THE LEGENDS OF VASIṢṬHA – A NOTE ON THE VEDĀṄGA ASTRONOMY

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1. Introduction

In this paper, I would like to discuss some topics about the Vedāṅga astronomy, which is a kind of ancient Indian astronomy.
The Vedāṅga (limb of the Veda) is a class of works regarded as auxiliary to the Veda. It consists of six divisions, one of which is astronomy (*jyotiṣa*).

2. Indian originality of the Vedāṅga astronomy

The fundamental text of the Vedāṅga astronomy is the *Jyotisa-vedāṅga*, of which two recensions, Ṛg-vedic and Yajur-vedic, are extant. The main structure of the Vedāṅga astronomy is as follows.

1 *yuga* = 5 years
= 60 solar months (one solar month is $\frac{1}{12}$ of a year),
= 61 *sāvana*-months (one *sāvana*-month is 30 *sāvana*-days),
= 1830 *sāvana*-days (civil days)
= 62 synodic months,
= 1860 *tithis* (one *tithi* is $\frac{1}{30}$ of a synodic month
= 67 sideral months,
= 1835 sideral days.

The Vedāṅga calendar is a luni-solar calendar, and there are two intercalary months in a *yuga* (five years). One *sāvana*-day (civil day) is from sunrise to sunrise.
David Pingree argued that Vedāṅga astronomy was formed under Mesopotamian influence during the Achaemenid occupation of the Indus valley. Pingree's argument is, however, definitely wrong. I shall show that Vedāṅga astronomy is based on the actual astronomical observations in North India.
Firstly, let us examine the length of a year. Pingree argued that one year in the Ṛg-vedic recension of the *Vedāṅga-jyotiṣa* was 366 sideral days and not 366 *sāvana*-days. Although Yajur-vedic recension of the *Vedāṅga-jyotiṣa* states the one *yuga* is 61 *sāvana*-months (=1830 *sāvana*-days) and the number of sideral days in a *yuga* is the number of s ā vana-days plus five, that is one year is 366 *sāvana* days or 367 sideral days, Pingree argued that this is due to the misunderstanding of the compiler of the Yajur-vedic recension. Pingree concluded that one year of the original Vedāṅga astronomy was 365 civil days, which is the same as the Egyptian-Persian year, and that it was introduced into India through Persia.
This Pingree's argument is, however, completely wrong. I shall show that one year of the Vedāṅga astronomy was definitely 366 civil days.
According to the *Vedāṅga-jyotiṣa* itself, the purpose of the Vedāṅga astronomy was to determine the proper time of sacrifices. Vedic sacrifices include the new and full moon sacrifices, seasonal (four monthly) sacrifice etc. At the time of the new and full moon sacrifices, the date of the new and full moon was fairly accurately determined. For example, the *Śāṅkhāyana-śrauta-sūtra* (I.3.5) states that the two days of full moon are the day on which the moon appears full about the setting

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of the sun and its succeding day. The day of full moon can be determined fairly accurately by this method, because the time of moonrise changes by about 49 minutes on the average per day. On the contrary, the change of season cannot be determined so accurately by naked eye observation. So, we can suppose that Vedāṅga astronomy could predict the date of the new and the full moon for at least five years with accuracy, if it could not predict the season with the same accuracy. Now, the modern exact value of 62 synodic months is 1830.90 days, and that of 67 sideral months is 1830.55 days. Therefore, one *yuga* of the Vedāṅga astronomy could not be different from 1830 days or so. If Pingree's argument is true, one *yuga* becomes 1825 days, and it makes nearly 6 days' error of the new and full moon sacrifices. Now, it is clear that one year of the Vedāṅga astronomy was 366 civil dyas. There is no similar calendar in ancient West Asia. So, the Vedāṅga astronomy must be Indian original astronomy.

Secondly, let us examine the seasonal change of the length of daytime and nighttime. The *Vedāṅga-jyotiṣa* states that the length of daytime is given by the following zig-zag function.

The length of daytime $= \left(12 + \frac{2}{61}n\right)$ *muhūrtas*,

where n is the number of days after or before the winter solstice. One *muhūrta* is $\frac{1}{30}$ of a day. According to this formula, the period of one solar month produces one *muhūrta*'s difference of the length of daytime. Therefore, according to this Vedāṅga formula, the proportion of daytime and nighttime at the solstice becomes 2:3 which is observed at the latitude 35°N or so. This is the latitude of Kashmir area, and much north of the basin of the Ganga River which was the central area in Post-vedic period. So, Pingree conjectured that this valued was borrowed from Mesopotamia, of which the central area is at the latitude 35°N or so.

This Pingree's conjecture is also wrong. I shall show that the above mentioned formula is based on the actual observations in North India.

The seasonal movement of the sun was well noticed by Vedic people.

For example, the *Kauṣiāki-brāhmaṇa* (XIX.3) states that the sun goes north for six month and stands still being about to turn southwards, and then goes south for six months and stands still being about to turn northwards.

This statement probably refers to the change of the position of sunrise or sunset. It changes much around the equinox, but does not change much around the solstice. So, the sun looks standing still around the solstice. This fact must have produced an idea that the seasonal change of certain phenomenon should be obtained from the observations around the equinox, and not from those around the solstice. So, the above mentioned formula of the Vedāṅga astronomy must have been obtained by the extrapolation from the observation of the change of length of daytime around the equinox, and not by the interpolation from the observation around the solstice. Pratically, there are two possibilities. If we assume that the formula was extrapolated from one *muhūrta*'s difference of the length of daytime during one solar month after the equinox, the most suitable latitude for this observation becomes 27°N. If we assume that the formula was extrapolated from two *muhūrta*'s difference during two solar months after the equinox, the most suitable latitude becomes 29°N. In any case, it is clear that his formula is based on the observations in North India.

3. Continous use of the Vedāṅga astronomy

The five-year cycle of the Vedāṅga astronomy was used in the *Artha-śāstra* (a political work attributed to Kautilya), the *Śārdūlakarna-avadāna* (a Buddhist work), the *Sūriya-pannatti* (a Jaina work), etc. And also, the *Paitāmaha-siddhānta* qouted in the *Pañca-siddhāntikā* (XII) of Varāhamihira (the 6th century AD) is a text of the Vedāṅga astronomy.

The *Artha-śāstra* (II.20.39-40) gives the diurnal variation of the gonom-shadow. As George Abraham rightly pointed out, it follows the following formula:

$$\frac{d}{2t} = \frac{s}{g} + 1 \qquad (1)$$

where $\frac{t}{d}$ is the fraction of daytime which has elapsed since sunrise or is remaining until sunset, and s is the length of the gnomon of length g.

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4. Vedāṅga astronomy under Greek influence

It seems that Venāṅga astronomy was still used when Greek astrology was introduced into India, and records of the Venāṅga astronomy under Greek influence are found in the *Yavana-jātaka* of Sphujidhvaja and the *Pañca-siddhāntika* of Varāhamihira.
The *Yavana-jātaka* (AD 269/270) of Sphujidhvaja is a Sanskrit work on Greek horoscopy. Its last chapter (chapter 79) is devoted to mathematical astronomy. The text tells that "the instruction of the Greeks" (*Yavana-upadeśa*) is explained there, but also mentions the name of "the sage Vasiṣṭha" (*Vaśiṣṭha-muni*), who seems to be an Indian traditional astronomer.
In the *Yavana-jātaka* (LXXIX.32), the diurnal variation of the gnomon-shadow is given. It can be expressed as follows.

$$\frac{d}{2t} = \frac{s - s'}{g} + 1 \tag{2}$$

where s' is the noon shadow.
The *Pañca-siddhāntikā* (IV.48-49) of Varāhamihira (the 6th century AD) also gives the same diurnal variation of the gonom-shadow. As George Abraham pointed out, the formula (1) is a special case of the formula (2).
The *Pañca-siddhāntikā* (II.9-10) also gives the annual variation of the gonom-shadow, which is the same as that of the *Artha-śāstra.* However, the position of the sun is given with reference to zodical signs, which must have been introduced into India along with Greek astrology, in the *Pañca-siddhāntikā*. So, this must be the remnant of the Vedāṅga astronomy under Greek influence. Varāhamihira tells that this annual variation is from the *Vāsiṣṭha-samāsa-siddhānta.* Here again appears the name of the sage Vasiṣṭha.
Mention may be made here that the *Yavana-jātaka* (LXXIX.31) and the *Pañca-siddhāntikā* II.8) give the annual variation of the length of daytime which is the same as the *Vedāṅga-jyotiṣa.*

5. Conclusion

The Vedāṅga astronomy is Indian original astronomy based on the actual astronomical observations in North India. after the introduction of Greek astrology into India, the Vedāṅga astronomy was still used with some modifications, such as the use of zodical signs, and was connected with the name of the sage Vasiṣṭha. This astronomical system was widely used for a certain period. Then, after the introduction of Greek mathematical astronomy, the Vedāṅga astronomy gradually gave way to new astronomical systems, and finally the Hindu classical astronomy (Siddhānta astronomy) was established at the end of the 5th century AD.

References

For the Vedāṅga astronomy in detail, see Õhashi, Yukio : "Development of Astronomical Observation in Vedic and Post-Vedic India", *Indian Journal of History of Science*, Vol.28, No.3, (1993), pp.185-251