Someśvara on the *Āryabhaṭīya*

—*Golapāda*, 45 on *valana*—

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Of many commentaries on the *Āryabhaṭīya*, Someśvara's¹⁾ is the most interesting one in that it is a kind of an abridged reproduction of Bhāskara I's commentary²⁾, which is the earliest of all the existing ones, and which is not preserved in a complete form with the last forty five stanzas of the fourth chapter (*Golapāda*) missing. Besides a few variant readings of minor significance, the verses of the *Āryabhaṭīya* commented by Someśvara are not much different from those commented by Parameśvara and Nīlakaṇṭha³⁾ although there is one important exception discussed in the present paper.

According to the two published texts, *Golapāda*, 45 runs—

madhyahnat kramagunito 'kṣo dakṣiṇato 'rdhavistarahrto dik|

sthiyardhac cārkendvos trirāśisahitāyanāt sparśe||

This stanza deals with so-called *valana* (deflection) to be computed in order to determine the direction of the moon in a lunar or solar eclipses. The *valana* is obtained from two components, *ākṣavalana* (γ_1) and *āyanavalana* (γ_2). The first line of the stanza, which gives the rule for finding *ākṣavalana*, was translated by Clark⁴⁾ as follows:

“The sine of the latitude multiplied by the sine of the hour-angle divided by the radius is the deflection due to latitude. It is south.”

The rule is identical with that given in Varāhamihira's *Pañcasiddhāntikā*⁵⁾ (VI, 8 and XI, 2) and is represented by the formula

$$\sin \gamma_1 = \frac{\sin \phi \times \sin t}{R} \quad (I)$$

where ϕ , t , and R stand for the geographical latitude, the hour angle, and the radius of the base-circle, respectively⁶⁾. The same rule is found in the *Brahmasphuṭasiddhānta*⁷⁾ (IV, 16), the *Sūryasiddhānta*⁸⁾ (IV, 27), and the *Siddhantaśiromaṇi*⁹⁾ (*Goladhyāya*, *Grahaṇavāsana*, 37) etc..

The manuscript of Someśvara's commentary, however, reads the first line 'madhyāhnotkramaguṇito' instead of 'madhyāhnaṭ kramaguṇito' and accordingly Someśvara's paraphrase is : —

madhyāhnaṭ prabhṛty utkramo madhyāhnotkramaḥ/ madhyāhnaṭiithyanta (-anta)-rāla-ghaṭika madhyāhnaśabdenocyate/ (folio 45B line 4-5)

Thus it is clear that the *Āryabhaṭīya* at the hand of Someśvara gave the rule using Versed Sine (*utkramajyā*), instead of Sine (*kramajyā*), of the hour angle between midday (or midnight in the case of a lunar eclipse) and the time of an eclipse. The rule intended is

$$\sin \gamma_1 = \frac{\sin \phi \times \text{Vers } t}{R} \quad (\text{II})$$

This second rule is by no means Someśvara's arbitrary invention, but it is an old one already found in Bhāskara's *Mahābhāskariya*¹⁰ (V, 42) and *Laghubhāskariya*¹¹ (IV, 15), and most assuredly the reading '-utkrama-' goes back to Āryabhaṭa's original text itself, because, as already suggested by Kuppanna Sastrī¹², Govindasvāmin (800-850) quotes the same stanza reading '-utkrama-'. Āryabhaṭa's preference of Versed Sine is evidenced from his another misapplication of it to the rule of *āyanadṛkkarma* (*Golapāda*, 36).

Taking it into account that Varāhamihira was a younger contemporary with Āryabhaṭa, it is possible to assume that there were, since the days of these two astronomers, two different opinions concerning the rule for finding *ākṣavalana*. From this point of view I classified main astronomical texts into two groups. one using *kramajyā* (I), the other *utkramajyā* (II).

I	II
<i>Pañcasiddhāntikā</i> (505)	<i>Āryabhaṭīya</i> (499)
<i>Brāhmasphuṭasiddhānta</i> (629)	<i>Mahābhāskariya</i> and <i>Laghubhāskariya</i> of Bhāskara I (fl. 628)
<i>Khaṇḍakhadyaka</i> (655)	<i>Siṣyadhīvr̥ddhidatantra</i> of Lalla (8th century)
Later <i>Sūryasiddhānta</i> (7-10th century)	Govindasvāmin (800-850) on <i>Mahābhāskariya</i>
<i>Mahāsiddhānta</i> (between 950-1100)	Pṛthūdakasvāmin (fl. 864) on <i>BSS</i>
<i>Siddhāntaśiromaṇi</i> (1150) of Bhāskara II	

Parameśvara (1360–1455) on *Sūrya-siddhānta* and on *Āryabhaṭṭiya*(?)

and *Kh-Kh*.

Utpala (966) on *Kh-Kh*.

Nilakaṇṭha (b. 1443) on *Āryabhaṭṭiya*

Someśvara (fl. 1040) on *Āryabhaṭṭiya*

Parameśvara on *Mbh.* and *Lbh.*

Of the commentators on the *Āryabhaṭṭiya*, Someśvara and Bhāskara I obviously belong to the second group; Nilakaṇṭha undoubtedly to the first, because in his commentary on *Golapāda*, 45, he first explains the rule of *ākṣavalana* using *kramajyā* and afterwards he expressly gives the special remark that *utkramajyā* is not used in this context¹³.

As for Parameśvara's commentary, however, the problem is more delicate, because, as Kern says in the Preface to his edition of the *Āryabhaṭṭiya* (with Parameśvara's commentary), the manuscript has a gap extending from the stanza in question to the first part of the commentary on it. Kern knew that there was a variant reading '*madhyāhnotkramaguṇito*' attested in Sūryadeva's *Prakāśikā*¹⁴ but he failed to employ it because it was "erroneous, both from an astronomical and grammatical point of view". He further had a suspicion that the gap was not owing to accident but it was an intentional erasure by some reader who clung to the opinion of the *Prakāśikā*.

I have a doubt to Kern's view because Parameśvara seems to have been indcisive on this subject; when he comments on the *Mahāskariya* and the *Laghubhāskariya* he does not throw any doubt to the use of *utkramajyā*, while in his commentary on the *Sūryasiddhānta*, he takes the use of *kramajyā* for granted. Such was his attitude that there must have been no reason for him to change a reading because it was astronomically or grammatically less correct. If Parameśvara's reading had been '*-utkrama-*', we could possibly have a suspicion, right opposite to Kern's, that the erasure was made by someone who clung to the idea that the rule should *not* be given in *utkramajyā*, or rather by someone who wanted to save *Āryabhaṭṭa*, simply by erasure, from the severe criticism of Bhāskara II¹⁵. We can say at least that there was an alternation of the reading of *Golapāda*, 45 somewhere during the period after Bhāskara II and before Nilakaṇṭha.

The second line of the stanza is unintelligible and Clark left it untranslated.

According to Someśvara's interpretation the rule for finding *āyanavalana* (γ_2) is

$$\sin \gamma_2 = \frac{\sin \varepsilon \times \beta \times \text{Vers} (\lambda + 90^\circ)^{16}}{R^2}$$

where ε , β , and λ are the greatest declination, the latitude of the moon, and the longitude of the moon, respectively. (Here is again Versed Sine!) For want of allotted pages I will discuss this problem separately.

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- 1) The text is preserved in two manuscripts, Bombay U. no. 329 and 335; the latter is an incomplete copy of the former. I want to express my thanks to Prof. D. Pingree who kindly allowed me to use the microfilm of these manuscripts.
 - 2) Long waited Bhāskara I's commentary was recently published: *Āryabhaṭṭiya with the Commentary of Bhāskara and Someśvara*, ed. by K. S. Shukla, Indian National Science Academy, 1976.
 - 3) *The Āryabhaṭṭiya with the Commentary Bhaṭṭadīpikā of Paramādīśvara*, ed. by Dr. H. Kern, Leiden, 1874. *The Āryabhaṭṭiya with the Bhāṣya of Nilakaṇṭha Somastuvan*, ed. by Sāmbaśiva Sastri (I and II) and Suranad Kunjan Pillai (III), TSS 101, 110, and 185, Trivandrum, 1930, 1931, and 1957.
 - 4) *The Āryabhaṭṭiya of Āryabhaṭṭa*, translated by W. E. Clark, Chicago, 1930.
 - 5) O. Neugebauer and D. Pingree, *The Pañcasiddhāntika of Varahamihira*, 2 parts, Kopenhagen, 1970, 1971.
 - 6) Neugebauer-Pingree, *op. cit.* Part II, p. 53f. and 78f.
 - 7) *The Brāhmasphuṭasiddhānta*, ed. by S. Dvivedi, *The PANDIT*, Benares, 1902.
 - 8) *The Saryasiddhānta with the Commentary of Paramēśvara*, ed. by K. S. Shukla, Department of Mathematics and Astronomy, Lucknow Univ., 1957.
 - 9) *Goladhyāya with Vasanabhāṣya and the Marici of Mumīśvara*, ed. by Viṣṇu Dettātreyā Apte, Anandāśrama Skt. Ser. no. 122, Poona, 1943.
 - 10) *Mahābhāskariya of Bhāskarācārya with the Bhāṣya of Govindasvāmin and Super-commentary Siddhāntadīpikā of Paramēśvara*, ed. with introduction by Kuppanna Sastri, Madras Govt. Oriental Ser. no. cxxx, Madras, 1957.
 - 11) *The Laghubhāskariya, with the Commentary of Paramēśvara*, ed. by Mahādeva Cimaṇājī Apte, Anandāśrama Skt. Ser. no. 128, 1946.
 - 12) See note (10) above, and Kuppanna Sastri's notes in pp. 299-300.
 - 13) Nilakaṇṭha, *op. cit.* (Part III) p. 103.
 - 14) Recently published by K. V. Sarma (Indian National Science Academy, 1976).
 - 15) *op. cit.* pp. 306-307.
 - 16) The formula is unique to Someśvara, though closely related to Bhāskara I's

$$\sin \gamma_2 = \frac{\sin \varepsilon \times \beta \times \text{Vers}(\lambda - 90^\circ)}{R^2} \quad (\text{Mbh. VI, 2-3})$$