

AN EARLY ECLIPSE RECORD OF INDIAN ASTRONOMY

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The present paper is an attempt to highlight an early record of the eclipse observation in the Indian astronomical tradition. Śaṅkaranārāyaṇa, a protégé of the King Ravi Varma Kulaśekhara who ruled at Mahodayapuram in Kerala has made a reference to the solar eclipse watched by the King and himself on the 1449066th day of Kaliyuga in the afternoon. Nīlakaṇṭha Somayāji has made an indirect mention of this eclipse in the context of Śaṅkaranārāyaṇa and *Bhaṭābda-samskāra*, which mean that the particular eclipse observation was used by Śaṅkaranārāyaṇa to convince the King of the efficacy of the *Vāghbhāva* corrections in accurate astronomical computations and thus achieved for the method royal recognition as well as popularity. The *Vāghbhāva* corrected mean longitude when accounted for precession using *ayaṅamaśa* of the Kerala School of astronomy tallied almost exactly with the modern longitudes. The mean Sun differed by 5 minutes of arc while mean Moon, Rāhu and Apogee of Moon differed only by 1 minute of arc. This eclipse observational record is of historical significance and point towards the prevalence of scientific astronomical observation and experimentation in Kerala during the 9th century AD.

Key words : Early eclipse record, *Bhaṭābda* correction, *Kalidina*, *Karaṇa*, *Vāghbhāva*, Śaṅkaranārāyaṇa.

INTRODUCTION

Eclipse observation in India dates back to Vedic antiquity as is evident from the hymns 5-9: Book V of *R̥gveda*. Inscriptional records of the eclipses are also available from AD 580 onwards¹. But records of astronomical observation of the eclipses have been almost nil in the history of Indian astronomy till the time of Paramēśvara and Nīlakaṇṭha Somayāji (1500) that

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there have been regular records of eclipse observations. The reference to a solar eclipse observed by the Kerala astronomer Śaṅkaranārayaṇa corresponding to the *Kalidina* of 14,09,066, which falls in AD 866 is significant in this connection. The present paper is an attempt to investigate the details of this event.

ŚAṅKARANĀRĀYAṆA

We have only very little information about the life and works of Śaṅkaranārayaṇa. His only work that has come down to us is the commentary on *Laghubhāskariya* from which we are able to understand that he was a protégé of the King Ravivarma Kulaśekhara of Mahodayapuram and he belonged to the place 'Kollapuri' [08°53' N, 76° 37' E]. K.V. Sarma has quoted a few verses from his *Labhubhāskariya vivaraṇa* in "*Indian Astronomy—A Source Book*", which tells us also about the *Golayantra* or armillary sphere installed at the observatory in the capital city of Mahodayapuram in Kerala. This city also had the name Vañci and was near the present-day Koḍungallūr of the Trichur [10°25' N, 76°15' E] district of Kerala. The opening verse of the afore-mentioned commentary viz.,

*acāryāryabhaṭam, varāhamihiram śrīmadgurum bhāskaram/
govindam haridattam atra śirasā vakṣye pranamyā kramāt//*

-tells us of his two illustrious but little known predecessors in the Kerala astronomical tradition—Haridatta and Govindasvāmin. Later in the text he has provided his date as Śaka 791, which corresponds to AD 869. He has mentioned the eclipse under reference in verses 31-32 of the fourth chapter and K.S. Shukla has translated these verses as follows²:

"When 14,49,066 days had elapsed (of Kaliyuga) and the Sun was eclipsed, causing darkness in the afternoon, Śrī Kulaśekhara, the Lord of the land surrounded by beautiful seashore, enquired of the eclipsed portion of the Sun corresponding to the end of the second *ghaṭi* since the commencement of the eclipse".

Nīlakaṅṭha Somayaji has referred to Śaṅkaranārayaṇa as the disciple of Govindasvāmī and also mentions the application of *Vāghbhāva* corrections by him in predicting the solar eclipse at Mahodayapuram. From *Laghubhāskarīya-vivarāṇa* this eclipse can be understood to be the one that took place for the *Kalidina* 1449066. Perhaps, this is one of the earliest record of an eclipse observation by an astronomer of the Indian astronomical tradition.

DETAILS OF THE ECLIPSE

Kalidina 1449065; Kali year 3967 (elapsed):

New Moon: 16 June 866 AD, Sunday, 15:10 LMT [10°25'N, 76°15'E] *Udayādi*: 23 *nāḍikas* 52 *vināḍikas*; including fraction, *Kalidina* 1449065.39777, JD [TDT]: 2037530.945897. Sun and Moon: 88°26'45". The near-total eclipse had its beginning at 15:38 LMT and end at 17:52 LMT with the near-totality at 16:48 LMT.

As mentioned in the above-quoted verses of Śaṅkaranārayaṇa the eclipse was in the afternoon and the duration was nearly 5^h 35^{min}. In *Jyotirmīmāṃsā* by Nīlakaṅṭha, we have the following indirect reference to this eclipse in the following words³.

*"tacca laghubhāskarīyavyākhyāne śaṅkaranārayaṇīye likhitam asmābhir
dr̥ṣṭam / govindasvāmināpi ime 'bhavabhā'nvādayo bījasamskāraśloka na dr̥ṣṭah /
nibandhasamskāra eka eva dr̥ṣṭah / sa ca govindakṛtau likhitah / tatra
bhaumādnām eva-catvāriṃśalīpta deyā madhye kujasya - ityādnoktā / na
candrasya / ata candrasphuṭe tattunṅamadhyaḥ saṃskāravekīkṛtyoktaḥ -
padonāṣṭāvīmśatih padonacchidraturjyā iti /*

*ekīkaraṇe sphuṭagatir apyapekṣyate, dhruvasamskāravat / govindasvāmini
svargate punaḥ tacchiṣyaḥ śaṅkaranārayaṇaḥ 'vāghbhāvonā'diyuktaṃ
bhaṭābdasamskāraṃ labdhvā mahodayapurastho arkagrahaṇam dr̥ṣṭvā, tasya
dr̥ksamvādam jñātvā rājñe kulasekharāya nivedayāmāsa / tena ayaṃ keralesu
prasāritah / tasyāpi punaridāntiṃ dr̥gvisamvādah abhūt / tatra candrasamskāre
'munyamśonah' kalā eva tyājya iti grahaṇam dr̥ṣṭvā kenaciduktaṃ / tatra
asmatparamaguru paramēśvarācārya bhārgavo āsvatthagṛāmajaḥ 'munyamśah'*

*saptamāṃśo vā pañcamāṃśo veti samsāyā bahūparāgadarśanena
pañcāṃśonatvaṃ nirṇīya siddhāntadīpikāyāṃ govindabhāṣyavyākhyāyāṃ
avadacca—*

*tatrendoḥ śākajā liptāḥ svapañcāṃśena varjitāḥ /
grāhyā, rāhor dvādaśāṃśāḥ nastuṅgasya kevalāḥ //*

The present author is not competent to attempt a satisfactory translation of these verses. Part of these can be found translated in the *Āryabhaṭīya*, edited by K.S. Shukla along with the commentary of Bhāskara-I, at page xxxviii of the Introduction:

“These two ārya verses (dealing with the *manuyuga* correction) were seen by me in Śāṅkaranārayaṇa commentary on the *Laghu-bhāskariya*. Govindasvāmī, too, did not see the verses giving the *bīja* correction, beginning with *bhavabhānu*. He saw only one *nibandha*-correction. That has been stated in the *Govindākṛti*... On the death of Govindasvāmī, his pupil Śāṅkaranārayaṇa, having obtained the *Bhaṭa*-correction beginning with *vāghbhāvonāt*, and observing a solar eclipse at Mahodayapura, informed King Kulāśekhara of his discovery. By him this was popularized in Kerala”.

Even this translation coming from a reputed scholar and astronomer is not satisfactory. What is implied in the verses is the fact that Śāṅkaranārayaṇa could inform Ravivarma Kulāśekhara of the aptness of *vāghbhāva* corrections after ascertaining it from the eclipse observation at Mahodayapuram. This discussion on the above eclipse observation by Śāṅkaranārayaṇa took place 600 years after him in the context of corrections to Moon and its Node to facilitate accurate computation of the eclipses. It is therefore apparent that Kerala had a tradition of eclipse observations since quite early times and such data were constantly employed in refining the astronomical elements.

MERIT OF ‘VAGHBHĀVA’ CORRECTION

It is apparent from the above disquisition by Nīlkaṇṭha that Śāṅkaranārayaṇa convinced the efficacy of *Vāghbhāva* corrections to Kulāśekhara with the observational data of the above eclipse. To understand

the significance of *Vāghbhāva* corrections corrections the mean elements related to the eclipse are provided in the accompanying Table as per as *Āryabhaṭīya* as well as *Vāghbhāva* corrected in contrast to modern values :

Mean Elements for Kalidina = 1449065.3977

**New Moon: 16 June 866 AD, Sunday, 15:10 LMT [10°25'N, 76°15'E],
JD [TDT]: 2037530.945897**

| Planet | <i>Āryabhaṭīya</i> | <i>Āryabhaṭīya</i> + <i>ayanāṃśa</i> * | <i>Vāghbhāva</i> | <i>Vāghbhāva</i> + <i>ayanāṃśa</i> | Modern astronomy |
|------------|--------------------|---|------------------|---------------------------------------|---------------------|
| Sun | 82°59'57''.91 | 88°84' | 82°59'57''.91 | 88°44' | 88°38'42'' |
| Moon | 79°55'52''.18 | 85°40' | 79°18'20''.66 | 85°02' | 85°02'47'' |
| Node | 85°29'35''.21 | 91°13'35'' | 83°09'39''.43 | 88°54' | 88°54'36'' |
| Apsis-Moon | 216°26'40'' | 222°11' | 213°39'32''.7 | 219°24' | 219°25'16'' |

**Ayanāṃśa* used : [(3623-3967)/60] = 05°44'

What better accuracy can we think of almost 1200 years before, in the pre-telescopic-phase of astronomy ? According to modern algorithms the correction involved in converting the Universal time to the astronomical time TDT is (+) 2209.6 seconds in AD 866. Without accounting for this variation of 37 minutes of time over which the Moon undergoes a longitudinal variation of approximately 19 minutes of arc, we could not have realized the above exactness of the ancient computations.

CONCLUSIONS

It is apparent from the above that the eclipse actually took place on the 1449066th day of the Kaliyuga and not after 1449066 elapsed days as the tradition has come to believe. It was a near total eclipse occurring two days before *Dakṣiṇāyana* in the afternoon and was over only 1.2 *ghaṭis* before sunset. Exactness of the *Vāghbhāva* corrected longitudes of Sun, Moon Rāhu, and Moon's Apogee with the modern values facilitates a better interpretation of the Nīlakaṇṭha's observations about Śaṅkaranārayaṇa in the context of *Bhaṭābda-saṃskara*. The above eclipse might have given Śaṅkaranārayaṇa an opportunity to convince King Kulāśekhara of

the accuracy and significance of the *Vāghbhāva* correction and thus the *Vāghbhāva* correction became popular in Kerala under royal patronage.

NOTES AND REFERENCES

1. *Epigraphica Indica*: XXVIII, pp. 1 ff.
2. *Āryabhaṭṭya* with the commentary of Bhāskara-I and Someśvara, ed. K.S. Shukla, Pub: Indian National Science Academy, New Delhi. Introduction p. xcix.
3. *Jyotirmīmāṃsā* of Nīlakaṇṭha Somayāji, VVB Institute of Sanskrit and Indological Studies, Panjab University, Hoshiarpur. ed. K.V. Sarma. pp. 15-16 (1977).
4. *Vāghbhāva* correction: Haridatta, in *Mahāmārganibandhana*, had stipulated the following corrections for the mean longitudes of Planets: Let (Śaka year-444) = Y. Correction for Moon : $9^{\circ}Y/85$, Moon's Apogee: $65^{\circ}Y/134$, Rāhu: $13^{\circ}Y/32$, Mars: $45^{\circ}Y/235$, Śīghrocca of Mercury: $420^{\circ}Y/235$, Jupiter: $47^{\circ}Y/235$, Śīghrocca of Venus: (-) $153^{\circ}Y/235$ and for Śani: $20^{\circ}Y/235$ [Page. 155, *Indian Astronomy—A Source Book*, ed. B.V. Subbarayappa, K.V. Sarma, Published by Nehru Centre, Bombay, 1984]. This correction, called also *Bhaṭṭābda* correction and *Śakābda* correction, is to be applied in the computation of the longitudes of the planets for the years passed after Śaka 444, which is the number represented by the words, *vāghbhāva* and *bhāvabhā* in the Kaṭapayādi notation.