by Abdul Hamid Lahori (completed around 1636), talks of jewels collected by Shah Jahan and says[13]:

'*In the course of years many valuable gems had come into the imperial jewel-house, each one of which might serve as an ear drop for Venus or as an adornment for the girdle of the Sun.*'

This is the only reference to the astronomical objects in the entire book and appears to be totally out of context. However, there are a few other indications of some celestial symbolism in connection with the Peacock Throne apart from the reference mentioned above. Different contemporary descriptions of the Peacock Throne agree about the 12 support pillars for the canopy (a Zodiac symbolism?). More work in this area is merited as the phrase mentioned above, is evocative.

While all of the narration mentioned above was highly speculative, with no tangible connection with any possible viewing of the 1631 transit of Venus, we have the whole recorded history of mankind to search for possible serendipitous naked-eye observations of the transits of Venus – as it did not need any knowledge of celestial movements or any observing tools.

There seems to be some indications of such an observation made by Babylonians in the 15th century BC, as inferred from a broken Assyrian Cuneiform tablet, which was translated as referring to the passage of Venus across the disk of the Sun[14].

Many reported medieval statements of Arab astronomers related to observing a transit of Venus, have been interpreted as large, naked-eye sunspot observations, as no transits occurred during those years of observations. However, the statement of Avicenna, the Persian polymath, wherein he talks of seeing Venus appear like a mole on the face of the Sun, in 1032, is taken as possibly an observation of a transit of Venus[15]. The 24 May 1032 transit of Venus was seen from Hamadan, Iran (the birthplace of Avicenna) at sunset, thus making it possible for Avicenna to have glanced at the setting Sun and seen the transit.

The caution about the translations from any of the archaic records being highly interpretation-oriented is valid here too, especially when the translator was ignorant of the possibility of a transit.

Therefore, it is quite possible that many such records will yield interesting results and need to be studied from an observational astronomer's point of view.

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ACKNOWLEDGEMENTS. We thank Dr Sripada Bhatta, Rashtriya Samskrithi Samstahnam, Tirupathi for help in translation and interpretation of the Sanskrit verses, and Patrick Das Gupta for useful discussions.

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Edited by P. Balaram, and printed & published by G. Madhavan for Current Science Association, Bangalore 560 080.
Typeset by WINTECS Typesetters (Ph: 2332 7311), Bangalore 560 021 and Printed at Lotus Printers, Bangalore (Ph: 2320 9909)