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Epoch of Lalla — An Overview*

Present paper is an attempt to overview the epoch of Lalla in the light of the ancient records of Indian siddhāntic astronomy. Corrections stated by Lalla, on the basis of which Sengupta and Bina Chatterjee had dated him to 748 AD, is shown to have existed much before 748 AD as the well known *Vāghbhāva* corrections with Śaka 444 as the base and 235 as the divisor. Divisor argument is shown to fall through when contrasted with the reference to *Vāghbhāva* using 235 as divisor by Devācārya in *Karaṇaratna* which spells out the epoch clearly as Śaka 611 or 689 AD – just five years after the promulgation of *Parahita-gaṇita* by Haridatta. Modification of the *Vāghbhāva* corrections by Lalla to suit his epoch of 749 AD is the only argument that sustains the known dating by Sengupta and Bina Chatterjee. The intricate indebtedness of Lalla to Vāghbhāva – Haridatta – *Karaṇaratna* factors is being highlighted here for the first time leading the epochal date of Lalla more to 749 AD.

1. Introduction

Lalla, author of the astronomical work *Śiṣyadhīvṛddhida Tantra*[1], is one of the well known figures of the ancient Indian astronomical tradition and belongs to the class of greats like Āryabhaṭa, Varāhamihira, Bhāskara-I, Brahmagupta etc. But his works are almost silent about his date as may be understood from the critical edition of *Śiṣyadhīvṛddhida Tantra* by Bina Chatterjee and little is known about his date through other authors as well. To summarize the well known facts:

1. Dikshit has placed Lalla around Śaka 560 or 638 AD as a contemporary of Brahmagupta and he has discussed the opinion of Kern and Dvivedi who have placed him at Śaka 420 or 498 AD.[2]
2. Sengupta[3] considers him as coming after Brahmagupta based on the similarity between *Śiṣyadhīvṛddhida Tantra* and the *Brāhmasphuṭasiddhānta* of Brahmagupta which suggests the borrowal of the special methods of the latter by Lalla.

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3. Two correction verses available in a few manuscripts and credited to Lalla by Sūryadeva Yajvā and Parameśvara suggests the epoch of Lalla as Śaka 420 + 250 = Śaka 670 (748 AD).
4. Following the dating by Sudhakara Dvivedi and certain references to Lalla as the disciple of Āryabhaṭa, Lalla is considered as a contemporary of Āryabhaṭa by many scholars.

Available literature on the topic adds nothing more about the date of Lalla and the epochs suggested have failed to receive critical examination in the light of his only available astronomical work viz. *Śiṣyadhīvṛddhida-Tantra.* Present paper is an attempt to examine the veracity of the Śaka 670 or 748 AD epoch.

2. Astronomical Grounds of the Epoch 748 AD

(a) *Credibility of the Divisor used in deriving corrections as denoting the epoch:*

As quoted by Sūryadeva, the verses implying the corrections to the longitudes obtained from *Āryabhaṭīya* are:

शाके नखाब्धिरहिते शशिनोऽ क्षदस्रैस्तत्तुङ्गतः कृतशिवैः तमसः षडङ्कैः।
शैलाब्धिभिः सुरगुरोर्गुणिते सितोच्चात् शोध्यं त्रिपञ्चकुहतेऽभ्रशराक्षिभक्ते।।
स्तंभेरामंबुधिहते क्षितिनन्दनस्य सूर्यात्मजस्य गुणितेऽम्बरलोचनैश्च।
व्योमाग्निवेदनिहते विदधीत लब्धं शीतांशुसूनुचलतुङ्गकलासु वृद्धिम्।।[4]

(śāke nakhābdhirahite śasino' kṣadasraistattuṅgataḥ kṛtaśivaiḥ tamasaḥ ṣaḍaṅkaiḥ / śailābdhibhih suragurorguṇite sitoccāt śodhyaṃ tripañcakuhate'bhra śarākṣibhakte// stambherāmambudhihate kṣitinandanasya suryatmajasya guṇite'mbaralocanaiśca / vyomāgnivedanihate vidadhīta labdhaṃ śitāṃsunucalatuṅgakalāsu vṛddhim //[4])

"Substract 420 from the Śaka 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 logitudes of Moon, its apogee and node, Jupiter and the Śigrocca of Venus. Again multiply the above remainder severally; by 48, 20 and 420. Divide each product by 250 and add the quotients in minutes respectively to the mean longitudes of Mars, Saturn and the Śigrocca of Mercury"[5]

How do these corrections to mean longitudes of *Āryabhaṭīya* can throw light on the epoch of Lalla?

In the words of Bina Chatterjee – "What could 250 signify? It shows that Lalla corrected the position of the planets calculated with the constants of Āryabhaṭa, by his own observations. According to the formula, 250 years after 420 Śaka, which is Āryabhaṭa's time, or in 670 Śaka (748 AD), corrections were necessary. Thus, 748 AD may well denote Lalla's time."

The same arguments has been put forward by Sengupta in his introduction (p. xxvii) to the translation of *Khaṇḍakhādyaka.*

We have little reason to doubt this argument until we see the same corrections in the *Karaṇaratna* of Devācārya which clearly gives its epoch as 689 AD which is 24 years after the *Khaṇḍakhādyaka* epoch of Brahmagupta. As given in *Karaṇaratna*:

करणाब्दं गिरिरसशशि सहितं प्रालेयदीधितेस्तत्वैः।
उच्चस्य वेदरुद्रैर्भुजङ्गराजस्य रसरन्ध्रैः।16।
भूसुनोः शरवेदैर्बुधशीघ्रस्यम्बराशिववारिधिभिः।
मुनिर्वेदैरिन्द्रगुरोः सितशीघ्रस्य त्रिबाणैकैः।17।
सौरस्य नखैर्गुणयेच्छराग्नियुग्मैर्भजेच्च ता लिप्ताः।
कुजशनिशशितनयेषु क्षेप्याः शेषेषु संशोध्याः।18।

(karaṇābdam girirasaśaśi sahitam prāleyadīdhitestattvaiḥ |
uccasya vedarudrairbhujaṅgarājasya rasarandhraiḥ |16|
bhūsunoḥ saravedairbudhaśighrasyambarāśivavāridhibhih
munir vedairindraguroḥ sitaśighrasya tribanaikaiḥ ||17|
saurasya nakhairguṇayeccharāgniyugmairbhajecca tā liptāḥ |
kujaśaniśaśitanayeṣu kṣepyāḥ śeṣeṣu saṃśodhyāḥ ||18|)

"To the *Karaṇābda* (Śaka 611 or 689 AD) and 167 and multiply the sum obtained by 25, 114, 96, 45, 420, 47, 153 and 20 respectively in the case of the Moon, its apogee, Rāhu, Mars, Mercury's śigrocca, Jupiter, Venus's śigrocca and Saturn. Divide the products by 235 and the quotients taken as minutes are additive in the case of Mars, Saturn and Mercury while negative in the case of remaining ones".

According to the argument of Senguupta and Bina Chatterjee quoted above, the *Karaṇaratna* employing the divisor of 235 to derive the corrections must have its epoch at Śaka 444+235 = 679 or 757 AD that is after the epoch of Lalla at 748 AD. The above corrections known as *Śakābda* (*Bhaṭā bda*) corrections or *Vāghbhāva* (444) are believed to have their origin in 683/684 AD by Haridattacārya of Kerala, six years before the epoch of *Karaṇaratna*[7]. Subbarayappa and Sarma have credited the *Vāghbhāva* verses to the *Mahāmārganibandhana* of Haridatta.[8]

In the light of the above, we need to interpret the divisor as the year at which the corrections led to whole number of minutes and they had their origin in 684 AD, 162 years after 522 AD and these corrections brought the mean motions of Āryabhaṭa closer to the modern values in the ensuing period. As such nothing bars the contemporaneity of Lalla with Deva who came after Haridatta or a date towards the end of seventh century AD for Lalla. In the light of this inference, the date of Lalla as stated by Sengupta and Bina Chatterjee on the basis of the divisor 250 viz. 748 AD, losses its credibility unless we can find other astronomical factors in *Śiṣyadhivṛddhida-tantra* which support 748 AD.

(b) *Implications of the Lalla's verses*

Even though the verses given above imply the same corrections as *Vāghbhāva*, the wordings and the numbers under use are different. This may be interpreted as adaptation of the practice to meet a specific epoch in a unique manner. Lalla differs from Haridatta in taking *Bhaṭābda* as Śaka 420 instead of Śaka 444 and uses 250 as the divisor instead of 235. Following Haridatta or Deva exactly would have meant the integer minutes corrections in Śaka 444+235 = Śaka 679 or 757 AD instead of Śaka 420+250 = Śaka 670 or 748 AD. Lalla had no reason to differ from Haridatta tradition unless the epoch 748 AD had some special significance to his work. As such a closer astronomical look is made at the epoch of Śaka 670 or 748 AD. In terms of the notable astronomical phenomena that may add grandeur to an epoch, Śaka 671 elapsed or 749 AD is more significant than Śaka 670 or 748 AD. As such we shall focus our attention to 749 AD which comes 250 years after the famous epoch of Āryabhaṭa viz., 499 AD. For Śaka 671

elapsed or Kali 3850 elapsed, the mean longitudes derived of the constants of *Āryabhaṭīya* and the modern astronomical values are contrasted in table below:

1	2	3	4	5	6
Planets	Revolutions as per Āryabhaṭa	Mean l Āryabhaṭa	Modern Mean l	Difference in minutes	Correction in 250 years (')
Moon	57753336	355.301	354.513	47	-25
Rāhu	232226	194.15	192.679	89	-96
Perigee-M	488219	306.929	305.157	106	-114
Mars	2296824	337.700	338.491	-47	+48
Mercury	17937020	193.917	193.455	28	+420
Jupiter	364224	215.200	214.329	52	-47
Venus	7022388	136.150	133.872	137	-153
Saturn	146564	222.617	223.451	-50	+20

Column (4) gives the modern mean λ of planets computed as elongation from Sun to concord with the methodology of the Siddhāntas. Columns (5) and (6) reflect the rationale of the corrections – corrections bridged the gap between Āryabhaṭa system and the observations almost perfectly. As explained above, this agreement alone does not attest that the epoch of the corrections in 749 AD.

(c) *Special Significance of Kali 3850 elapsed = 749 AD Epoch*

- *Ahargaṇa* = 1406245.92031 i.e., 1406245 days 55 *ghaṭis* and 13 *vighaṭis*, New moon. As such *ahargaṇa* of 1406246 was Sunday, 23rd March 749 AD, sunrise at Ujjain, 06:00 LMT, JD (UT) = 1994711.53958.
- New moon as per modern compuation was at JD (UT) = 1994711.71680 which meant 05:12:12 UT or 10:15:12 LMT of Ujjain, 10 *ghaṭis* 38 *vighaṭis*. λ of Sun and Moon = 05°56′32″ and Rāhu = 15°34′. At Ujjain and in south Gujarat which is believed to be the place of Lalla, a partial eclipse of Sun was visible – beginning at 08:45 and ending at 10:38 with the maximum magnitude of 0.283 at 0939 LMT. Solar eclipse thus coincided the New Year.

- Above features reflected the Yugādi positions of Sun, Moon and the Nodes and therefore the epoch Kali 3850 would have been an ideal choice as epoch for any astronomer who might have lived around this time.
- Succeeding Full Moon was on 7th April 749, 2143 LMT [JD (UT) = 1994727.1946], and had a lunar eclipse, beginning at 18:54 and ending at 00:32 on 8th April.
- After six months, the eclipse duo was to recur again on 16th and 30th September 749. But the solar eclipse was not visible in Ujjain/S. Gujarat while the total lunar eclipse was completely visible.
- New moon JD (UT) 1994889.08763, Sun and Moon = 176°53′ and Full Moon JD (UT), 1994903.40722, Sun = 191°07′, Moon = 11°07′.

(d) ***Do these features find any reflection in Śiṣyadhīvṛddhida-tantra?***

749 AD can be taken as the epoch of Lalla if we are able to trace some reflections of the above eclipse duo of Caitra and Āśvina in his work *Śiṣyadhīvṛddhida-tantra*. As is well known, Lalla has not spoken of any eclipse observations in his work. But in his discussion on the probability of an eclipse at any time, the following data is available which are quite noteworthy.

Eclipse at ± six months – probability may be examined by finding the logitudes of Sun, Moon, its apogee and Node with the mean motions, 174-27-6, 172-12-53, 19-42-53 and (-) 09-22-41.

Eclipse at ± half lunation – mean motion of finding longitudes are respectively, 14-47-02, 197-38-42, 1-40-13, (-) 00-47-45.

1	2	3	4	5
Planets	±6 Months Lalla	±6 Months Āryabhaṭa	± Half lunation Lalla	± Half lunation Āryabhaṭa
Sun	174°27′06″	174°37′57″	14°47′02″	14°33′9.77″
Moon	172°12′53″	174°37′57″	197°38′42″	194°33′9.77″
Moon-apogee	19°42′53″	19.736	01°40′13″	1.645
Node	(-) 09°22′41″	-09.388	(-) 0°47′45″	(-) 0.782

1. It may be noted that the values of Lalla are not the mean motions derivable from his treatise (Āryabhaṭa revolutions) for sun and moon. But the values of Moon's apogee and Node are those derived from Āryabhaṭa revolutions.
2. Above discrepancy suggests that the values given may be observed values across eclipse duos across half-a-lunation and six months which was possile in the year 749 AD.
3. Bina chatterjee has added the note that "Brahmagupta gives only the six monthly motions in BSS, xvi, 30-32, Śripati gives both in SiSe, vii, 3-4. They are slightly different from those given by Lalla". This pecularity of Lalla may have its genesis in 749 AD, the epoch.
4. Also, it may be due to make the integer corrections suitable to 749 AD that Lalla modifed the Vāghbhāva (based on Śaka 444) to be based on Śaka 420 with the new divisor of 250. Integer values of Haridatta were applicable to Śaka 444+235 = Śaka 679 or 757 AD.
5. Further, the Kali New Year or solar transit to Aries coincides with Caitra śukla (1) as in the case of the Varāha epoch of Kali 3606 elapsed. Intervening 244 years had an integer number of solar and lunar revolutions – both sidereal and synodic in the case of the latter.

Other than the merits of the above conjectures in respect of the peculiarity of 749 AD, that might have inspired Lalla to adopt the same as epoch and accordingly modify the *Vāghbhāva* corrections with divisor as 250 and Śaka 420 as the basis, the divisor argument alone renders no clue towards the date of Lalla.

3. Lalla's Indebtedness to Haridatta

Bina Chatterjee has dealt upon the similarity of the work of Lalla with those of Brahmagupta viz., *Brāhmasphuṭasiddhānta* and *Khaṇḍakhādyaka*. In respect of the accuracy of computed longitudes neither of the above texts would have been of much help to him in the absence of the corrections that Bina Chatterjee had mentioned as occurring in some manuscripts and credited to Lalla. It is apparent from the earlier discussions that the so-called corrections of Lalla had their origin in Kerala in 684 AD in the formulation of *Parahita-gaṇita* by Haridatta.[9] Lall's computational basis of mean motions as such is exclusively of the Āryabhaṭa tradition.

Further it may be noted that these corrections do not mean any significant improvements in the mean motions made by Lalla through observations as is made out in certain quarters.[10] The integer minutes of corrections were in existence 65 years before the epoch of 749 AD and were also associated with '*ayanāṃśa*' as stated by Deva in *Karaṇaratna*.

On the contrary, if we assume borrowing by Haridatta and Deva of Vāghbhāva corrections from Lalla, Lalla must have lived before the date of Devācārya – that is – before 684/689 AD. Deva's epoch is just 24 years after the *Khaṇḍakhādyaka* epoch of Brahmagupta and 60 years after Bhāskara-I and thus an intermediate date for Lalla has only a remote possibility.

4. Conclusions

Lalla's date 748 AD inferred exclusively from the divisor used in deriving the corrections is shown to be of fragile foundations. Lalla's indebtness to *Vāghbhāva* corrections of Haridatta – introduced in Kerala in 684 AD and to the Āryabhaṭa tradition of Kerala are well established.

His modification of the *Vāghbhāva* corrections based on Śaka 444 and divisor 235 to Śaka 420 base and divisor 250 is shown to have made for the epoch 749 AD or Kali 3850 for which the solar and lunar year beginning coincided with Caitra śukla (1).

References

1. Bina Chatterjee, *Śiṣyadhīvṛddhida Tantra of Lalla*, INSA, New Delhi, 1981.
2. SB Dikshit, *History of Indian Astronomy*, Part-II, Controller of Publications, Civil Lines, Delhi, p. 93
3. Quoted by Bina Chatterjee in (1) above
4. *Āryabhaṭīya of Aryabhaṭa* with the commentary of Sūryadeva Yajan, INSA, New Delhi, 1976, p. 93
5. Translated by Bina Chatterjee in (1) above
6. *Karaṇaratna*, Davācārya, Department of Mathematics & Astronomy, Luknow University, 1979, pp. 12-13.
7. Ibid, Introduction, p. ii
8. BV Subbarayappa & KV Sarma, *Indian Astronomy-A Source Book*, Nehru Centre, Mumbai, p. 155
9. Details of Hardatta's epoch may be known from – K Chandra Hari, "Date of Haridatta", *IJHS* 37.3 (2002) 223-236.
10. G. Abraham & JS Cornelius, "Observational Astronomy", *IJHS*, 38.4 (2003) 367-76.