HISTORICAL NOTES

ARCHAEO-ASTRONOMICAL SIGNIFICANCE OF THE VEDIC *DĀRŚAPAURṆAMĀSA* ALTAR

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Introduction

Ancient Vedic Hindu practices prescribe fire–offerings to be carried out on special occasions. Among these the *Dārśa-paurṇamāsa-iṣṭi* (Newmoon-fullmoon rite) is directly connected with lunar astronomical events as the name indicates. The ritual is described to varying levels of detail in the *Yajurveda Saṃhitā*, the *Brāhmaṇa* and the *Sūtra* texts. The constructions of the vedis or altars in which the sacrificial offerings are done are described in the *Śulbasūtra* texts which are formulaic and hence cryptic but preserve the scientific developments of the Vedic period. The mathematics and geometry behind the construction of the different shaped altars (*vedi; citi*) has been investigated in the past notably by Datta (1932), Saraswati Amma (2007), Sen and Bag (1983) and Seidenberg (1983). While the square, circle and semicircle are relatively simple the geometrical details in the construction of the *Śyenaciti* (Falcon altar) are involved. Even then the deliberate bird shape is explicit in the descriptions. On the other hand among all the altars the *Dārśapaurṇamāsa-vedi* (*DP-vedi*) is intriguing since the symbolism behind the shape is not described in the texts, but is deliberately made to have a special curved shape. The ancient ritual is observed in India to this day as prescribed in the *Śrautasūtras* of Āśvalāyana, Baudhāyana, Āpastamba but no special astronomical significance is explicit in the procedures.

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Since the *DP*-rite is connected with the moon it is natural to question whether the *DP-vedi* also has had some hidden relation with the moon. This question is investigated here by analyzing the geometric details given in the *Śulbasūtras* and other older Vedic texts describing the ritual. It is found here that the area of the *DP-Vedi* was expected to be equal to the Ṛgvedic number 3339, which in turn was a proxy for the 18-year eclipse period (Iyengar 2005). Further the shape of the *vedi* is found to be closely matching with the envelope of Moon's position over the above period as seen from the earth.

Dārśapaurṇamāsa **Altar** *(DP-vedi)*

The construction of the DP-altar invariably called the *vedi* or the *antarvedi* is described in the various *Śulba-sūtra* texts (*ed.* Sen and Bag, 1983, pp.174-175). The details are same in all the texts except for minor differences. An isosceles trapezium ABCD as shown in Fig.1 is constructed symmetrically about the east-west line. The eastern and the western sides AC and BD are respectively 48 and 64 *aṅgula* long. The height of the
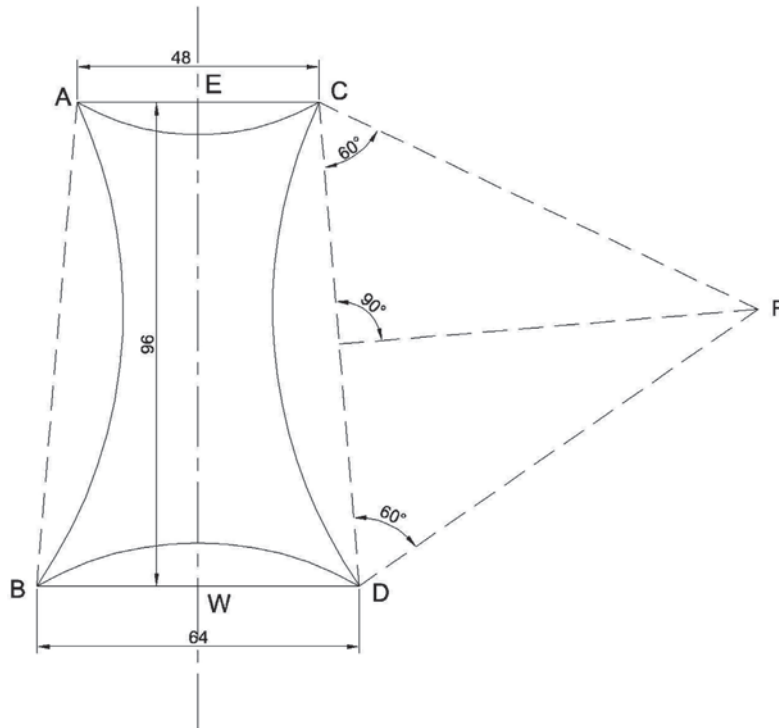

Fig. 1 Construction of the *DP-vedi* as prescribed in the *Śulbasūtra.*

trapezium is 96 *aṅgula*. With points C and D fixed, a rope of length 2CD is stretched in the southern direction till point F. With F as the centre and FC as the radius an arc of a circle is made to pass through points C and D. This is repeated symmetrically on the northern side AB. Similar arcs are drawn on the eastern and western sides. The trapezoidal figure with arcuate sides is the *DP-vedi* in plan. Significantly there are no prescriptions about the shape of the bricks or layers.

Area of the *DP*-altar

An important concept associated with Vedic altars is their shape and area. The principle of equivalence of the areas of the circular *gārhapatya*, square *āhavanīya* and the semicircular *dakṣiṇāgni* altars has been discussed in the past by several persons and hence will not be detailed here. Vedic symbolism equates the *gārhapatya* altar with the earth and the *āhavanīya* in the east with the sky (*Śatapatha Brāhmaṇa* 7.1.1.13 and 8.2.1.2). All texts are clear that the three fire altars should have equal area of one *vyāma* and built in five layers using burnt bricks of prescribed numbers and sizes. The *DP-vedi* is situated within the space enclosed by the above three as shown in Fig. 2, but is neither built in five layers nor with any special bricks. No fire is lit on the *DP-vedi* even though it is as important as the others in the
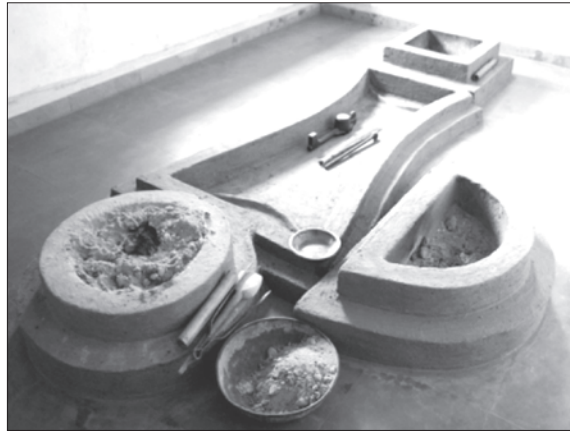

Fig. 2. The elongated altar is the *DP-vedi*. The circular *gārhapatya* the square *āhavanīya* and the semi-circular *dakṣiṇāgni* fire altars are of equal area. (source: http://world. mitrasites.com/imgs/vedic-altars.html).

DP-rites. The ritual manuals discriminate the *DP-vedi* from the other three altars for some special reason. What strikes the eye is the peculiar shape of the altar which is deliberate and painstakingly explained in the manuals. The principle of equivalence of the areas encourages us to find the area of the *vedi*, the construction of which is clearly given in the Baudhāyana *śulba sūtra*. The area of the basic trapezium is 5376 square units. Since by construction CDF is an equilateral triangle, the area of the curved region cut out from the trapezium is $(\pi/6 - \sqrt{3}/4)\ CD^2$. The length of the side CD is 96S(!) units, which is slightly more than the height of the trapezium. From these considerations the area cut out on the four sides of the trapezium can be found to be 2261 units. This gives the exact area of the *vedi* to be 3115 units. It is to be noted here the above value is based on the presently known accurate values of the irrational numbers π and $\sqrt{3}$. However in the Vedic period the priests handled these irrational numbers rather approximately and perhaps computed the area of the arc by dividing it into squares and triangles. What area the manuals aimed at for the *vedi*?

The best of the ancient approximations were $\pi = 3.0885$ and $\sqrt{3} = 26/15$ as explained in detail by Sen and Bag (1983, p. 161). Hence the area they implied to remove from the trapezium was equal to 2032 square units making the area of the *vedi* to be 3345 units. There is one unknown step here in that we do not know whether the priests took the length of CD as 96 or more correctly as 96S(!). In the former case the area of the *DP-vedi* would become 3334 units. The above two numbers are the best estimates of the area of the *DP-vedi* of the Vedic period. This result is remarkable since the average of the two values happens to be close to 3339, a number stated twice in the *Ṛgveda* for invoking a special fire known as *saucīkāgni*.

The Waning Moon

The *Ṛgveda* has several references to Moon as *Soma*. In the Vedic cosmological model gods drink *Soma* during the dark fortnights, whereas Moon waxes afterwards (*Ṛgveda*: X.85.1). This simile is elaborated very well in the *Brahmāṇḍa purāṇa* to explain the legend of 3339 gods drinking moon digit by digit only in the dark fortnights. This number is same as the count of the 3339 *viśvedevāh?* who bring *saucīkāgni* for sacrificing Moon as per the *Ṛgveda* (III.39; X.53-55). This astro-legend has been discussed

previously by Iyengar (2009) and Abhyankar (2006) to show the above number to be cognate with the 18-year eclipse period in its most fundamental form. Combining both the bright and dark fortnights the long count is 6678 *tithi* equal to 18-years of 371 *tithi* each, as per the *Vedāṅga jyotiṣa*. This is easily recognized as the so called Saros of 223 lunations which was known to the Chaldeans purportedly inherited from their Babylonian predecessors (Neugebauer, 1975). We note here that 223 is a derived number based on the more basic count of the sequence of nights making up the total of 6678 *tithi*, half of which is 3339. It is significant that the area of the DP-altar was conceived to be equal to this Ṛgvedic lunar number. With this background we are in a position to investigate the shape of the *DP-vedi*.

Moon's Path

Moon is the fastest celestial object for viewers on earth. The orbit is known to be complex. Hence naked eye observations are not easy and such results are usually not accurate. Additionally, in the bright fortnights moon can appear in day time making observations still more difficult. It is in this context the Vedic concept of deities drinking Moon only in the dark fortnight has to be appreciated as a model of scientific naturalism adopted as fundamental by Hindu culture. Moon will be visible in the night sky all through the dark fortnight and hence observing moon at a fixed time, say before sunrise, would be possible except under bad weather conditions. From modern astronomy it is known that moon's orbit is inclined to the ecliptic by about ±5°. Since the ecliptic and the equator are inclined at about 24° with each other, for an observer on earth moon will appear wandering north-south in the range of ±29°. If one were to start with a major standstill of moon and mark the declination for a period of 18.6 years or 230 lunations till the next major stand still, the resulting figure will be very similar to the shape of the *DP-vedi*. The minor standstill will be in between at the central part of the figure giving a pinched shape. However, we have not been able to locate statements about lunar standstills in the Vedic texts. Moreover the *DP-vedi* relates to the eclipse period number 3339 which is equal to 223 lunations. Nevertheless lunar standstills provide a clue to how the Vedic people might have arrived at the *DP-vedi* in keeping track of the long count 3339. Suppose the Vedic astronomers started with a lunar eclipse very near a major standstill and marked moon's declination approximately, in the dark

fortnights for a period of 3339 *tithi* by placing a piece of stone on the ground, the shape of the resulting figure would have been similar to the *DP-vedi*. A verification of this claim is provided in Fig.3.
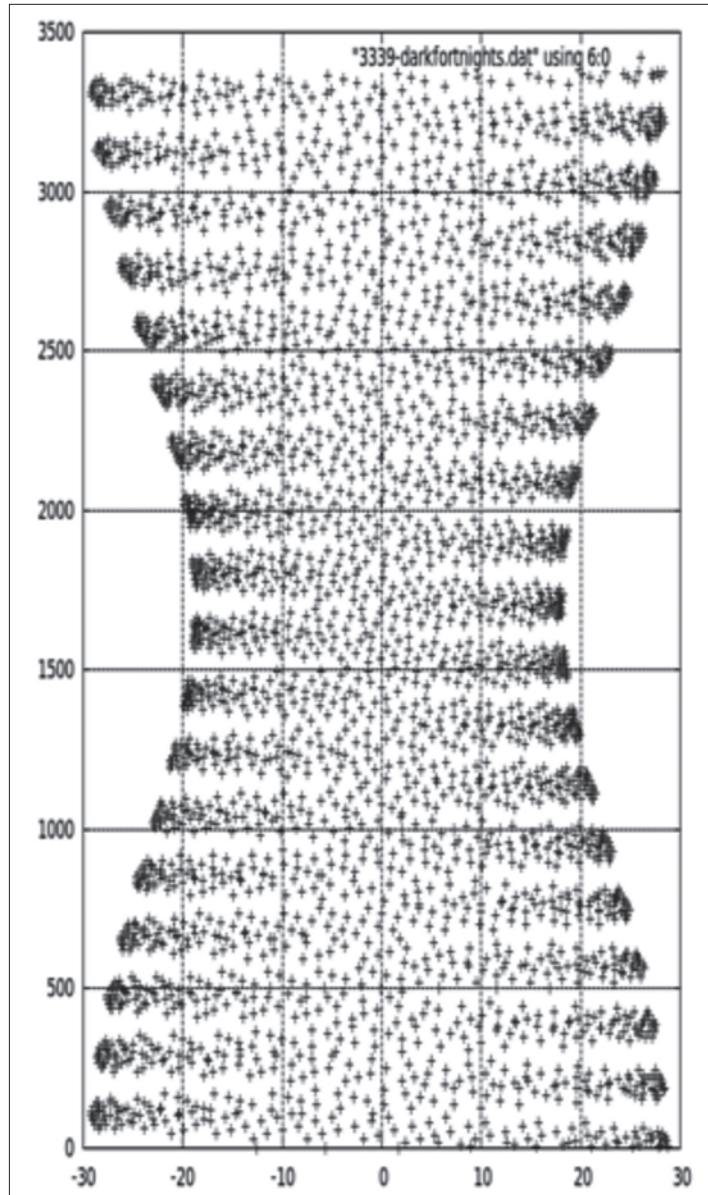

Fig. 3. Location of Moon on 3339 dark nights starting with a Lunar eclipse.

In this figure the declination position of moon for exactly 3339 consecutive observations in the dark fortnights are shown. The plot starts from the bottom with an eclipse on 7th September 2006 and ends with the New Moon on 13th September 2024. A lunar eclipse is possible on the next Full Moon. This figure though modern, clarifies several features of the ancient *DP-vedi*. Firstly the serpentine path of the moon in the sky as transferred to the ground is very robust. The shape emerges by just marking the visible Full Moon (*pourṇami*) and the waning half-moon (*kriṣṇāṣṭami)* positions. Even with many misses the symbolic shape of moon's location in the sky is unaltered. The symmetry about the E-W line is striking and is clearly maintained in the *DP-vedi*. The enveloping boundaries are not circular arcs, but the figure described in the *Śulba* texts is a good approximation.

It is known from modern astronomy that 223 lunations coincide with 241 nodic and 252 sidereal months. This means if the Vedic people started with a lunar eclipse near a particular *nakṣatra* they could expect an eclipse near the same asterism in the sky after 3339 *tithi* counted in the dark fortnights. Thus the *DP-vedi* in use to this day in Vedic rituals is an archaeo-astronomical construct representing the locus of moon in the sky. Some further interesting information may emerge if the Vedic hymns and the procedures prescribed for the DP-rite are studied from the above astronomical perspective.

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