IJNRD.ORG ISSN : 2456-4184
INTERNATIONAL JOURNAL OF NOVEL RESEARCH AND DEVELOPMENT (IJNRD) | IJNRD.ORG
An International Open Access, Peer-reviewed, Refereed Journal

Lallacharya(Lalla): An Early Indian Astronomer and Mathematician.

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1. Life sketch of Lallacharya (720 CE- 790CE).

Lallacharya was an eminent scholar of astronomy, mathematics, and astrology in early India. He used place value system [1, p-87]. Trivikarma Bhatt was his father and Taladhvaja was his grandfather. However, his time and place of birth was not mentioned clearly in his work, but it can be inferred only from the available sources, a commentator of Brahamagupta's Khandakhadyaka namely Amaraja called Lallacharya was also a commentator of Brahamagupta's Khandakhadyaka. Some clues about Lallacharya's life and time were found in works, which are as the following:

"Subtract 420 from the Saka year elapsed. Multiply the remainder severally by 25, 114, 96, 47 and 153. Divide each product by 250. The quotients in minutes should be subtracted respectively from the mean longitude of Moon, its apogee and node, Jupiter and the Sighrocca i.e., Sighra apogee of Venus. Again, multiply the above remainder severally by 48, 20 and 420. Divide each product by 250. Add the quotients in minutes respectively to the mean longitude of Mars, Saturn, and Sighrocca of Mercury". This statement indicates that Lallacharya made a correction in the Aryabhata-I's constant of positions of the planets calculated 250 years before the time of Lallacharya. Thus, the Lallacharya's time suggested about 748 CE or 670 CE [1 p. 321].

The other clue about the period of Lallacharya can be traced in the similarities between the Lallacharya's work, Shishyadhividhidantantra, and Brahmagupta's work Brahmasphutasiddhanta. Thus, it can be concluded that he was a follower of Aryabhata-I, Brahmagupta and Bhaskara-I all of them were Indian mathematicians and astronomers prior to him. So, it is roughly suggested that Lallacharya was an eighth century's Indian mathematician. But a general believe is that he was born in 720 CE and passed away in the year 790 CE at the age seventy years. As far as concerned the place of observations and the place of his birth, an astronomical clue, mentioned in his work that, he compares, the half-moon with the forehead of place Latadesa, which falls in the southern part of modern Gujarat state. In another work Ratnakosa, in the section on seasons called Rutucarca, he wrote: "Lalate latinam luthitam alakam tandavayati".

The implication is that wisps of hair play havoc with the foreheads of the women of Lata i.e., Latadesa. Lata was well known in the region of south towards the south of Vindhya hills. Because of this description possibly Lallacharya lived in the region of Latadesa [3 p. 86].

2. Lallacharya' work on Astrnomy.

Lallacharya summarized his astronomical and mathematical works at least in the following three texts.

(a). Shishyadhividhidantantra, is an astronomical work of Lallacharya, which is available so far and considered as the most important work on mathematical astronomy. This text is now available in two parts viz. Grahadhaya and Goladhyaya. In the first part i.e., Grahadhaya he described Mean planets, True planets, True Sun, True Moon, Three problems, solar eclipse, lunar eclipse, and prediction of eclipses etc. On the other hand, the second part viz. Goladhyaya mainly described the rules of calculations of spherical solids used in astronomy, mean motions, sphere of earth, motion of the celestial, description of the earth, false notions, astronomical instruments and the astronomical problems, longitudes of the planets, cusps of the moon, conjunction of planets, conjunction of the planets with the stars, rising and setting of the planets and rationale of corrections etc. Lallacharya followed the astronomical principles of Aryabhata-I and corrected some of them for his astronomical calculations [3 p. 86-87].

Some chapters of, Shishyadhividhidantantra, are discussed geographical knowledge of his time, and the astronomical instruments used by him for the actual observations of astronomical events. Lallacharya was the first Indian astronomer who wrote a section on the topic "Celestial sphere" and this is considered as his original work on astronomical science and the formulae for the calculation of the height of the cone of the earth's shadow as well as the diameter of the earth's shadow during the lunar eclipse [3 p. 88-89]. These are as the following:

(i). The height of the cone of the earth's shadow

= [5(Sun's distance from earth)]/16.

(ii). The diameter of the earth's shadow

= [1050(earth's shadow – moon's distance)]/ (earth's shadow)

The prediction of eclipses after six months can be given by applying these following steps [3 p. 90].

(i). At first find the mean longitude of the Sun, Moon, its apogee, and nod on that day.

(ii). Then add it to the first three longitudes 5^s, 24^0 27′6′′, 5^s, 22^0 12′53′′ and 0^s,19^0 42′53′′ and the subtract 0^s, 90^0, 22′41′′ respectively from the longitude of the cone.

(iii). The process must be reversed to determine the eclipses of the previous six months.

Lallacharya explained common beliefs (false notions) related to astronomical phenomena which were prevalent during his time, most of them appeared in Puranas, he refuted them with the astronomical basis. Some of them and their explanation quoted from [3 p. 91-92] are as the following:

(i). The Earth is supported in various ways.

Explanation: He refutes the belief that the earth is supported by an external agency. Lallacharya says that the earth remains unsupported, suspended in space. If it were supported by something, the latter, in its turn, would have to be supported by something else and so on. Then, there would be no end of supporters, and that is not possible. Many wonderful things happen in this world; so, there is nothing to be surprised at if the earth hangs in space.

(ii). Directions can be determined at Meru.

Explanation: Lallacharya says that no direction can be determined at Meru, because there, the observer's horizon coincides with the celestial equator and hence there is no east point.

(iii). The night comes when the mountain Meru covers the Sun.

Explanation: Lallacharya's mention is that the night is not caused by Meru but by the shadow of the Earth.

(iv). The Moon's orbit is above that of the Sun.

Explanation: Lallacharya says that if the moon were above the Sun, it would always be illuminated like a star. Moreover, then it could neither cause a solar eclipse nor could it be obscured by the earth's shadow.

(v). The dark half of the lunar month is the day of the manes, and the light half is their night.

Explanation: Lallacharya states that the whole of the light half of the lunar month cannot be the day of the manes because they do not see the see the Sun after the eighth day.

(vi). The Earth is infinite.

Explanation: Lallacharya says that earth could not be infinitely large, as then the sphere of the fixed stars could not go round it in one day.

(vii). The illuminated portion of the Moon decreases because it is being sucked by the Gods.

Explanation: If the Moon's daily decrease were due to its being sucked by the Gods, mathematics would be of no use in computing its light and dark portions.

(viii). The Earth moves.

Explanation: The Bauddhas maintain that the earth was falling in space. So Lallacharya says that if it were so, how could a thing when thrown up come down again on the same piece of a ground. Again, if the earth were continuously moving up, the constellations would be nearer every moment.

(ix). The Earth is plane like a mirror.

Explanation: Lallacharya's mention is that the earth is spherical and not a plane. But as only a small portion of it visible at a time that may be the reason for its appearing as level as a mirror. If it were level, the topes of high trees could be seen even from a great distance.

(x). The days of the observers at the north pole begins when the Sun starts for the summer solstitial point and that of the observers at the south pole begins, when it starts for the winter solstitial point i.e., solstitial is that great circle of the celestial sphere through the celestial poles and the solstices.

Explanation: Lallacharya's argument is that if the observers at North Pole can see it descending from Aries to Gemini, they should also see it descending from Cancer to Virgo when the Sun travels exactly along the same diurnal circles. So, the current belief cannot be correct.

(b). Siddhantatilaka, Yallaya mentioned that this text is another astronomical work of Lallacharya and contains summaries of the earlier astronomical texts. This text also includes the methods of calculation for the mean longitudes of planets which were given by Lallacharya [3 p. 92].

(c). Jyotisaratnakosa, this is an astrological work of Lallacharya remained a very popular work on astrology in India for around three centuries [4 p. 50]. Some of the other astrological topics discussed in this text are as the following [3 p. 92]:

(i). The signs of rainfall.

(ii). Times of journey.

(iii). Different stages of childbirth.

(iv). Good or bad feature of man and woman.

(v). The effect of tithies (dates), weekdays and stars etc.

(vi). Types of elephants and horses to be bought.

(vii). Details of house building, temple building, setting up of idols, sowing seeds etc.

3. LALLACHARYA'S WORK ON MATHEMATICS

Although, Lallacharya's work on mathematics is not available so far [1, p-321], but through the references found in the works of latter mathematicians like Bhaskara-II, Narayana etc. it is inferred that Lallacharya must have also written some work on mathematics.

Conclusion: In this paper we have discussed LALLA's astronomical work however, his astronomical and mathematical work shows influence of earlier indian mathematician and astronomers like Aryabhata-I, Brahamagupta etc.

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