

ON AN ASTRONOMICAL CONCEPT IN VIṢṆUPURĀṆA

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A couple of paradoxical lines and an interesting concept of variable speed of motion of the Sun along the Ecliptic occurring in the *Viṣṇupurāṇa* are examined. These arise in the context of explaining the variation of the length of daytime in the northern and the southern declination of the Sun.

Key words: Ancient astronomy, Annual and diurnal motion of sun., *Viṣṇupurāṇa*.

INTRODUCTION

The following lines describing the motion of the sun occur in chapter 8 of the second book of *Viṣṇupurāṇa* (VP):

ahorātreṇa yo bhuñkte samasto rāśayo dvija / (2.8.41.2)

ṣaḍevarāśayo bhuñkte rātrā vanyāṃścaṣaddivā / (2.8.42.1)

“Oh twice-born, in the course of the whole day, who (the Sun) passes through all the *rāśis* covering six of *rāśis* by night and the other six by day”

The *rāśis* of course, are the signs of the Zodiac. It would appear that the Sun would cover the entire course of the Zodiac in one day, six during daytime and six during night. But, it is elementary knowledge that the signs of the Zodiac are the divisions of the Ecliptic, which the Sun covers in a whole year, at the rate of one Zodiacal sign per month. In fact, in the *saumāna* system, (i.e., solar calendar) months are named after the *rāśi* in which the Sun is found. How can the Sun cover all the twelve signs in one day? Is the author of *Viṣṇupurāṇa* totally ignorant of the elementary facts of astronomy? Or is he just confused? Does this statement also belong to the group of concepts that one discards as being absurd, or, “just puranic”? The purpose of this note is to offer, after an examination of the proper context, an alternate possible explanation of these paradoxical lines.

THE DAILY AND THE ANNUAL MOTION OF THE SUN

Earlier in the same chapter it is stated:

kulācakraparyantaḥ bhramanneṣa divākaraḥ / (2.8.27.1)

karoti ahas tathā rātriṃ vimuñcan medinīm dvija / (2.8.17.2)

“Oh twice-born, whirling round like the circumference of the wheel of a potter, the maker of day (sun) distributes day as well as night on earth.”

These lines clearly refer to the daily motion of the sun across the sky along a circular path, the so-called diurnal circle. These are followed by:

ayanasyottarasyādaṁ makaraṁ yāti bhāskaraḥ/ (2.8.28.1)

tataḥ kumbhañ ca mīnañ ca rāse rāśyantaraṁ dvija / (2.8.28.2)

“The Sun enters the sign of Capricorn at the beginning of his northern course. Oh twice-born, he then goes to Aquarius and then to Pisces going successively from one sign to another.”

triṣveteṣv atha bhukteṣu tato vaiṣuvatim gatiṁ / (2.8.29.1)

prayāti savitā kurvann ahorātraṁ tataḥ samaṁ / (2.8.29.2)

“ Having thus covered these three signs, the Sun then attains the equinoctial movement causing the day and night of equal duration then.”

tato rātriḥ kṣayaṁ yāti varddhate anudinaṁ dinaṁ ? (2.8.29.3)

tataśca mithunasyānte parā kāṣṭhām upāgataḥ / (2.8.30.1)

rāśim karkaṭakaṁ prāpya kurute dakṣiṇāyanaṁ / (2.8.30.2)

“From then on the length of the night decreases while the length of the day increases every day. Then (crossing the signs of Aries and Taurus) reaches the extreme point (in his northern course) at the end of Gemini. On entering Cancer, he begins his declination to the south.”

The lines (2.8.28.1) through (2.8.30.2) clearly refer to the annual motion of the Sun. The northern and the southern courses of the Sun, of course, divide the year into two parts, with concomitant increases and decreases of the duration of daytime. It is also clear that the crossing of the zodiacal signs successively from one to the other refers to the annual motion of the Sun along the ecliptic. This is obviously different from the daily motion of the Sun across the sky causing day and night referred to in (2.8.27.1) and (2.8.27.2) above. The author of VP cannot be accused of being ignorant of the elementary facts of astronomy known from times long before they were codified by Lagadha¹ in the *Vedāṅga Jyotiṣa*² (VJ). There is further evidence for the knowledge from VJ. It is stated for example, that the longest day of eighteen *muhūrtas* occurs on the summer solstice day:

aṣṭādaśa muhūrttaṁ yad uttarāyaṇapaścimaṁ / (2.8.35.1)

The shortest day occurs on winter solstice and is only of twelve *muhūrtas* duration:
 *dvādaśābhīḥ* *muhurttair dakṣiṇāyane* / (2.8.33.1)

but, the day and night are equal on the equinoctial day:

..... *aharātraḥ tataḥ samaḥ* / (2.8.29.1)

The *muhūrta* is itself 1/30th part of a day :

triṃśasbhāgantū medīnyāstadā mauhūrttikī gatiḥ / (2.8.26.2)

These parameters for the variation of the length of day and night are basically from VJ.

THE PARADOX

In astronomical terms, the earth revolves around the Sun in an orbit completing it in a year and also rotates on its axis once a day. Projected on to the celestial sphere (i.e., as observed from the earth), the Sun appears to move along a great circle, the Ecliptic, at the rate of about one-degree per day, completing it in a year. The signs of the zodiac are the twelve divisions of this circle. According to VJ, the Ecliptic is divided into twenty-seven parts, each part is a *nakṣatra*. Thus there are two and a quarter *nakṣatra* in every *rāśi*. The planets also appear to move in a region very close to the Ecliptic and travel at different speeds in the same direction as the Sun (prograde) or, sometimes, in a direction opposite to the Sun (retrograde). The time interval required for one complete circuit around the Ecliptic varies from planet to planet. It takes only a month for the Moon, a year for the Sun, twelve years Jupiter and nearly thirty years for Saturn. the point to emphasize is that, except for the Moon and Mercury, the motion along the Ecliptic is slow.

Because of the rotation of the earth, the Sun (as do all other heavenly objects, excluding the circumpolar stars) rises in the east and sets in the west moving along a circular path in the sky, the diurnal circle. It is obvious that the author of VP is fully aware of these elementary facts of astronomy. Then, how can one explain the paradoxical lines (2.8.41.2) and (2.8.42.1) that the sun crosses all the twelve signs in the course of a day ?

These lines arise in the context of explaining the variation of the length of day time during the year and in order to facilitate the understanding of these lines they are quoted in their full context, (2.8.39.1) through (2.8.43.3):

ubhayoḥ kāṣṭhayoḥ madhye bhramato maṇḍalānitu / (2.8.39.1)

divā naktāñca sūryasya mandā śīghrā ca vai gatiḥ // (2.8.39.2)

“As the Sun describes circles moving between the two limits (marking the northernmost and southernmost positions), the relative lengths of the day and night depend on the slow or fast pace of the Sun.”

mandāhni yasminn ayane śighrā naktam tadā gatiḥ / (2.8.40.1)

śighrā niśi yadā cāsyā tadā mandā divā gatiḥ // (2.8.40.2)

“In the *ayana* in which the day time pace is the slow, the nocturnal pace is fast. Likewise, when the pace is fast in day time, it is slow in night time

ekapramānam evaiṣa mārgam yāti divākarah / (2.8.41.1)

ahorātrena yo bhunkte samasto rāsāyo dvija // (2.8.41.2)

ṣaḍ eva rāsāyo bhunkte rātrāvanyāṁśca ṣaḍ divā / (2.8.42.1)

“The Sun covers the same extent in either case. Oh twice-born, in the course of the whole day, who (the Sun) passes through all the *rāsīs* covering six of the *rāsīs* by night and the other six by day.”

raśipramāṇajanitā dīrghahrasvātmatā dine / (2.8.42.2)

tathāniśāyām rāsīnām pramāṇair laghuḍīrghatā // (2.8.42.3)

dināder dīrghahrasvatvaṁ todbhogenaiva jāyate / (2.8.43.1)

“The lengthiness and the shortness of day is caused by the size of the *rāsīs*. In the same manner, the lengthiness and shortness of night time is caused by the size of the appropriate *rāsīs*. The long or short duration of the day or night is determined by the time interval required by the Sun for passage through them.”

uttare prakrame śighrā niśimandā gatiḥ divā / (2.8.43.2)

dakṣinetv ayane caiva viparītā vivasvataḥ // (2.8.43.3)

“ In the northern declination, the Sun moves quickest by night, but slowest during day. In the southern declination, the reverse is the case for the Sun.”

THE RESOLUTION

Suppose the lines (2.8.41.1) through (2.8.43.1) were deleted. Then, the remaining verses would read:-

“ As the Sun describes circles moving between the two limits (marking the northernmost and the southernmost positions), the relative lengths of the day and night depend on the slow or fast pace (of the Sun). In the *ayana* in which the daytime pace is slow, the nocturnal pace is fast. Likewise, when the pace is fast in daytime, it is slow in nighttime. In the northern declination, the Sun moves quickest by night, but slowest during day. In the southern declination, the reverse is the case for the Sun.”

The author is trying to explain the variation in day and night times, relating it to the speed with which the Sun describes the diurnal circles. There is a suggestion that the speed of the Sun is not uniform along its path and that the variation of the length to the day is caused by the variation in the speed. While the explicit statement refers to the diurnal path, it may be implicit that the annual motion may not be uniform either. However, the latter is at variance with the generally accepted notion of uniform speed of motion of the Sun along the Ecliptic. The lines (2.8.41.1) through (2.8.43.1) try to reconcile these two notions:

“The Sun covers the same extent in either case. Oh twice born, in the course of the whole day, who (the Sun) passes through all the *rāśis* covering six of the *rāśis* by night and the other six by day. The lengthiness and the shortness of day are caused by the size of the *rāśis*. In the same manner, the lengthiness and shortness of nighttime is caused by the size of the (appropriate) *rāśis*. The long or short duration of the day or night is determined by the (time interval required by the sun for) passage through them.’

In astronomical terms, it is the point on the horizon (east or west) that goes through all the *rāśis* in one night, and not the Sun. It is obvious that the ancient astronomers were hampered by the fact that they could not determine directly which *rāśis* the Sun is at any give time, because the constellations could be observed only at night. However, they could infer the *rāśis* of the Sun by observing the point on the Ecliptic exactly opposite to the Sun. This point would rise in the east at the same moment the Sun would set in the west. In fact, the length of the day is the time interval between Sunrise and the instant the point exactly opposite to the Sun on the Ecliptic rises. For instance, let us say that the position of the Sun is 0° in *meṣa rāśi*. The point exactly opposite to the sun is 0° in *tula rāśi*. Hence, this latter point would be rising as the Sun sets. Thus the length of the day can also determined as the time interval between the rising of 0° in *meṣa rāśi* and the rising of 0° in *tula rāśi*. The Sun moves long the Ecliptic at the rate of approximately one *rāśi* per month. If the *rāśis* were of different extent, this would result in a variation of the daytime, as the rising times for different *rāśis* would occur at unequal intervals. This is what is meant by

rāśipramāṇajanitā dīrgha hrasvātmatā dine.

“The lengthiness or the shortness of day is caused by the size of the *rāśis*.”

The author is saying that the two models, one in which the *rāśis* are of equal extent, but traversed at varying speed and the other is which the *rāśis* are of different extents, but traversed at a uniform speed, are equivalent, because,

ekapramāṇam evaiṣa mārگاṃ yāti divākaraḥ

“ The Sun covers the same extent in either case.”

This must clearly refer to the annual motion when the Sun covers all the twelve signs in one year. Then, what is the meaning of “Oh twice born, in the course of the whole day, who (the Sun) passes through all the *ras̄is* covering six of the *rās̄is* by night and the other six by day”? The clue comes from an earlier sloka:

ayanam dakṣiṇam rātrir devānām uttaram dinam / (1.3.10.2)

“ The southern *ayana* is a night and the northern *ayana* is a day of the gods.”

Then it is clear that the Sun could cover six *rās̄is* by day (of gods) and another six *rās̄is* by night (of gods), provided the *ahorātra* in (2.8.41.1) and *rātrā* and *divā* in (2.8.42.1) refer to those of the gods. This would then resolve the apparent paradox. After all it is quite common to refer to the two halves of a month as the day and the night of *pitṛs* and even *kalpa* as the day of *Brahmā*.

It is interesting to note that it was thought even in those early days that the apparent motion of the Sun, which is a reflection of the motion of the earth in its orbit was not of uniform speed. However, this model does not appear to have been described in any other *Purana*, as was also noted by Wilson, whose comments appear in a footnote³:

“ This passage which is somewhat at variance with the general doctrine, that the length of the day depends upon the velocity of the Sun’s course, and which has not been noticed in any other puranic text...”

CONCLUSION

In conclusion, the lines (2.8.41.2) and (2.8.42.1) can be understood in the context as referring to the annual motion of the Sun along the Ecliptic. The purpose of these lines, it appears, is to reconcile the two models for the motion of the Sun along the Ecliptic: one of unequal *rās̄is*, but uniform speed and the other, of non-uniform speed, but *rās̄is* of equal extent. It will be interesting to see if there is further evidence of this model of non-uniform speed. One can only speculate why this model was not explored further, especially, when it is noted that in the Keplerian model of the earth in its orbit is non-uniform.

NOTES

1. The codification of Vedic astronomy is traditionally attributed to sage Lagadha and the composition of the text of VJ to his disciple, Suci.
2. I have used the critical edition of Sastry quoted in the Bibliography.
3. Footnote 11 on p. 320 of the text quoted in the Bibliography.

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