From Vedic Science To Vedānta

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Abstract

Vedānta has often been studied without relating it to the Vedic system of knowledge. The reason behind this situation is the fashionable but wrong view that Vedic thought is "pre-scientific" and at best it represents "archaic modes of thought". But recent scholarship has shown that astronomy was one of the bases of the design of Vedic fire altars and an astronomical code has been discovered in the organization of the Rigveda. It is now being accepted that the Vedic people knew considerable astronomy that included the knowledge of planet periods. Knowledge of astronomy and the concomitant sciences provides the backdrop in which the development of the science of "self" can be understood. The Vedic system of knowledge is based on equivalences (bandhu-) between the cosmic, the terrestrial, and the physiological. This recursive system of knowledge was represented in terms of altar designs at one level and by the richly symbolic language of the Vedas, where there is a constant allusion to the equivalences, at another level.

1 Introduction

One measure of progress is the development of language. In our times we have witnessed the enrichment of language as new sciences have evolved and as nature has been studied at finer levels. This progress is literally handed down from one generation to another. Should the process of onward transmission be interrupted by some catastrophe which left mankind with only cryptic formulae and theories related to the system of knowledge, the surviving texts would appear nonsense to future generations until such time that these theories were discovered afresh. Clearly philological analysis will be inadequate in any process of decipherment of these texts. With these remarks as the background we ask the following

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question: Has the tradition of Vedic scholarship been interrupted in a catastrophic manner so that the philological analysis of the past two centuries has failed to reveal the true intent of the Vedic books? As far as the academic scholarship of the nineteenth century is concerned, there was a deliberate choice by many to make a clean break with the earlier views and build an interpretative system guided primarily by philology and certain assumptions regarding the movement of the early Indo-Europeans and their culture.

But even within traditional Indian scholarship there exists considerable evidence that points to earlier breaks and loss of valuable strands of meaning. First, the Purāṇic accounts of Vedic schools[1]imply a break in the tradition since the lists of the Vedic ṛṣis comes to an end not too long after many rival Vedic schools emerged. Now one might argue that these list have an early end since that was the time the earliest Purāṇa was composed, but the fact that the later additions to the Purāṇa do not update these lists indicates that before the latter event the tradition was broken. The Purāṇas also speak of a golden age.

Archaeologists have discovered that the Indian tradition shows broad continuity that can be traced back to at least 7000 B.C. The most prosperous phase of this Indus-Sarasvatī tradition was the Harappan period of 2600-1900 B.C. when two-thirds of the settlements were along the Sarasvatī river. The recent archaeological discovery that the Sarasvatī river dried up around 1900 B.C. explains the reason behind the end of the Harappan phase.[2]Archaeologists generally agree that this drying up was due mainly to the capture of its two main tributaries, Śutudrī and Yamunā, by the Indus and the Gaṅgā rivers, respectively. This evidence also means that the Ṛgvedic period should be dated before 1900 B.C., since the Sarasvatī river was the pre-eminent river of that period. The discovery of the astronomical code in the organization of the Ṛgveda has forced a re-examination of the astronomical evidence in the texts that points to epochs as early as the fourth or the fifth millennium B.C. corroborating the inference from the Sarasvatī evidence. The drying up of the Sarasvatī and the relocation of the people to the east is also mentioned in the later Vedic literature. The collapse of the Harappan phase must have been a catastrophic break in the tradition. Archaeologically, we find that the use of writing declined and the script itself evolved later into Brāhmī.[3]A careful analysis of several cultural factors led Jim Shaffer to the following interpretation of the archaeological data:[4]

> [The first millennium B.C.] urbanization reflects a society that had experienced pronounced social, political, and economic changes. At the same time, the noted similarities that link [this] development with earlier cultural phenomena indicate that changes occurred within a single Indo-Gangetic cultural tradition which can be traced for millennia.

A memory of the earlier glory days was also preserved during the times of Al-Bīrūnī (1030 A.D.) who describes it in legendary terms:

> As to the writing or alphabet of the Hindus, we have already mentioned that it once had been lost and forgotten; that nobody cared for it, and that in consequence people became illiterate, sunken into gross ignorance, and entirely estranged from science. But then Vyāsa, the son of Parāśara, rediscovered their alphabet.[5]

The fact that many aspects of the symbolic meaning of the ritual came to be generally forgotten also supports the thesis of a break in the tradition. It was this loss of meaning that led to the questioning of the ritual by the Buddhists and the Jainas. Nevertheless, the notion of a break does not imply that there did not exist groups that were still connected to the old learning. But certainly by the post-Buddhist period many elements of the Vedic system of knowledge were lost to the mainstream scholarly circles and some had disappeared.

Another reason why a reappraisal of the Vedic texts is called for is related to the translation process. Translations of texts are naturally made in categories known to the translator. Therefore, ideas which have not yet become a part of the system of knowledge in the translator's culture get mistranslated. As we show later in this paper the main focus of the Vedic system of knowledge was the nature of consciousness, a subject that is becoming a part of the Western discourse only now.[6]It is no wonder then that the translators of the nineteenth and the early twentieth century were woefully equipped to deal with these ideas.

Let me summarize the reasons why the old model within which Vedic studies were made has collapsed:

- The chronological framework within which the Vedic texts have been placed by the scholarship of the past century has been called into question not only by the archaeological discovery related to the Sarasvatī, but also by Seidenberg's[7]analysis of the origin of mathematics. Seidenberg showed how the dating of the sūtra texts was decided by assuming the priority of Greek geometry over the geometry described in the Śulba Sūtras; but essentially the same geometry is to be found in the Śatapatha Brāhmaṇa which, by the most conservative estimates predates Greek geometry by centuries. This pushes back the rise of earliest geometry, mathematics, and astronomy by at least a millennium implying, therefore, a milieu during the early Vedic period quite different from what has been hitherto assumed.

- New linguistic analysis has revealed fundamental structural connections between the Indo-Aryan and the Dravidian languages and it is being theorized that these languages belong to a larger family called the Nostratic.[8]The epochs for the dispersal of the speakers of the Indo-European languages are being pushed back to periods as early as 7000 B.C. and the Vedic civilization is being seen as one where different ethnic groups participated; the term Aryan itself is seen as denoting a "cultured" person without any racial connotation, exactly as the texts proclaim. (In Prakrit languages *anārya* or *anāṛī* stands for an uncultured fellow.) On the other hand earlier Orientalist analysis was based on the premise that the cognitive, social, and religious categories of India arose out of a violent struggle between the Aryans and the Dravidians for which no credible evidence has emerged. The term *dasyu* which was earlier thought to have represented the Dravidians has by new linguistic evidence shown to stand for Iranian groups; note that *dahyu* in Iranian stands for the common people.

- New findings suggest that the Vedic people were indigenous to India; this is the only position consistent with the following statement of Shaffer and Lichtenstein, who have analyzed currently available archaeological data:[9]

The shift by Harappan groups and, perhaps, other Indus Valley cultural mosaic groups, is the only*, archaeologically documented west-to-east movement of human populations in South Asia before the first half of the first millennium B.C.*

- The Orientalist approach to the Vedic texts completely ignored datable astronomical references such as the one in Śatapatha Brāhmaṇa 2.1.2.3 that states that the Kṛttikā do not swerve from the east whereas others do which was so only in the third millennium B.C. The stated logic behind not giving credence to these dates was the claim of Al-Bīrūnī that the Indians did not have a reliable tradition of observational astronomy; it was assumed what Al-Bīrūnī found for the medieval period was true for the earlier period as well. Careful analysis of the evidence by Billard[10]has determined the falsity of this belief for the medieval period, and the discovery of the astronomical basis of the Vedic altars shows that this is false for the Vedic period as well.

For a proper assessment of the Vedic literature it is essential to start with a fair understanding of the foundations of knowledge of its time. This understanding has two elements: What was the nature of science then? and (ii) How are the technical words in the Vedas to be interpreted? For the latter, Yāska, in spite of the limitations of his Nirukta, provides useful pointers.

The Vedantic slogan Ātman=Brahman should be seen in the background of the theory of the equivalence between the ādhidaivika, the ādhibhautika, and the ādhyātmika. These equivalences were represented in terms of the designs of the Vedic altars. This is the reason the Vedic gods could represent either the stars and the planets as well as the psycho-physiological centers within the body, or even the bricks in the altar. The correct interpretation can only be obtained from the context. As pointed out by Aurobindo,[11]most translations into English have wrongly ignored or underplayed the psychological and spiritual sense of the hymns.

We will ask several questions related to the connections between the physical and the physiological sciences of the Vedic times and Vedānta, viewed as a theory of the universe and consciousness. The Vedic system seems to be a fully developed system and we do not have enough information on the earlier stages of Vedic thought to understand the developmental phases that led from an early science to the later Vedānta. Nevertheless, the connections described in this paper illuminate many aspects of Vedic knowledge.

2 Vedic Science And Its Context

If we do not wish to project our own meanings on to the Vedic texts we must use the internal evidence from the texts to validate our interpretations. This is why we will first present a brief review of Vedic system as known to us from the texts.

The Vedāṅgas, the auxiliary sciences of the Veda, consist of phonetics, ritual, grammar, etymology, meters, and astronomy. But at the same time there are extensive references to a variety of occupations that include shipwork, medicine, agriculture, metalworking, weaving, animal husbandry amongst others that would have been based on systematic study or, in

other words, the use of corresponding sciences. There is frequent mention of bhiṣaj, physician, in the Ṛgveda. Atharvaveda 10.2 describes the anatomy of the human body in detail and with good accuracy. Clearly the Vedāṅgas do not exhaust the sciences of the Vedic times. Certainly sciences related to the human body, plants, metals, animals existed.

Why were not these sciences listed amongst the Vedāṅgas? Because the Veda and its auxiliary sciences deal primarily with the overarching science of the equivalences between the astronomical, terrestrial, and the psychological. Some of the equivalences were by number while some others were only analogies.

One can see a plausible basis behind the equivalences. Research has shown that all life comes with its inner clocks. Living organisms have rhythms that are matched to the periods of the sun or the moon. For example, the potato has a variation in its metabolic processes that is matched to the sidereal day, the 23-hour 56-minute period of rotation of the earth relative to the fixed stars. The cicadas come in many species including ones that appear yearly in midsummer. The best-known amongst the others are those that have 13-year and 17-year periods. There are quite precise biological clocks of 24-hour (according to the day), 24 hour 50 minutes (according to the lunar day since the moon rises roughly 50 minutes later every day) or its half representing the tides, 29.5 days (the period from one new moon to the next), and the year. Monthly rhythms, averaging 29.5 days, are reflected in the reproductive cycles of many marine plants and those of animals. It has been claimed that there are others that correspond to the periods of the planets. There are other biological periodicities of longer durations.

In humans the menstrual period has by tradition been taken to correspond to the moon's motion; in fact "menses" means lunar month. New research supports this:[12]

> In a study of a number of women with variable onset of menstrual periods, artificial illumination of the bedroom through the 14th to 17th nights following the onset of menstruation resulted in the regularization of the period, with the period length coming very close to 29.5 days, the natural synodic month. That this period is a biologically significant one for the human species is further suggested by the fact that the average duration of pregnancy (from ovulation to birth) in the human is rather precisely nine 29.53 synodic months.

From the perspective of the ancient Indians, with their emphasis on time bound rituals and the calendar, it is easy to see that many of the biological periods would have been discovered by them. This would include the menstrual cycle and its connection with the motions of the moon, the life cycles of various plants, and the semimonthly estrus cycle of sheep, the three-week cycles of cattle and pigs, and the six-month cycle of dogs. It is quite clear that the ancient calendar with its intercalary month every third year was a direct result of the lunar cycles, but it is also possible that further developments in the calendar were inspired by biological rhythms of the kind seen in the deep-sea lily near Japan:[13]

> This echinoderm liberates its sex cells once every year in October at about 3 PM on the day of one of the Moon's quarters. In succeeding years the time of sex cell release changes, among the Moon's two quarters, first-third-first, to progressively slightly earlier dates in October. The triplets are repeated until about the first

of the month whereupon the following year it jumps abruptly to near the end of the month to start the advancing triplet progression again. The result is an 18-year cycle, which is essentially the period of regression of the Moon's orbital plane.

Having seen rhythms matched closely to the principal astronomical periods, it must have been further assumed that there were less obvious cycles that were matched to the motions of the other heavenly bodies.

Such equivalences are not to be seen as being caused directly by particular heavenly bodies, but rather as a manifestation of the motions of the body's inner 'planets'. In the language of evolution theory one would argue that these periods get reflected in the genetic inheritance of the biological system as a result of the advantage over millions of years that they must have provided for survival. One can imagine that just as the Vedic calendar represents the attempt to harmonize the motions of the sun and the moon, yoga would have been the corresponding harmonization of the motions of the 'inner planets' of the body. This explains the importance that was given to astrology.

The gestation periods for mammals must have provided the basis for singling out certain animals as special symbols. Some of these periods are:

ass	365 days
baboon, sacred	183 days
cat	63 days
cow	280 days
dog	61 days
elephant	645 days
goat	151 days
horse	337 days
human	267 days
rabbit	31 days
sheep	148 days

It is no wonder then that the ass is used as a symbol for the year in the Śatapatha Brāhmaṇa. Likewise the horse with its average gestation period only one day off from the nakṣatra year of 336 days (for 28 nakṣatras) is a natural symbol for the year in the context of the nakṣatras and this we do find in the texts. Likewise the fact that the gestation period for the sacred baboon is exactly half of the solar year is likely to have played a role in the special significance attached to it by the Egyptians. The fact that the gestation periods for the human and the cow are quite close may be another reason for the sacredness assigned to the cow. In other words, knowledge of biological periods appears to have played a role in the choice of some as sacred symbols.

The Vedas speak of the equivalences and so pre-suppose a knowledge of the analytical and the empirical sciences, but their own focus is on a synthesis and the unity.

3 Astronomy Of The Fire Altars

We now begin with a survey of the astronomical basis to the fire ritual. The details may be found in my book *The Astronomical Code of the Ṛgveda*.[14]

A fire altar, generally made of bricks, is called an agni. Agni is the Vedic god; it also represents time and in sacrifices it represents the year. Agnicayana, or the building of a fire altar, is the symbolic creation of Agni-Prajāpati-Puruṣa.

There are several references to fire altars in the Ṛgveda. RV 1.164.35, 1.170.4, 5.31.12, 7.35.7, 8.19.18 and 10.61.2 are some of the places where the vedi is mentioned. Three places of Agni, which are doubtless gārhapatya, āhavanīya and dakṣiṇāgni, are mentioned in RV 5.11.2. Taittirīya Saṃhitā 5.2.3 speaks of the gārhapatya being made of 21 bricks. It is also stated that if made for the first time it should be in five layers; for the second time in three layers; and for the third time it should be in one layer.

The books speak of altars of various shapes that provide different benefits. But these objectives are merely etymological or symbolic associations with the shapes chosen. Beneath the superficial associations the logic of the altars was representation of knowledge. This was not only in terms of the intricate geometric constructions that were a part of the ritual of the altars; but also in the oft-repeated claim that only self-knowledge sets one free.

Agnicayana is one of the Soma sacrifices. The altar is generally made in the shape of the falcon, śyena or suparṇa. This construction is in five layers. Altars are made of bricks unless they are constructed symbolically of mantras. Bricks to be used in altar construction are classified into two types: ordinary, lokampṛṇā, and special, yajuṣmatī. Each yajuṣmatī brick is consecrated in a specific manner and each such brick is marked in a unique way. Bricks are built in different shapes to different measurements.

ŚB 10.4.3.14-20 describes the total number of yajuṣmatī bricks to be 396. This was to be taken as 360 days of the year and 36 additional (including one being the fillings between the bricks) as the days of the intercalary month. By layers, the first has 98, the second has 41, the third has 71, the fourth has 47, and the fifth has 138 (ŚB 10.4.3.14-18). The sum of the bricks in the fourth and the fifth layers refer to the 186 (together with the one space filling) tithis in the half-year. The number of bricks in the third and the fourth layers equals the integer nearest to one third the number of days in the lunar year. The number of bricks in the third layer equals the integer nearest to one fifth of the number of days in the lunar year. The number of bricks in the second and the third layers equals one third the number of days in a nakṣatra year of $28 \times 12 = 336$ days. Once the basic number of 21 is subtracted from the number of bricks in the first layer, the sum of the remainder together with the bricks in the second layer are once again the integer nearest one third the number of days in the lunar year.

The total lumber of lokampṛṇā bricks is 10,800 which equals the number of muhūrtas in a year (1 day = 30 muhūrtas), or equivalently the number of days in 30 years. Of these 21 go into the gārhapatya, 78 into the eight dhiṣṇya hearths, and the rest go into the āhavanīya altar.

The fire altars are surrounded by 360 enclosing stones (pariśrita), of these 21 are around the gārhapatya, 78 around the dhiṣṇya, and 261 around the āhavanīya (ŚB 10.4.3.13). The āhavanīya includes the dhiṣṇya, therefore the number of days assigned exclusively to the

āhavanīya is 261-78= 183 days, which is equal to the days in the uttarāyaṇa of a 366 day year. The choice of the 21 days for the gārhapatya is from the unique symbolism of this number. It is also the sum of the first six integers. Once the numbers 21 and 183 are chosen the number 78 becomes the only choice for the dhiṣṇya. This number 78 is the sum of the first twelve integers.

ŚB 10.3.1 describes how the altar can also be constructed symbolically by the meters. The altar is made with gāyatrī (24 syllables) as the breath, uṣṇiḥ (28 syllables) as the eye, anuṣṭubh (32 syllables) as the voice, bṛhatī (36 syllables) as the mind, paṅkti (40 syllables) as the ear, triṣṭubh (44 syllables) as the generative breath, and the jagatī (48 syllables) as the downward breathing. Kāṭhaka Saṃhitā Brāhmaṇa speaks of the gāyatrī altar being upto the level of the knees, the triṣṭubh one upto the level of the navel and the jagatī upto the level of man's height. Clearly there were correspondences acknowledged between the altars of meters and that of bricks.

3.1 Equivalence Through Area And Number

The rule that the gārhapatya and the āhavanīya are of one square puruṣa is mentioned in Taittirīya Saṃhitā and the Śatapatha Brāhmaṇa. The Śulbasūtras also indicate that the gārhapatya, the āhavanīya, and the dakṣiṇāgni are all to have the area of one square puruṣa. In the agnicayana ritual the original āhavanīya altar later takes the place of the gārhapatya altar after the uttara vedi has been built. The gārhapatya represents the womb or the earth and it is thus circular whereas the āhavanīya is the sky, shown by the four cardinal directions, and it is represented by a square.

The five layers of the mahāvedi altars were generally supposed to reach the height of the knee. Each layer in the falcon altar had 200 bricks leading thus to a total of 1,000 bricks in the five layers. It appears that the Ṛgveda knew of such an altar because Puruṣa is described in RV 10.90 as "thousand headed, thousand eyed, thousand footed." In some cases ten or fifteen layers of bricks were prescribed. The basic falcon-shaped altar had an area of 7 1/2 square puruṣa. The body of the basic falcon-shaped altar was 2 × 2 (=4) square puruṣas, the wings and the tail were one square puruṣa each. To make the shape look more like that of a bird, the wings were lengthened by one-fifth of a puruṣa and the tail was lengthened by one-tenth of a puruṣa. This defined the total area of 7 1/2 square puruṣas at the end of the first construction. On the second construction the area of the altar was increased by one square puruṣa to a total of 8 1/2 square puruṣas. Further constructions successively increased the area by one square puruṣa at each step until one came to the "one-hundred-and-one-[and-a-half]-fold" altar. In the construction of the larger altars the same shape as the basic altar is required and this requires solution of several geometric problems including that of the theorem of the diagonal. It is important to note that the altars are to be built in a sequence of 95.

To discuss the question of intercalation necessary to harmonize the solar and the lunar years, we note the following facts from modern astronomy:

Solar (sidereal) year = 365.25636 solar days

Solar (tropical) year = 365.24219 solar days

Moon's sidereal period = 27.32166 solar days

Lunar month = 29.530588 solar days = 30 tithis

Lunar year = 354.367 solar days

Tithis in a solar year = 371.06239

The solar year was known to be a little more than 365 days, although its nominal period was taken to be 360 days. TS 7.1.10.1-3 speaks of the 5 excess days over the Sāvana year of 360 days to complete the seasons, where 4 days are too short and 6 days are too long. TS 7.2.6.1 speaks of the extra 11 days, *ekādaśarātra*, over the 12 lunar months of 354 days required to complete the year. That the reckoning was done both by the solar and the sidereal or nakṣatra counts is clear from the references to the year having 13 months (ŚB 7.1.1.32 or 7.2.3.9). Later books, such as the Nidāna Sūtras, speak clearly of the nakṣatra year being equal to 324 days which is 27×12. In a system of 28 nakṣatras the nakṣatra year equals 336 days. Śatapatha Brāhmaṇa knows the nakṣatra year.

The eleven extra days in the solar year, when compared to the lunar year, were each assigned a separate god. A triple division of space and time is a common Ṛgvedic theme. Ṛgveda speaks of the three-fold world which then leads to a total of 33 gods.

To get further information on the length of the solar year, one can use evidence regarding the extent of intercalation needed after the nominal year period of 360 days. Was the year taken to be 365 days or 366 days? With 366 days one would require intercalation of 12 days a year, whereas 365 days imply intercalation of 11 days. ŚB 10.5.4.5 describes the 756 bricks to be used in building the fire altar. These represent the 720 lunar days and nights followed by the 36 lunar days and nights in the intercalary month. This supports an intercalation of 18 days every 1 1/2 years. In other words, the basic year was taken to be 366 days, which would correspond to 372 tithis. But the ekādaśarātra also points to 365 days or 371 tithis. The only conclusion to be drawn is that the true length of the year was known to be between 365 and 366 solar days, or equivalently 371 or 372 tithis. This is corroborated by RV 4.33.7 we hear about the ṛbhus, the receptacles of time (RV 1.111.1; 4.34.9) who rest for 12 days after the year is over.

The period of 5 solar years was called a yuga. A five year period was convenient because it led to two intercalation months of 30 tithis each, which the Vedāṅga Jyotiṣa evidence suggests were added at intervals of 2 1/2 years. But this would lead to an excess of about 4.688 tithis in 5 years, necessitating further corrections in greater periods.

ŚB 6.1.1.1-3 speaks of how the ṛṣis (here they are vital airs) created seven separate persons, who doubtlessly represent the seven cognitive centers. Now they made these seven persons into one person and this is represented by the seven (and a half) puruṣa altar. ŚB 10.2.3.18 now describes the process of building larger altars: "Prajāpati was created sevenfold in the beginning. He went on constructing (developing) his body, and stopped at the one hundred and one fold one." Later it is added that "the one hundred and one fold altar becomes equal to the seven fold one" (ŚB 10.2.4.4).

BSS 5.6 speaks of how the altar at the mth augmentation is obtained with the new unit x after such augmentation satisfying $x^2 = 1 + (2m/15)$ where m runs from 1 to 94. The 101 1/2 square puruṣa altar is obtained when $m = 94$ and for this $x^2 = 13\ 8/15$. Now ŚB 10.2.3.11 describes a "ninety-eight-fold" bird as having dimensions of 14 square puruṣa and Seidenberg[15]has convincingly shown that this must have referred to the 101 1/2 square puruṣa altar.

The agnicayana ritual leads to a cycle of 95 years, as explained. The logic behind this cycle is that this leads to exactly 35 intercalary months (with a residual small error) in 95 years if the year is counted as 360 tithis. The intercalation is seven months in each subcycle of 19 years. Later we show that 95 years represent a big period even when the year is taken to be a nakṣatra year of 324 days. If each altar is taken to represent a yuga, the cycle would then become 475 years.

The use of the Yājñavalkya cycle at a later time is corroborated by the creation of the 2850 year cycle in the Romakasiddhānta, which is 30×95, or a "month" of such a cycle.

3.2 More On Altar Design

ŚB 10.4.4.2 speaks of the number of stars in the sky being equal to the number of muhūrtas (1 day = 30 muhūrtas) in 1,000 years or $1000 \times 360 \times 30 = 10,800,000$. This is followed by consideration of muhūrta as a basic measure in the consideration of the grand year of 1,000 ordinary years. A muhūrta is to a day what a day is to a month. In other words the grand year consists of 10,800,000 units, which were presumably taken to correspond to years.

The important gārhapatya altar, that represents earth or the womb, has an area of 1 square puruṣa which equals 14,400 square aṅgulas. This requires drawing a circle around a square of side one vyāyāma (1 vyāyāma = 4/5 puruṣa). It is constructed with 21 bricks in each layer (ŚB 7.1.1.34). With 7 1/2 square puruṣa considered equal to 360 days, the area of the gārhapatya altar equals 48 days.

Note also that the falcon altar symbolizes all the three years: nakṣatra, lunar, and solar. The increase in the area in each new construction of the falcon altar is one square puruṣa which equals 48 days. The purpose of the increase is to make the altar become closer to the actual year. If the nakṣatra year is now taken to be 324 tithis, the additional 48 tithis are needed to make it exactly equal to the nominal year of 372 tithis. On the other hand, it may indicate the size of a larger yuga by the following correspondence:

1 tithi = 9 bhāṃśas like 1 year (371 tithis) = 3339 bhāṃśas;

48 days expands to a larger period of $48 \times 9 = 432$.

This multiplier of 9 may have also been used in going from 12 months to a period of 108.

The expansion of 48 tithis is required every year since it is clearly stated that the expanded altar is to be viewed as before as Prajāpati. Since we do know that the number of tithis in a year is supposed to be 371.06239, this implies an excess of 0.93761 tithis per year. In 95 years this excess would be almost exactly equal to 89 tithis. It appears that the period of 95 years was chosen because observationally the excess was taken to be 90 tithis or 3 lunar months. Every 95 years a major adjustment of the calendar would then have been required. This also means that the adopted solar year would be 372 - 90/95 = 371.05263 tithis. This corresponds to 365.24675 days. This is quite close to the tropical year of 365.24219 days and it is quite possible that such a year was meant.

One may assume that the altar ritual came to have its fundamental importance by expressing significant astronomical knowledge regarding the incommensurability of the solar and the lunar years, as is hinted by the statements that agnicayana is not only ritual but also knowledge. The observations muat have been made over centuries and a calendrical system of reckoning must have existed. It appears that the Saptarṣi centennial reckoning was this

system.

Altars are mentioned in the Ṛgveda in connection with many early ṛṣis and kings. The astronomy of the fire altars is therefore early Vedic knowledge.

3.3 The Astronomical Plan Of The Ṛgveda

I will not describe the astronomical code in the organization of the Ṛgveda in this paper since its details may be found in my book *The Astronomical Code of the Ṛgveda*. Briefly the astronomical code provides strong evidence that the Vedic astronomers made careful observations of the sun, the moon, and the planets[16]in the third millennium B.C. We have indirect evidence that this knowledge was described in the earliest Siddhāntas, no longer extant, that led to the unique constants and models of the later Siddhāntas.

But even without going into the details of the astronomical code of the altars and the Vedic texts, there is enough evidence regarding an equivalence between the outer world and the design of the texts. There are many references to the larger plan of the texts. ŚB 10.4.2.23-24 describes that the Ṛgveda has 432,000 syllables; Yajurveda has 288,000 and Sāmaveda has 144,000 syllables. The syllable count of the canonical text of the Ṛgveda has only 394,221 syllables, however.[17]It appears that the number 432,000 is the ideal number of syllables. Considering that RV 1.164.45 declares that speech is of four kinds, three of which are unmanifest, then the shortfall of 37,779 syllables must be in terms of unmanifest syllables.

ŚB 10.4.4.2 speaks of the number of stars in the sky being equal to the number of muhūrtas (1 day = 30 muhūrtas) in 1,000 years or $1000 \times 360 \times 30 = 10,800,000$. This means that the ideal number of syllables in the Ṛgveda equals the number of muhūrtas in 40 years. The number of days in 40 years is 14,400 and if one took the identity of a day to a verse then this would be the number of verses in the Ṛgveda. The average number of syllables per verse is therefore 30, or the mean of gāyatrī and bṛhatī. Now we know that sky (or heaven) is ascribed the number 261 in Vedic ritual. If we consider the equation that the verse is to the sky-day what the syllable is to the muhūrta, then the number of verses in a span of 40 years, considering 261 sky days per year, equals 10,440. This is only two less than the actual count obtained by Macdonell, and it appears that the canonical text had two fewer verses by reorganizing, say, four shorter verses into two longer ones. As argued by Macdonell his count of 10,442 for the Ṛgveda verses can be reconciled with Śaunakas's figure by considering the 127 dvipadās twice; this raises the count to 10569 verses which is only 11 verses less than Śaunakas's figure. It is possible that the 11 hymns of the khila were counted as the remainder in a count across categories, evidence of which is common as in the number 17 counted as 12 months and 5 seasons in the brāhmaṇas.

One can propose another theory that the Ṛgveda is supposed to be ideally 10,800 verses with an average of 40 syllables per verse. The shortfall between this number and the actual of 10,440 is exactly 360 verses. Since 10,800 are the muhūrtas in one year, the shortfall amounts to the muhūrtas in 12 days.

One may assume that the logic of considering the muhūrtas of 40 years to represent the syllables of the Ṛgveda flows from the time span of 100 years to represent all the four Vedas. As explained above Yajur and Sāmaveda taken together also get 40 years; the remaining 20

years would then be assigned to Atharvaveda. That such a logic must have been at work is suggested by the fact that the total number of hymns in the Śaunakīya recension, when considering only the Kuntāpa hymns of the Book 20 is 5,226, just six more than the number of hymns according to our theory.

The distribution of all the verses of the Vedas as they have come down to us is:

Table 1: Verses in the Vedic books

Ṛgveda	10522
Yajurveda	1984
Sāmaveda	1875
Atharvaveda	5977
Total	20358

That this total is exactly 261×78 implies that the verses were, metaphorically, supposed to pervade the entire space of span 78 and breadth 261.

One might assume that the original structure started with $261 \times 40 = 10,440$ verses for the Ṛgveda corresponding to 40 years; Atharvaveda had $261 \times 20 = 5,220$ verses for 20 years. The Yajurveda and the Sāmaveda were assigned 40 years, but by the space number of 78 and by its half 39. Also we claim that the Śatapatha Brāhmaṇa reference to the verses of Yajurveda and Sāmaveda being in the proportion 2:1 is only approximately true; the correct proportion being 25:15. This leads to the figure $78 \times 25 = 1,950$ verses for Yajurveda; and $39 \times 15 = 585$ verses for Sāmaveda. The figure for Yajurveda is very close to the value leaving out the Īśa Upaniṣad verses of chapter 40 and the Sāmaveda figure is identical to the Pūrvārcika verses. Various considerations, like the ones for the Ṛgveda verse totals outlined earlier, led to modifications of these numbers with the constraint that the total had to be $261 \times 78 = 20,358$.

Other numerical and perhaps astronomical considerations may have played a role in the modifications that were introduced. Is it possible that the Atharvaveda number was first increased to 5,226 because it is 78×67. From another perspective, we expect that the syllable count for the Sāmaveda by the Śatapatha Brāhmaṇa reference comes to 4,800 verses and that for the Yajurveda to 9,600 verses. Now note that the 585 Pūrvārcika stanzas are in practice sung to double the number of tunes; this allows us to modify the total count as $1,225 + 2 \times 585 + 54 + 11 = 2,395$. This is just 5 short of the half of the total 4,800. Considering still another angle, note that Sāmaveda has 1810 verses plus 5 hymns in the Āraṇyaparva and the 11 mahānāmnī verses. If we add across categories we get a total of 1826, only one less than 261×7.

In summary, then there is considerable direct evidence from archaeology, altar designs, and texts that speaks of a tradition of careful observation of nature. These observations are perfectly in accord with the central emphasis placed on ṛtā, order, in the Vedas.

4 A Science of the Universe and its Cognition

What is remarkable about Vedic science is that it went beyond an examination of the outer reality and studied the cognitive process and consciousness. We see this in the early emphasis on *parā* or the knowledge of the self.

Clearly, it was believed that complementing the task of understanding the detailed order in nature, was the task of unifying this knowledge. However this unifying principle could not be described as any formula and so symbols and metaphors, *pratīka*, were used instead. This principle was named *Brahman*.

Chandogya U. speaks of prāṇa, manas, āditya, ākāśa and so on as symbols of Brahman. Kauṣītaki U. 3 says that Brahman is to be sought in consciousness (prajñā) and presents the equation: prāṇa = prajñā. Ch. U. 4.10.5 presents prāṇa = kaṃ (ānanda) = khaṃ (ākāśa). Bṛhadāraṇyaka U. 2.3 presents two forms of Brahman: One material and the other immaterial. In the outer world, the sky and the (cosmic) wind are immaterial whereas in the body prāṇa and the ether are immaterial. The essence of what is immaterial in the space is the puruṣa in the sun whereas what is immaterial in the body is the puruṣa in the right eye. Brahman is defined as *neti neti*, not this nor that, and as *satyasya satyam*, the essence of existence.

Elsewhere Brahman is defined as bliss and knowledge, as satyaṃ, prajñā, and ānanda or as saccidānanda (sat, cit, ānanda), existence, consciousness, and bliss. Brahman is also defined in terms of opposites such as sat and asat, existence and non-existence and so on, or in negatives as being timeless, spaceless, and independent of causality. In other words, the principle of Brahman is used to denote an essential unity of things.

Since the physical universe is apprehended by consciousness the latter is rooted in unity. Muṇḍaka U. 1.1.3 says that ātman "is that with the knowledge of which the entire universe becomes known." Further on Brahman is defined as being beyond all descriptions, as "that which cannot be seen, nor seized, which has no family and no class, no eyes no ears, no hands no feet, the eternal, the omnipresent and imperishable." This provides justification for the slogan: "ahaṃ brahma asmi." (Bṛ. U. 1.4.10).

4.1 Tantra in Vedic Texts

Tantra represents a theory of the structure of consciousness. We encounter details of such theories only in the literature from the medieval times. These medieval texts do speak of a continuity with early traditions and we do find evidence for the existence of tantra in the Vedic books if the earliest interpretations of the Brāhmaṇas and of Yāska[18]are used.

The theory of the bandhu- or equivalences implies that the structure of consciousness has parallels with the outer reality. It appears certain that Vedic tantra used planets, the sun, and the moon as internal categories to describe the nature of the mind. But the task of interpreting the Vedic texts from this point of view has just begun.

Below is a quick summary of the tantric or yogic concepts that we come across in early Vedic texts.

Ṛgveda places great emphasis on *Vāc* the Word. Thus Book 10 hymn 71 is dedicated to Bṛhaspati, the lord of the sacred mantra, where the knowledge of the origin and secrets of Vāc is described. What is significant here is the comparison with Bṛhaspati who likewise guides the planets and the sun and the moon on their divine courses. In hymn 10.125 Vāc is glorified as the supreme power that supports Varuṇa and Mitra, bears Indra and Agni, and pervades heaven and earth. Elsewhere "the gods created Vāc, whom all kinds of animals speak" (8.100.11); "Brahman expanded as large as the Word" (10.114.8). Aitareya

Brāhmaṇa 4.21.1 proclaims: *brahma vai vāk*, Brahman is the Word.

Atharvaveda 4.1.5 divinizes Vāc as Bṛhaspati; in 19.9.3 Vāc is called "most exalted goddess, sharpened by brahman." A full account of these Vedic references may be found in the book *Vāc* by Andre Padoux.[19]

Says Chāndogya U. 2.23 says: "Prajāpati brooded over the worlds. From the worlds issued forth the three-fold knowledge. Brooding on it arose the syllables: *bhūr, bhuvaḥ, svar*. He brooded over them; therefrom arose the name *oṃ, (oṃkāra)*. As leaves are held together by the stalk, so all the words merge into *oṃkāra*. The sound *oṃ* is the whole universe." Ch. U. 2.22 says that the inner nature of the vowels (svara) is Indra, that of sibilants (ūṣman) is Prajāpati, and that of the consonants (sparśa) is Mṛtyu.

Taittirīya U. 1.8 says that "oṃ is brahman." Māṇḍūkya U. begins by saying: "Hari is oṃ. This syllable is this whole. The past, the present, the future—everything is just the phoneme oṃ."

Maitrāyaṇa U. speaks of a six-limbed *ṣaḍāṅga* yoga. In 6.18 these are called prāṇāyāma, pratyāhāra, dhyāna, dhāraṇā, tarka, and samādhī. In 6.21 is explained how suṣumṇā, going upward from the heart to the Brahmarandhra, serving as the passage of the prāṇa, is divided at the palate. Śaunaka's Ṛgvidhāna describes tapas and yoga.[20]

Thus at the Upaniṣadic times, not only was an equivalence of the universe and the body, in its structural forms, proclaimed but that the details of the structural equivalence were also described.

5 A Recursive System of Knowledge

Once one sees that the Vedic knowledge was defined in a recursive fashion, it becomes easy to see Vedānta, tantra and yoga, as well as Vedic ritual as different aspects of this system. In this system the equivalences were sometimes defined only by number, as in the equivalences of 360 days of the civil year to the 360 bones of the body. The equivalences between the 72,000 nāḍīs in the human body and one third the number of muhūrtas in twenty years, or that of 21 organs in the middle body and the number signifying the earth are of a similar nature. At other times the equivalences were more metaphorical. The eyes are the sun and the moon, likewise one can speak of the planets (graha) inside the body; nevertheless, here a numerical connection in terms of planet periods and body processes might have been meant.

This recursion worked for other concepts as well. Thus agnihotra was replaced by prāṇa-agnihotra. The fires of the altar have the parallel in the fires inside the body. A sacrifice, yajña, is a recursive system: any given level is based on a transcendence of the lower level. This is to be seen not only in life but also within the mind, which was viewed as a hierarchical system with systems of the the gross body, prāṇa, manas, vijñāna, and ānanda.

In analysis a dynamic balance between three fundamental categories was postulated. Śvetāśvatara U. 4.5 speaks of a balance between red, white, and black made conscious by puruṣa; this is repeated in the rajas, sattva, and tamas of prakṛti in Sāṅkhya. Clearly, the regions of atmosphere, sky, and earth correspond to these three. In Vedic society also there is mention of an original single class that divided into the three brāhmaṇa, rājanya, and vaiśya. The altars are made in five layers to represent the three regions and the two intermediate spaces where atmosphere and earth and also atmosphere and sky meet. Paralleling this later

a fourth class of śūdra was added to the societal classes to represent the new "foundation" against which the other classes were defined; the fifth class of "sages", who transcended class categories, was described only indirectly. The texts themselves do not speak with this directness about the parallels but these are easy enough to infer.

Bṛ. U. 1.2.2 speaks of three primary constituents. Later like the expansion of the altar from three to five layers, we come across five primary elements, pancabhūtas, earth, water, fire, air, and ether. The three dośas or dhātus (humors) vāta, pitta, and kapha in the human body likewise define a basic tripartite model. But each of these dhātus is taken to have five types.

6 Concluding Remarks

Owing to a variety of reasons Vedic studies in the academy have not been subjected to the same scrutiny that other fields of scholarship face routinely. Considerations such as an overarching framework of biblical chronology, speculative theories about movements of pre-historic peoples, and a Eurocentric view of the rise of science led to a hasty dismissal of traditional interpretations with long-standing textual support. For example, Śatapatha Brāhmaṇa and the Śulba Sūtras state that the syllable count of the Vedic texts has an astronomical basis, but until recently no one thought it worthwhile to examine this issue.

The resistance to new ideas, which is many cases are the old explanations, is not surprising since shifts in understanding are met by similar response in other disciplines as well. Relativity and quantum theories were not accepted by many of the older scientists of their times. The decipherments of the Egyptian hieroglyphs and in our times that of the Mayan writing has been challenged by the establishment.

The Vedic system is based on the theory of the equivalence between the ādhidaivika, the ādhibhautika, and the ādhyātmika. These equivalences were represented in terms of the designs of the Vedic altars. This is the reason the Vedic gods could represent either the stars and the planets as well as the psycho-physiological centers within the body, or even the bricks in the altar. The correct interpretation can only be obtained from the context. As description of the psycho-physiological structure, Vedic knowledge could be of relevance to the emerging science of consciousness. New theories propose that consciousness is characterized by 40 cycles per second oscillations inside the brain. But oscillations in themselves do not explain how consciousness arises and even if this theory is correct, the oscillations may just be a result rather than the cause. Oscillations are in later tantras represented as śakti or as spanda. The Vedic view of consciousness goes beyond the notion of spanda and it represents a unity. This is why Vedic ideas find rich resonance in quantum theory which is also a theory of wholes.[21]

It is this rational basis that provides the explanation for the strength of the Vedic tradition. Viewed in this perpective, it becomes clear that the division of society into three or four social classes is not a fundamental basis of the system, but rather an attempt to see a system in symmetry with corresponding categories in the outer and the inner worlds. The *Puruṣasūkta* hymn (RV 10.90) of the Ṛgveda that describes the four varṇas created from different parts of the body of puruṣa, the primeval man, can also be interpreted as one where each person has aspects of all the four varṇas within him since the puruṣa resides within each

person. On the other hand, in Mahābhārata, the fifth Veda, it is clearly stated[22]that a person's nature alone defines his varṇa. These and other conflicting accounts show that social categories were not the basis on which the Vedic system of the knowledge was constructed.

7 Notes

For a detailed bibliography related to the issues raised in this paper see Kak (1994b, 1994c).

1. See Pargiter (1922); see also Frawley (1991).
2. See Kenoyer (1991), Kak (1992), Misra (1992), Gupta (1992-3).
3. Kak (1988, 1989, 1990, 1992).
4. Shaffer (1993).
5. Sachau (1910).
6. Horgan (1994).
7. Seidenberg (1978).
8. Kak (1994c).
9. Shaffer and Lichtenstein (1993).
10. Billard (1971).
11. Aurobindo (1914-20). Steven Phillips of the University of Texas at Austin informs me that these issues are well discussed in T.V. Kapali Sastry's *Rig-Bhashya Bhumika* (1950) but I have not yet seen this book.
12. Encyclopaedia Britannica (1994), Macropaedia article on Behaviour, Animal, p. 761; see also Brady (1982), Cloudsley-Thompson (1980), and Palmer (1976).
13. Encyclopaedia Britannica (1994), Macropaedia article on Behaviour, Animal, p. 761.
14. Kak (1994b).
15. Seidenberg (1978).
16. Kak (1994b); see also Frawley (1994) for additional textual support.
17. Kak (1994b) for details of the discussion that follows as well as significance for other texts.
18. Sarup (1920-7).
19. Padoux (1990); see also Beck (1993).

20. Bhat (1987).

21. Kak (1993b).

22. Mahābhārata, Vana Parva, the dialogue between Yudhiṣṭhira and Yakṣa.

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