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The calendric astronomy of the vedas

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Abstract. The Rig Veda described both a solar and a luni-solar calendrical scheme. Once the precision of Rig Vedic astronomy is recognized, the Great Cosmic Cycles of ancient India can be interpreted meaningfully.

Key words : year length, mahayuga, kalpa

1. Introduction

The Rig Veda, the oldest extant piece of Indo-European literature, contains a great deal of Calendrical Astronomy and Astronomy in general. In fact the Rig Veda stresses *ṛta* or cosmic order and the word for season namely *ṛtu* is derived from the above word. (Indeed this is the origin of the English word 'ritual'). The hymn (Rig Veda I - 164 - 39) specifically states that these Riks (hymns) are writ in the high heavens wherein are situated the celestial luminaries.

The Rig Vedic hymns however are often deliberately obscure and camouflaged. A good example of this is found in hymn, (Rig Veda I - 105-8) : " A ruddy wolf beheld me once, as I was faring on my path . . ."

But Yaska an ancient scholar who lived much more than two thousand years ago, realized that the word for wolf namely *Vrika* in the above hymn is really a shortened form for the Moon. Then the words *ma* and *sakrit* are really to be read as *masa-krit*, literally maker of the month. With this insight the apparently meaningless passage now reads, "the Moon the maker of the months moves seeing (the mansions, that is lunar mansions or asterisms or *nakshatras*)" (Roy, 1976).

2. The lunar and solar years

But there is no need to sift through the allegory and camouflage to get an idea of some of the elements of Calendric Astronomy in the Rig Veda (R.A.) A few examples are given below :

(1) R. V. 1-25-8 : Varuna knows the twelve Moons. He also knows the Moon of later birth. This is a reference to the twelve 29.5 day months (synodic months - the period from full/new moon to the next full/new moon) of a normal lunar year of 354 days and the thirteenth intercalated month added periodically to reconcile the above lunar year with the solar year of about 365 days. This luni solar scheme is used in the Indian calendar or *panchangas* even today.

(2) R. V. 1-164-11&48 : The wheel of time has twelve parts and 360 spokes or days or 720 pairs of day nights, with a remainder of about five days. The same hymn also speaks of the alternative scheme of six month-pairs and the thirteenth intercalary month. This is a reference to a solar calendar of twelve thirty-day months, as also the luni-solar scheme.

(3) R.V. I-155 : This refers to Vishnu or the Sun who sets in motion the wheel of three 120 day periods. This is a reference to the three seasons, each season consisting of four months or 120 days, in a solar calendric system.

There has been a view that the *nakṣhatra* (lunar asterism) scheme of sub division of the zodiac into 27 (or 28) parts corresponding to the 27.32 day sidereal month is not present in the Rig Veda. They have been explicitly mentioned in the later Yajur Veda for example. In the *Puranas* or loosely, relatively later mythological works the 27 lunar asterisms are described as daughters of the heaven, married to the Moon (Soma) who spent one day with each of his consorts. However the Rig Vedic hymn quoted above points to the origin of the *nakṣhatra* system in the Rig Veda. Other more explicit references confirm this. For example (R. V.X-85) says, "Soma (Moon) in the midst of all these nakshatras hath his place . . . The Moon is that which shapes the years . . . Soma (Moon) was he who wooed the maid (*nakṣhatra*) . . ." So not only the *nakṣhatra* system but also the more poetic version for their origin is found in the Rig Veda itself.

3. Accuracy of the length of the year

A more careful analysis shows that the Vedic Calendric Astronomy was not just workable, but extremely accurate; with the mystic and the magical thrown in for good measure. In any case if we assume that a very precise knowledge of astronomy including the precessional cycle and the eclipse cycle existed, otherwise unintelligible and diverse information becomes consistently meaningful. The Rig Veda (R. V. III-9-9) says that 3339 devas worship Agni, (the Sun), who is "Lord of the seasons". A simple way to understand this is that in the basic Vedic unit of 33 years, there are 371 intercalary days so that in 9×33, that is 297 year period the number of intercalary days is 3339. Further these 3339 intercalary days equal (Sidharth, 1993) almost exactly 113 synodic months. All this means that in a 297 lunar-year-of-354 days period, 3339 intercalary days or 113 synodic months have to be added to get back 297 solar years. So if a year starts with a full moon or new moon, after the 297 year cycle, the year would again start with a full moon or new moon. The length of the year by this calculation is an amazing 365.2424 days (mean solar days).

This number has a further significance. The difference between a synodic and sidereal month is 2.20893 days. In one synodic month therefore, the position of the moon is the degree equivalent

of this many days away from the preceding *nakṣhatra*. After 3339 synodic months, this difference is about 7375.61727 days which is 270 times a sidereal month. So if a month begins with the moon exactly at a given *nakṣhatra*, after 3339 synodic months, the month again begins with the moon at the same *nakṣhatra*.

Finally there is a third significance of this number which in the very ancient Nivids (Vaiswadevanivid) (Haug, 1977) is expressed as there being 33 Gods and then 303 Gods and then 3003 Gods, suggesting a sort of a series development. We can show that this is indeed so. The 33 year unit in the Rig Veda has an even more basic unit, namely 11. Thus the devas or bright ones or years are 3×11 in the earliest Vedic literature. All this can be explained as follows : In a cycle of 11 lunar years, one has to intercalate 120 days, or four months, to bring the period approximately in tune with tropical (ordinary) years. So in a 33 year period one has to intercalate one full year. Let us call these intercalated years, as the first generation years. The above means that 33 first generation years equal 33 (tropical or loosely solar) years. In this approximation, the year is almost 365 days.

Now consider the Vedic group of 11 first generation years. To 303 such groups, 37 intercalary months have to be added to bring these years into tune with ordinary (solar) years. In other words 303 first generation 11 year groups approximate 303×11 year periods even more closely. The length of the year now is an incredible 365.2421 days.

We can continue in this vein and at the next step 3003 second generation 101 year groups would almost exactly equal 3003×101 years. Thus we see the emergence of the series, 33, 303, 3003, . . . as a method of approximating the year through intercalated lunar years even more closely. This process can be continued and is at the root of the concept of 30 (or 33) million Gods of Hindu Mythology.

4. Gandharvas

We next come to the concept of Gandharvas in the Rig Veda and Vedic literature in general, a concept that has been to date grossly ill understood and misunderstood. The Gandharvas are associated with the moon or Soma. Indeed they observe all the forms (Haug, 1977) (or phases) of the moon. According to the Aitareya Brahmana (A. Br,5,27) Soma (the moon) lived among the Gandharvas who returned the Moon in exchange for a woman (that is *nakṣhatra*).

Their number is given variously as 27 and 6333. All this is perfectly and exactly meaningful, if we realize from the above quote the Gandharvas represent synodic months. Firstly, 27 synodic months approximately equal two years, whereas 6333 synodic months equal 512 years very accurately. This last relation infact gives the value of the synodic month as 29.5285 days and the year as 365.2422 days, revealing an incredible degree of accuracy.

Further 6333 synodic months equal 6854 sidereal months. This means that if an year began with the full moon at a particular *nakṣhatra* or lunar asterism, after 512 years, the year will again

begin with the full moon at the same lunar asterism.

There is a further twist. 512 is equal to eight raised to the power three, and the well known Gayatri metre of the Rig Veda is an 8-3 metre.

It can now be seen why, in the Rig Veda the Gandharva is called Viswavasu or the universal Vasu, the term Vasu being associated with the number eight : It is specifically declared, that the Vasus (eight in number) are associated with the Gayatri metre.

5. Mahayuga

This brings us to the scheme of the Great ages or Cosmic cycles referred to in Vedic and later ancient literature.

Several Indian *Puranas* for example the Markandeya, the Bhagavata, the Mahabharata and others (Sidharth, 1991) expound the well known large cosmic cycle of 4320000 years and the even larger period of 4320000000 years. (Interestingly such a vast period of time is also found in the lore of Sumerians.)

The exact meaning of such a vast cycle of time has puzzled scholars through the centuries. There have been a number of interpretations which are based on astronomical, numerological geological and other considerations.

Let us first see how one arrives at this large time period. According to several *Puranas* for example the Bhagavatam and the Markandeya Purana, the computation is as follows : The starting point is the ordinary day and night of human beings, comprising 24 hours. The two fortnights - the bright and the dark - of the month constitute the day and night of the forefathers or *pitris*. The tropical year, consisting of two six months halves, namely the "bright half" when the sun goes from vernal equinox to autumnal equinox, and the "dark half" when the sun traverses from autumnal equinox to vernal equinox are the day and night respectively for the "gods". Infact it is the day and night for an observer at the North Pole.

Next the "divine year" or the year of the gods is defined - it is 360 full days of the gods, that is 360 years. Finally 12,000 divine years, that is 4320000 years, constitute a great age or *mahayuga*. This great age is divided into four sub ages or *yugas*, whose duration decreases in the ratio 4:3:2:1. Each age consists of a main period, and two twilight periods, each twilight period being of one tenth the duration of the main period. The first age is the *Krita* which consists of 4000 divine years, with 400 divine years before and after as twilight periods. Next comes the *Treta* period with a similar 3000 divine year main period and the twilight periods. Then the *Dvapara* period consisting of a total of 2400 divine years and finally the *Kali* period of 1200 divine years. The total adds up to 12,000 divine years as above.

The very interesting point in this enumeration is the definition of two twilight periods one before and one after, and each, one tenth the main period. This bears a very strong resemblance to

the morning and evening twilight associated with each day - each twilight lasts as long as the Sun is less than 18 degrees below the horizon, and 18 degrees in one tenth of 180 degrees - roughly the path of the sun above the horizon. In fact as can be seen, the entire sequence leading to the definition of the divine day, that is the day at the North Pole, and the divine year of 360 divine days is arrived at through a process of astronomical analogy.

Another analogy I would like to point out is that a full day of 24 hours consists of 86400 seconds, so that the day and night each consists of 43200 seconds. The Puranas contain many deliberately fanciful explanations of these four ages. For example the Mahabharata expounds how each age gets shortened compared to its earlier age due to the decrease in moral calibre.

But then, what is the significance of these vast time periods? Several scholars right up to the Indian astronomers of the early centuries of the Christian era believed that in a period of 4320000 years, all the planets, the moon's nodes etc. returned to their starting point. Yet another and very recent, exotic school of thought attributes this vast age and its complicated ancient break down into sub ages called *manvantaras*, to geological epochs (Dutt, 1993). The great French astronomer cum mathematician P.S. Laplace did not write off this great age as mere fancy. Rather, he wrote, "Nevertheless the ancient reputation of the Indians does not permit us to doubt that they have always cultivated astronomy and the remarkable exactness of the mean motions which they assign to the Sun and the moon necessarily required very ancient observations".

6 Precession and kalpa

The ancient Hindus knew that the eclipse pattern repeats itself after every 18 years and odd in what is popularly called the Chaldean Saros. Further they knew of the precessional cycle of about 25,800 years. (The Maitri Upanishad mentions in passing, in a philosophical context that nothing in the world is permanent, that even the fixed Pole Star moves away.) The Markandeya Purana, while computing the great age invokes the factor, "71 and a fraction thereof" which is an interesting clue. Infact due to precession the vernal equinox moves along the ecliptic by one degree in a little over 71 years. When we take all this into account it is easy to see that after about 4320000 years a total solar eclipse recurs in the same lunar asterism when the sun is at a fixed point on the ecliptic e.g., the vernal equinox. In fact this period is divisible by the eclipse cycle of 18 years and the precessional cycle of 25867 years corresponding to a precession of 50".1 per year. (This is the figure given in "The Story of the Heavens", R.S. Ball. However, it is subject to minor variations.)

There is an interesting numerological, more correctly numerical twist, which is typical of the poetic and mysterious nature of ancient Hindu astronomy : 86400000 equals product $1^1 \times 2^2 \times 3^3 \times 4^4 \times 5^5$! Infact the breakdown of the great age into sub ages whose periods decrease in the ratio of 4:3:2:1 is itself a numerical pun!

The matter does not end there, however. An even longer period of time is defined in the literature. This is the *Kalpa*, which equals 1000 mahayugas that is, equals 4320000000 years. This is also called Brahma's day time, there being an equally long night. Brahma is the creator, the universe itself being called *Brahmanda* or the cosmic egg. There is an universal cycle which

equals but a day in Brahma's life, that is 8640 million years. The concept of this cycle has been expounded in several of the Puranas. For example in the Bhagavad Gita, Krishna tells Arjuna (Sastri, 1961) : "All worlds from Brahma's world (the universe) are periodic, Arjuna. "They, those who know the day and night, know that the day of Brahma is a thousand yugas long and a night is a thousand yugas long.

"From the unmanifested, all the manifest things spring forth on the arrival of the day (of Brahma). On the onset of night all these sink into what is called the unmanifested.

"Partha (Arjuna) this multitude of created things having existed over and over again and helplessly destroyed at the onset of night, spring forth on the onset of the day."

In fact a hundred years of the Brahma constitute a *Mahakalpa* and so on! It is intriguing that all this bears an uncanny resemblance to modern cosmology.

Finally there is another scheme, that of the *Manvantaras* which has also been a puzzle but in fact follows a straightforward analogy in a similar vein. According to this scheme a day of Brahma, that is 1000 *Mahayugas* or 4320 million years is divided into 14 parts, each part being ruled by a *Manu*, each *Manu* having a sway for about 71 and odd *Mahayugas*. Here a complete cycle of day and night of Brahma, is divided into 28 parts on the lines of a month with the two *pakshas* or fortnights, the bright fortnight and the dark fortnight. Moreover the analogy with the 71 and odd years for a degree of precession alluded to earlier, that is 1/360th of a full precessional cycle, rather like a day in the year is also quite transparent.

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