

# Eclipses in Ancient India<sup>1</sup>

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## **Abstract:**

The earliest description of a solar eclipse can be found in the Rig Veda, the oldest document from India dated to between 1700 and 1400 BC (Subbarayappa 2008; Sarma and Subbarayappa, 1985). In later literature, dated to between 900 and 600 BC, a more detailed description of the phases of an eclipse can also be found. However, these details are not accompanied by calendrical details and hence it is not possible to date them. The eclipses are explained through the existence of a body-less head of Rahu who tried to eat up the Sun and the Moon due to an enmity to them (Damle, 2011). In 499 AD, Aryabhata gave a formal theory of eclipses based on the transit of Moon between Earth and Sun and in the shadow of the earth. In India, eclipses are considered occasions when the gods are in trouble because the Sun or the Moon is eaten up by Rahu and hence large donations are common at the time of eclipses. These donations are often recorded on stone or copper plate inscriptions along with the date and place of donation. A fraction of these are catalogued in various records of the Archaeological Survey of India. We have scanned them and found record of more than a thousand records dated to between 400 AD and 1800 AD. They make a useful database for systematic studies of  $\Delta T$  (Soma and Tanikawa, this volume) as well as other possible causes of perturbations in earth's rotation.

## **1. Introduction**

Eclipses must have appeared unnerving and erratic to early humans. Their periodicity is complex and not easy to fathom. The effect of solar eclipses in particular is both dramatic and transient. In solar eclipse, it appears as if the sun disappears from the sky with the experience further dramatised by the appearance of shadow bands due to diffraction on lunar surface and its jaggedness. It is natural therefore that eclipses would find mention even in the earliest literature and their occurrence would be marked by specific customs. Records of these can be found in different contexts.

The location of the occurrence of solar eclipses in particular are extremely sensitive to the subtle changes in the earth's spin due to tidal interactions or other changes in the earth's angular momentum distribution (Soma and Tanikawa, this volume).

Here we discuss the references to eclipses in ancient Indian literature and the quality and quantity of reports available from India.

## **2. Literary reference of Eclipses**

The earliest reference to an eclipse in the subcontinent can be found the earliest of India written records in Rig Veda book V verse 40 dated to around 1400 BC (Subbarayappa 2010). In a

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description there, a demon (Swarbhanu), using magic makes the sun disappear from the sky with devastating consequences for humans and gods. The gods then appeal to the great sage Atri to undo the magic of the demon. Atri obliges and undoes the magic of the demon and the Sun is restored to his original glory.

In a later book *Pancavimsa Bramhana* (Subbarayappa 2008) dated to between 900 and 600 BC, the description of the eclipse is more detailed. Here it is said that at the eclipse the Sun originally becomes black, then silvery and eventually red before returning to its original glory. One can identify these colours with modern descriptions of eclipses starting from totality.

In 499 AD the great Indian mathematician and astronomer, Aryabhata explained that the eclipses occur because either the moon comes between the sun and the earth or the moon goes into the shadow of the earth. Using purely geometrical arguments and the relative sizes of the object, he gave an excellent formulation of the calculation of eclipse parameters. Prior to him, the methods of tracing the line of movement of the Sun and the moon were known and hence combining to two it became possible to scientifically understand and explain the date, time and nature of eclipse around 500 AD. Later Indian astronomical texts on mathematical astronomy have devoted chapters for calculating the both lunar and solar eclipses and this tradition continued over time, and the calculations are available even today. It is also noted that even at conjunction if the vertical separation is more than the sum of the angular radii of the Sun and the Moon, then no eclipse would occur. This method allowed predictions of exact date and time of eclipse, their type and the place where it would be visible. Subsequently all texts discuss predictions of eclipses.

There is at least one record dated to 1128 AD of an eclipse was predicted and it occurred as predicted and the astronomer who predicted it received generous gifts from the King (Subbarayappa, 2008).

### **3. Mythology of eclipses**

The original story of the eclipse goes as follows (Damle, 2011, p 52). The great god Bramha reveals to the gods and the asuras (who are another other group of super humans who fight with gods for supremacy) that there is an immortality giving elixir of life in a pot at the bottom of the sea. Whoever drinks this elixir will become immortal. Neither the gods nor the demons had the necessary capability to churn the great oceans. Hence they agree to cooperate. Using the great snake Sheshanaga as the rope and the mountain Mainak as the shaft, they began churning the seas. Several strange things happen during the churning as the sea keeps throwing out a variety of items before the nectar can be given out. However, we do not discuss it here and refer the interested reader to Damle (2011). After several complications, they eventually succeed. However, when the elixir (called amruta – the one that prevents death) eventually comes, the gods become dishonest. One of them (Lord Vishnu) takes the form of a beautiful maiden named Mohini (“the one who enchants”). The asuras are completely mesmerised by her beauty and completely forget about the nectar. Mohini calmly takes the pot. She instructs the gods and the asuras to sit in two parallel lines so that she can systematically distribute the Amruta. However, she begins by distributing it to the gods. While most asuras remain oblivious to the trickery, one of them, called Swarbhanu realises the trick and quietly goes and sits in the line with the gods. Mohini dutifully hands out the nectar to him but before he can take it the Sun and the Moon realise what is happening and complain. Mohini immediately cuts off the head of Swarbhanu. However, since Swarbhanu has already tasted the nector he becomes immortal. The head of the slain but living

demon is then cared for by his mother and is called Rahu. The body, looked after by another priest is called Ketu. However, Rahu and Ketu are both very angry with Sun and Moon and now spend all their time trying to take revenge on them. Hence the eclipses occur when Rahu gulps down Sun or the Moon. However, because Rahu is only a head, the Sun and the moon escape Rahu as he gulps them down.

Since Rahu and Ketu also move in the sky like other planets, they are called dark or unseen planets. Their motion is also predictable and hence the ancient Indian practice is to worship 9 planets – Sun, Moon, Mercury, Venus, Mars, Jupiter, Saturn, Rahu and Ketu.

Later on, when Aryabhata gave the complete formulation of the eclipses, he used the concept of Rahu and Ketu to describe the ascending and descending nodes of the point of intersection of the Lunar and Solar orbits (Subbarayappa, 2008, Kochhar 2010). These are then transformed into specific moving points of a periodicity of 18.6 years and a conjunction of Rahu and Ketu with Sun and Moon are identified as periods of eclipse.

#### **4. Records of eclipses**

However, one of the peculiarities of Hinduism is that humans are expected to help the gods with donations whenever the gods are in trouble. Hence, at the time of eclipses, generous donations are expected, a practice that continues even today. The purpose of these donations and gifts (to temples and priests) were to ward off the presumed ill effects of an eclipse and to get boons for their family.

Because the rich and the famous like to record their donations for posterity, these donations are recorded on stones or copper plates etc. These records can be found. The Archaeological Survey of India has collected various such inscriptions for more than a hundred years and these records are available. We have scanned these records and noted down the references to eclipses including the date and type of eclipse, the location (where the writing is found) and the nature of donation.

We have found records of 469 lunar eclipses and 470 Solar Eclipses for which we have dates. In this, there are multiple records of the same eclipse. However, many eclipses are recorded at more than one place or multiple donations are recorded at the same site. Hence the we have records of 340 distinct Lunar and 286 distinct solar eclipses. They cover a period from 400 AD to 1800 AD (figure 1).

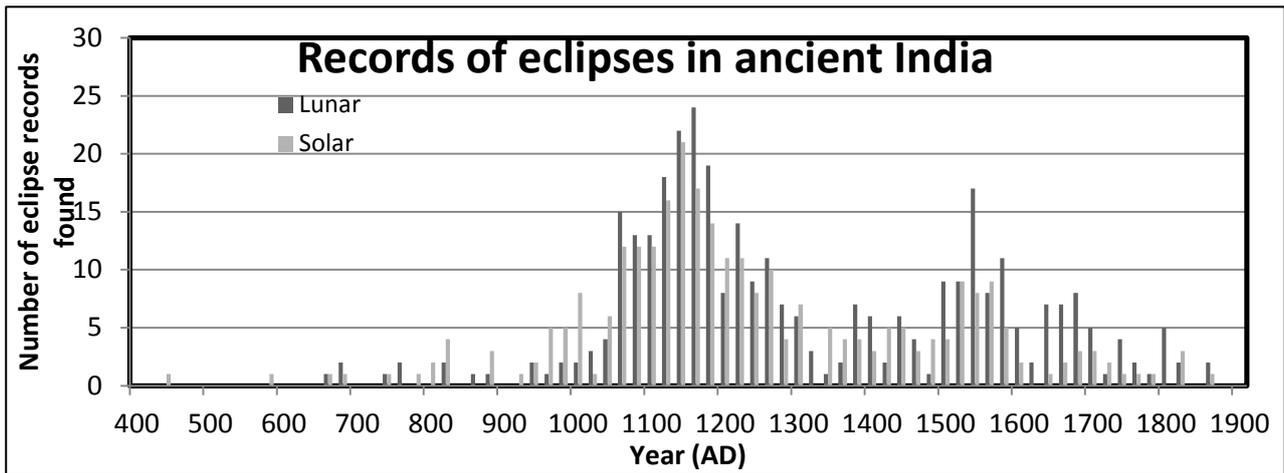


Figure 1: Records of Solar and Lunar Eclipses in India

The unevenness of the data is partly due to social upheavals and partly due to non uniform scanning of the records over the period. We believe that the true records must be several times this data and we plan to continue this search.

We have analysed about 300 eclipses against the NASA’s calculation of solar and lunar eclipses (Subbarayappa 2010) and we find that in 13% the cases eclipse is not seen, in 18% it is on a slightly different day and there may to have been a recording error. Also, sometimes the donations were made after the eclipse occurred and this may account for some of the discrepancies in the dates. In rest of the cases, the eclipse is seen. Hence, the data quality is quite acceptable (87% are genuine) and should lead to some interesting results in future.

## 5. Conclusion

References to eclipses in ancient India date back to the oldest document, the Rig Veda and sporadic discussions exists in the literature. However, in later period, the records of donations at the time of eclipses can be found and we have records of almost a thousand such records. A substantial database of eclipses recorded in the subcontinent between 400 AD and 1800 therefore now exists and it should provide a rich dataset to extract information on subtle changes in earths precession over this period.

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## Reference

- Damle Leena, 2011, Stars of Asia, ed. Kaifu,
- Kochhar R, 2010, Rahu and Ketu in mythological and ‘astronomical’ context, Indian Journal of History of Science, vol 45, no 2, June 2010, p 287-297
- Soma T and Tanikawa, 2011, this conference

- Subbarayappa, B V, 2008, Traditions of Astronomy in India and Jyotishshastrs, Centre for Studies of Civilizations, Vol IV part 4, Centre for Studies of Civilisations, Viva Books
- Subbarayappa B V and Sarma K V, 1985, *Indian Astronomy a Source Book*, Nehru Centre, Mumbai.