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MEASURING TIME WITH LONG SYLLABLES

BHĀSKARA I'S COMMENTARY ON ĀRYABHAṬĪYA, KĀLAKRIYĀPĀDA 2

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Bhāskara I, in his commentary on *Āryabhaṭīya, Kālakriyāpāda* 2, cites a verse for measuring *palas*. The verse is corrupt in the printed edition. This paper offers the correct version of the verse and explains its significance.

Keywords : *gurvakṣara*, long syllables, *palavṛtta*, water clock.

One of the most valuable documents on Indian astronomy published in recent times is Bhāskara I's commentary on the *Aryabhaṭīya*.[1] Unfortunately the commentary is not complete; it breaks off at *Golapāda* 6. In the available portion too there are occasionally readings which are not satisfactory. One such reading occurs in the commentary on the second verse of the *Kālakriyāpāda*. In this verse, Āryabhaṭa states that the time taken to utter sixty long syllables *(gurvakṣara)* is one *vināḍikā* of a sidereal day.[2]

But then, if a man utters sixty long syllables very fast, it will be less than one *vināḍikā;* or if he utters them very slowly it can be more than one

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[1] *Āryabhaṭīya of Āryabhaṭa* with the Commentary of Bhāskara I and Someśvara, critically edited with Introduction and Appendices, by Kripa Shankar Shukla, Indian National Science Academy, New Delhi 1976.

[2] Āryabhaṭa is the first one to introduce a completely sexagesimal division of time in analogy to the sexagesimal division of the circle. In this scheme, one *nāḍī* or *nāḍikā* is divided into 60 *vināḍikās*, which are further subdivided into 60 *gurvakṣaras* each. Thus the *gurvakṣara* is the 3600th part of the *nāḍī* and equals 0.4 seconds. Some scholars erroneously equate this *gurvakṣara* with a time unit called *akṣara* defined in

vināḍikā. Refuting such a possible objection, Bhāskara proclaims that the sixty syllables should be uttered neither too fast nor too slowly, but at a middling speed.

To this one may again object by saying: how can you say middling speed when Āryabhaṭa himself did not specify this. Bhāskara counters this by stating that in all cases where no specification is made, one should take the middle course (*loke anirdiṣṭeṣu kāryeṣu madhyamaprāptiḥ*). Having thus established the speed at which the long syllables should be uttered, Bhāskara adds that the following 60 long syllables constitute the duration of one *vināḍikā*:

> *"māsānte pakṣasyānte sa hy ākāśe deśe svaṃ miśraṃ vakraṃ kāntaṃ vṛttaṃ pūrṇaṃ candraṃ sattvād rātrau te kṣutkṣāma prādante śveto prāyo krūras tasmād vānte harmyasyāntaḥ saṃsuptasyaikānte kartavyā/"*
> *etāni ṣaṣṭir gurvakṣarāṇi vināḍikākālaḥ //*[3]

These are indeed sixty long syllables. If one recites these at a middling speed, it should take one *vināḍikā*. But these syllables make no sense and appear to be badly garbled. The manuscripts used in the edition do not seem to offer any alternative readings of this passage. Neither Sūryadevayajvan[4] nor Parameśvara,[5] whose commentaries on the *Aryabhaṭīya*

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verse 39 of the Yajus recension of the *Vedāṅga Jyotiṣa*. Commenting on this verse, A. Weber (*Über den Vedakalender, namens Jyotisham*, Berlin 1862, p. 104, n. 3) opines that these *akṣaras* are the same as the long syllables of two *mātras*. T. S. Kuppanna Sastry shares the view (*Vedāṅga Jyotiṣa of Lagadha, in its Ṛk and Yajus Recensions*, with Translation and Notes by T.S. Kuppanna Sastry, critically edited by K.V. Sarma, Indian National Science Academy, New Delhi 1985, p. 38: "The *akṣara* mentioned here is the length of time called *gurvakṣara*, equal to two *matrās* of time"). However, it is obvious that these two units cannot have the same duration. According to the *Vedāṅga Jyotiṣa*, 1 *naḍikā* consists of 10 1/20 *kalās*, 1 *kalā* of 124 *kāṣṭhās*, and 1 *kāṣṭhā* of 5 *akṣaras*. Accordingly there will be 6231 *akṣaras* in 1 *nāḍikā* as against 3600 *gurvakṣaras* of Āryabhaṭa.

[3] *Āryabhaṭīya of Āryabhaṭa* with the Commentary of Bhāskara I and Someśvara, p. 175.

[4] *Āryabhaṭīya of Āryabhaṭa* with the Commentary of Sūryadeva Yajvan, critically edited with Introduction and Appendices, by K.V. Sarma, Indian National Science Academy, New Delhi 1976.

[5] *Āryabhaṭīya of Āryabhaṭa* with the Commentary *Bhaṭadīpikā* of Paramādīśvara [= Parameśvara], ed. H. Kern, Leiden 1874.

are available in print, cite this passage.

In these circumstances, it is fortunate to find the correct reading of this passage in an unpublished manuscript entitled *Ghaṭīyantraghaṭanāvidhi* ("Method of Setting up the Water Clock").[6] After explaining how to set up the water clock for determining the auspicious moment of the wedding, this anonymous work cites the correct version of the passage which got jumbled up in the manuscript tradition of Bhāskara I's commentary. In the *Ghaṭīyantraghaṭanāvidhi,* the passage reads thus:

mā kānte pakṣasyānte paryākāśe deśe svāpsīḥ

kāntaṃ vaktraṃ vṛttaṃ pūrṇaṃ candraṃ matvā rātrau cet /

kṣutkṣāmaḥ prāṭaṃś cetaś ceto rāhuḥ krūraḥ prādyāt

tasmād dhvānte harmyasyānte śayyaikānte kartavyā //

"Do not, O pretty one, at the end of the [bright] fortnight, sleep at a place open to the sky. Should it turn night, the cruel Rāhu, starving with hunger and roaming hither and thither, may eat you up, taking your pretty round face for the full moon. Therefore, after darkness, make your bed at a secluded place inside the house."

It is a pretty poem, consisting of only long syllables. Evidently, this is a verse with four uniform feet *(sama-vṛtta)* and each foot consists of five *maganas.* Indeed, this metre is noticed in several works on prosody, albeit with different nomenclature. Thus Kedāra's *Vṛttaratnākara* and Hemacandra's *Chando'nuśāsana* call this metre *Kāmakrīḍā. Chandomañjarī* of Gaṅgādāsa designates it as *Līlākhela.* It receives an unusual designation *Jyotiḥ* or *Mitra* in Jayakīrti's *Chando'nuśāsana,* and the anonymous *Prākṛtapaiṅgala* styles it *Sāraṅgī.*[7] But all these manuals on prosody belong to periods much later than Bhāskara I's own time.

A single recitaton of the verse at an even pace will last one *vināḍikā,* which is also known as *vighaṭikā* or *pala,* and which equals 24 seconds. It is the one-sixtieth part of the *nāḍikā,* which is also called *nāḍī, ghaṭikā* or *ghaṭī.* This is equal to 24 minutes and was the standard unit of time measurement in pre-modern India.

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[6] MS No. 37074, Sarasvati Bhavan Library, Sampurnananda Samskrita Vishvavidyalaya, Varanasi.

[7] H. D. Velankar (ed), *Jayadāman (A Collection of Ancient Texts on Sanskrit Prosody and a Classified List of Sanskrit Metres with an Alphabetical Index),* Bombay 1949, p. 135.

The *Ghaṭīyantraghaṭanāvidhi* suggests that this and similar verses in this metre are recited after installing the water clock *(Ghaṭī-yantra).* A story in the *Kathāratnākara,* composed by Hemavijaya Gaṇī at Ahmedabad in 1600 AD,[8] informs that such verses are called *pala-vṛttas* (i.e. verses for measuring a *pala*).

Though there is no clear statement in any text, it is possible that the *pala*-verses were employed in measuring time in the following manner. A hemispherical copper bowl *(ghaṭī)* with a fine hole at its bottom is set up on the surface of the water in a larger receptacle *(kuṇḍa).* Each immersion of the bowl measures one *ghaṭī.*[9] For measuring the sub-multiples of *ghaṭī,* the height of the bowl can be sub-divided with appropriate markings. To do so geometrically is difficult, but one can empirically divide the bowl, say into six or ten parts. Each part then would denote either 10 *palas* (= 4 minutes) or 6 *palas* (= 2 minutes and 24 seconds). Gilchrist reports about the existence of water clocks with such sub-divisions towards the close of the eighteenth century.[10] But in the course of my survey of Indian time measuring instruments, I have not come across even a single specimen of such a bowl. All the bowls I have seen are without sub-divisions. With these one can measure only full *ghaṭīs.* How does one then measure fractions? One possible method is to measure the complete *ghaṭīs* by means of the water clock and the fractions in terms of *palas* by reciting the *pala*-verses. Thus, if an auspicious moment is set for 10 *ghaṭīs* and 15 *palas* after sunrise, the water clock is set up exactly at sunrise. After ten immersions of the bowl are complete, the *pala* verse is recited 15 times. Then the time will be 10 *ghaṭīs* 15 *palas* after sunrise.

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[8] Hemavijayagaṇī, *Kathāratnākara,* published by Hiralal Hansaraj, Jamnagar, 1911, No. 211, pp. 538-540. Translated into German by Johannes Hertel, *Kathāratnākara: Das Märchenmeer: Eine Sammlung indischer Erzählungen,* 3 volumes, Munich 1920, pp. 253-55.

[9] On measuring time with water clocks, see S. R. Sarma, "The Bowl that Sinks and Tells Time," *India Magazine, of her People and Culture,* 14.9 (September 1994) 31-36. See also Virendra Nath Sharma, "Astronomical Instruments at Kota," IJHS, 35 (2000) 233-44, esp. Figs. 4 and 5.

[10] John Gilchrist, "Account of the Hindustanee Horometry," *Asiatick Researches,* 5 (1795) 81-89, esp. 87: "These *kutorees* [bowls] are now and then found with requisite divisions, and subdivisions, very scientifically marked in *Sanscrit* character..."