The astronomical code of the Rigveda

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The recently discovered astronomical code at the basis of the organization of the Rigveda is reviewed. It is explained that information on the latitude of the place of the composition of the code and periods of the five planets can be obtained from the code. Since new archaeological discoveries suggest that the Rigveda should be dated prior to the hydrological changes that led to the drying up of the river Sarasvati (1900 B.C.) this implies that careful astronomical observations were made at least one millennium earlier than previously believed. The discovery of this code explains several features of the later Siddhantic astronomy.

The discovery that the Vedic altars as well as the Rigveda represent astronomical information[1-3] raises questions about how far back in time the earliest measurements of astronomical phenomena can be attested. Archaeoastronomy has revealed that many ancient civilizations observed the stars and planets[4,5]. Examination of Rigveda adds a unique perspective to such studies since this ancient book has been preserved with incredible fidelity for at least 4000 years. The number of syllables and the verses of the Rigveda are according to an astronomical plan[6]. Rigveda is like a Stonehenge in words. Its new estimates of antiquity follow from the recent discoveries that date the drying up of the river Sarasvati, the pre-eminent river of the Rigvedic era, to around 1900 B.C.[7,8]. Decipherment has shown that the Rigvedic Indians were careful observers of astronomical phenomena. They were interested not only in the motions of the sun and moon but also the planets. Such a conclusion might appear surprising if one considers the contents of Vedanga Jyotisha, a text generally believed to have been composed[9] around 1300 B.C. because it does not address planetary motions at all. But there is other textual evidence that the Vedic Indians did study the planets. Since this knowledge was not of significance in calendrical concerns, texts like Vedanga Jyotisha had no need to mention this knowledge. On the other hand, in cosmological theory and speculation, as is the concern of the Rigvedic code, information about the planets should show up.

For reasons that have been well summarized by Seidenberg, ancient Indian texts have not been carefully examined for their mathematical content. Seidenberg[10,11] tried to remedy this situation by reanalysing the geometry and mathematics of the *Shatapatha Brahmana* and the *Shulbasutras*. The reason why no attempt was made to search for astronomical knowledge in the Rigveda was because the assumptions made regarding the context of this book were in error as recent archaeological discoveries have shown. Now it is generally accepted that there exists a

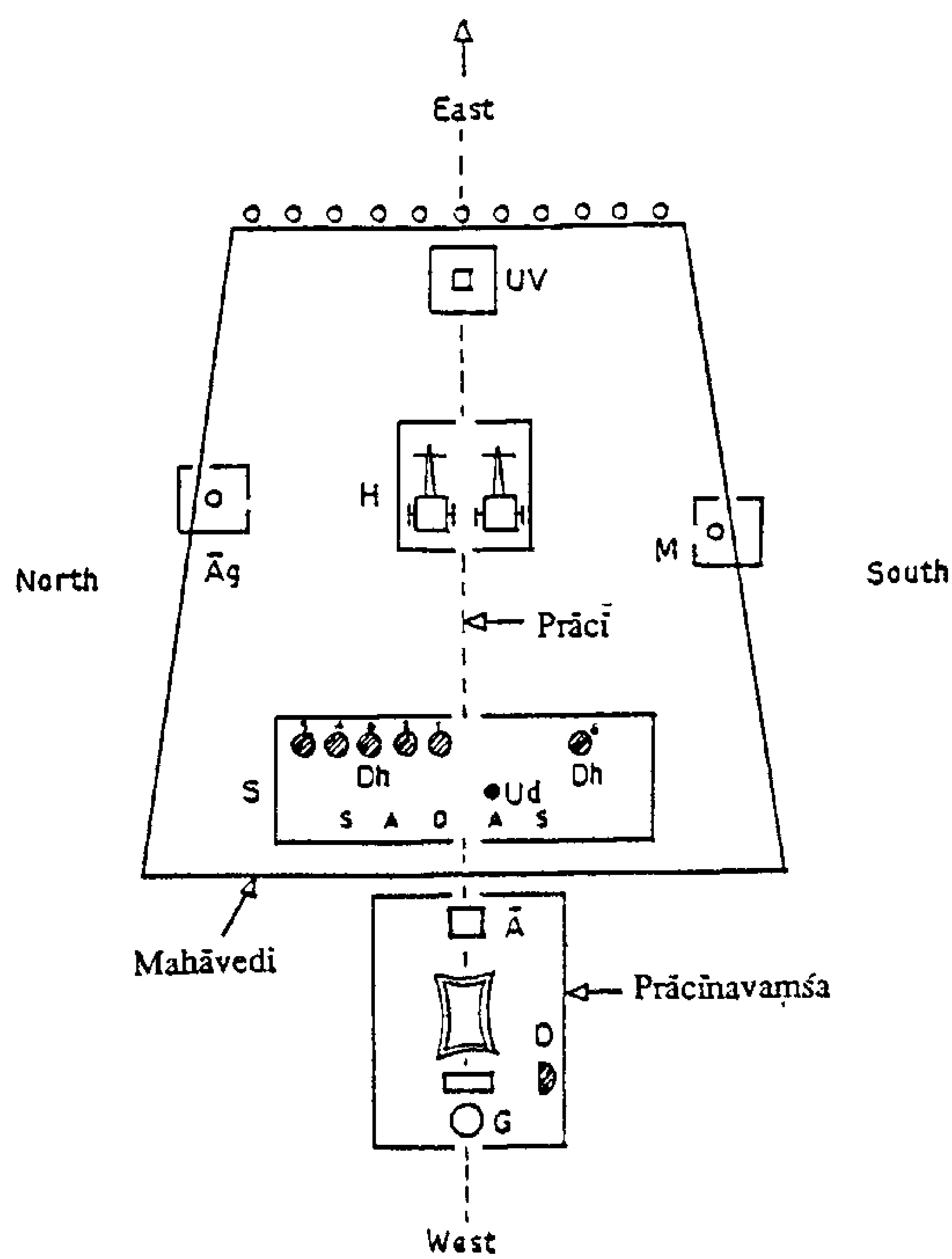

Figure 1. The altar field in agnichayana.

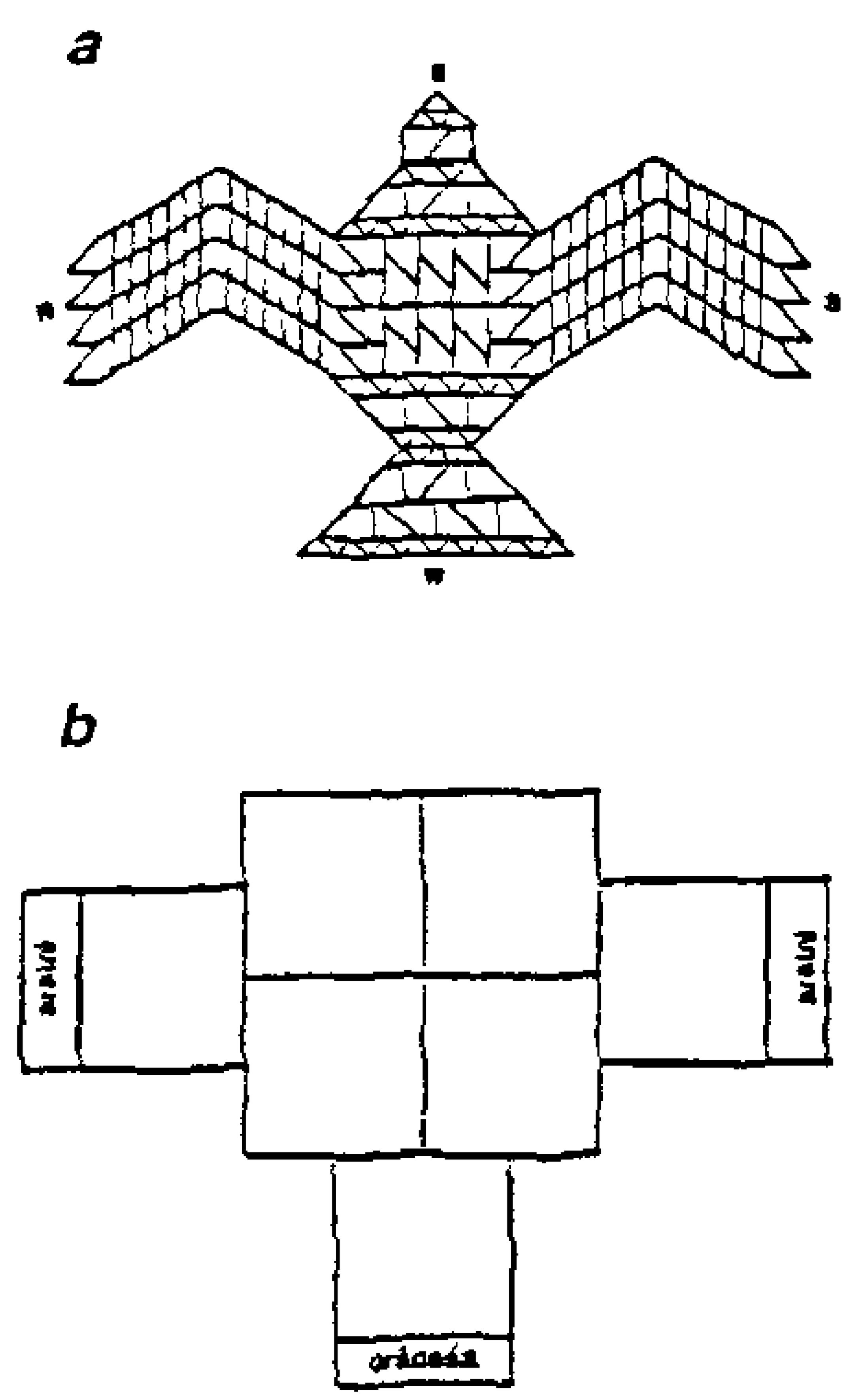

Figure 2. The ahavaniya altars. *a*, the final falun design; *b*, the initial frame.

continuity in Indian culture that can be traced back at least to 6500 B.C. in Mehrgarh. We will sidestep controversial questions on the evolution of Vedic astronomy by considering Rigvedic data alone. We will assume that the reader will consult references 2 and 3 to obtain a background on the astronomy of the Vedic altars. These papers show that altar design was based on astronomical numbers related to the reconciliation of the lunar and solar years With this background we take up the question of planetary astronomy. We show that there is considerable evidence in the organization of the Rigveda that leads to the conclusion that period information on the planets was known. We also sketch how the hymn numbers might have been chosen.

Vedic rites often were meant to mark the passage of time. A considerable part of the ritual deals with altar construction (Figures 1 and 2). The fire altars are supposed to symbolize the universe. *Garhapatya* represents the earth, the *dhishnya* hearths represent space, and the *ahavaniya* altar represents the sky. This last altar is made in 5 layers The sky is taken to represent the universe therefore it includes space and earth. The first layer represents the earth, the third the space, and the fifth the sky. The second layer represents the joining of the earth and space, whereas the fourth layer represents the joining of space and sky.

The fire altars were surrounded by 360 enclosing stones, of these 21 are around the garhapatya, 78 around the dhishnya, and 261 around the ahavaniya. In other words, the earth, the space, and the sky are symbolically assigned the numbers 21, 78, and 261. Considering the earth/cosmos dichotomy, the two numbers are 21 and 339 since cosmos includes the space and the sky.

That Rigveda was in itself taken to represent a symbolic altar is confirmed by the number of syllables in the Rigveda. According to the *Shatapatha Brahmana* the number of syllables in the Rigveda is supposed to add up to the number of muhurtas (1 day = 30 muhurtas) in forty years. In reality the syllable count is somewhat less because certain syllables are supposed to be left unspoken. The verse count of the Rigveda can be viewed as the number of days in forty years or 261 × 40 = 10,440, and the verse count of all the Vedas is 261 × 78 = 20,358. Reference 6 also shows how the Rigvedic syllabic count of 397,265 can be obtained from these astronomical numbers. These facts alone indicate that astronomical numbers are at the basis of the design of the Vedic books.

The Rigveda consists of 1017 or 3 × 339 hymns distributed in 10 books and grouped in a total of 216 groups. One would expect that if the Rigveda is considered akin to the five-layered altar described in the Brahmanas then the first two books should correspond to the space intermediate to the earth and the sky. Now the number that represents space is 78. When used with the multiplier of 3 corresponding to the tripartite view common in the Vedas, this yields a total of 234 hymns. We find that is indeed the number of hymns in these two books. One may represent the Rigvedic books as a five-layered altar of books with two books to each layer.

More astronomical sums are obtained when the hymn counts of the various books are added. For example, the count of the first four books is 354 which is the length of the lunar year. Likewise, the count of the middle four books is 324 which equals the nakshatra year My decipherment proposes that the Vedic poet-mathematicians had found the astronomical significance of the numbers 108 and 339. The number 108, which is one-half the number of hymn groups as shown in Table 1, is roughly the average distance that the sun is in terms of its own diameter from the earth; likewise, it is also the average distance that the moon is in terms of its own diameter from the earth. It is easy to compute this number The angular measurement of the sun can be obtained quite easily during an eclipse. The angular measurement of the moon can be made on any clear full moon night. A easy check on this measurement would be to make a person hold a pole at a distance that is exactly 108 times its length and confirm that the angular measurement is the same.

The second number 339 is simply the number of disks of the sun to measure the path across the sky during equinox:

$$\pi \times 108 \approx 339$$

This represents an early approximation to π that takes it equal to 3.1389.

Once 108 was arrived at 339 could be easily calculated. These estimates may have been refined through mutually related measurements. For example, one could count the number of disks of the sun or the moon that would go into an arc of a specified extent. That the Rigveda should reflect the sun-steps during the equinox is very fitting owing to the special role of the Rigvedic hymns in the spring equinox celebrations.

It may be noted that the Vedic year of 366 days was divided into two equal parts of 183 days, the *uttarayana* and the *dakshinayana*, where the uttarayana was taken to belong to the gods. We propose that the 339 steps of the sun were now reconciled with the 183 count of the gods by postulating a space count of 78, since 339 = 183 + 2 × 78.

That the proposed interpretation of the numbers 108 and 339 is not a coincidence is provided by additional

Table 1. Hymns and groups in the Rigvedic books

Books	1	2	3	4	5	6	7	8	9	10
Hymns	191	43	62	58	87	75	104	92	114	191
Groups	15	5	4	11	7	5	12	18	7	132

evidence. Our validation emerges from the sun-steps for winter and summer solstices that are also obtained from the code[12]: these two numbers are 296 and 382. These two numbers provide the ratio between the longest to the shortest day from which the latitude of the place of the composition of the hymns, or the code, can be obtained. This ratio corresponds to the region of the lower Sarasvati valleys and the textual evidence confirms that this was the region of the composition of the hymns.

Planetary periods

If the arrangement of the Books was entirely by design then there should be another seven independent pieces of information. If our inference that the Rigvedic astronomy was based on careful observations is correct, then it is likely that, many or all of these seven represent information on the periods of the planets This information could be in terms of sidereal or synodic periods or both. The sidereal period is against the background of stars whereas the synodic period is the interval from the date a planet is in the middle of its retrograde motion to the next date it is in similar state. Naked eye astronomy suffices to compute both such periods. The sidereal and the synodic periods are given in days in Table 2.

Consider the sidereal periods first. There is evidence that the approximation of 87 was used for the Mercury period. It appears that the synodic period of Mercury was taken to be one third of the year and that 87 is one third of the sky number 261 and played some role in this choice. This latter reason would then stand for modifying observations to fit a theory. The sidereal periods can be factored into the components given in Table 3.

Factors from each of these equations show up in the Book hymn numbers. It may be supposed that these factors were the starting points in the construction of the code. Similarly, factors of the year were used in the choice of the number of bricks in different layers of the agnichayana altar[13,14]. It is likely that the specific factors of the sidereal periods were chosen so that other astronomically significant numbers would be obtained.

Now consider the synodic periods. One may see that for Mercury, Venus, Mars, Jupiter, and Saturn 23, 5, 8, 9, and 29 synodic periods are completed in nearly 10, 8, 17, 10, and 30 years, respectively. One would expect a new cycle to begin every 2040 years. A different fit is provided by the synodic periods 3, 72, 15, 120, and 30 which would then be completed in 3, 115, 32, 130, and 31 years. The least common multiple of the synodic periods is now 1080. The emphasis on the number 1080 that is to be seen in the Vedic altar constructions indicates that the second fit may have been the one used. This also indicates that the period of Mercury was not represented with the same accuracy as that of the other planets.

The 1023 combinations of the 10 hymn numbers map into 461 different numbers. Although this is a large set, the fact that all the synodic periods, with the assumption that the period of Mercury is represented by 120 days, show up in this set within an error of one day is significant. A non-unique set is provided in Table 4.

Apart from these numbers we also obtain 118, 780 and 379 that provide even better approximations. It appears that the fame of the Rigvedic book arrangement was spread by the fact that it also gives the synodic periods in *tithis* especially since the use of the *tithi* (the lunar year divided into 360 parts) seems to have been commonly used in altar ritual. A solar day is approximately 1.0159 *tithis*.

We get the hymn numbers that are factors of the sidereal periods, and we get combinations for the three sidereal periods, five synodic periods in days as well as the five synodic periods in *tithis*. Let the probability of picking a correct number be p. Considering a random model of choice, in a sample of n the expected number of correct picks is $\mu = np$ and the variance is $\sigma^2 = np(1-p)$. A sample of twenty-three numbers, as in our case, implies that $\mu = 11$ and $\sigma = 2.39$. And that all the twenty three numbers are correct implies that we are five standard deviations away from the mean. The probability of that happening is 2.87×10^{-7}. Now one might argue that only ten of the twenty three numbers must be considered to be primary and that the comparison should be based on the sample size being equal to ten. In this case $\mu = 4.5$ and $\sigma = 1.58$ so that the probability of obtaining ten significant random numbers in a sample of ten is 2.33×10^{-4}. These probabilities are so small that the claim that the Book numbers were deliberately chosen can be taken to be confirmed.

Table 2. Sidereal and synodic periods in days

Planet	Sidereal period	Synodic period
Mercury	87.97	115.88
Venus	224.70	583 92
Mars	686.98	779.94
Jupiter	4332 59	398 88
Saturn	10759 20	378.09

Table 3. Sidereal periods factored

87 = 87 × 1 (Mercury)
225 = 58 + 75 + 92 = 75 × 3 (Venus)
687 = 191 × 3 + 114 ≈ 43 × 16 (Mars)
4332 ≈ 62 × 70 ≈ 58 × 75 (Jupiter)
10760 ≈ 104 × 104 ≈ 92 × 117 (Saturn)

Table 4. Synodic periods in days by books

Books [3 + 4] = 120 (Mecury)
Books [1 + 5 + 9 + 10] = 583 (Venus)
Books [1+5+7+8+9+10] = 779 (Mars)
Books [2+3+5+8+9] = 398 (Jupiter)
Books [2+4+5+6+9] = 377 (Saturn)

Conclusions

The existence of an independent tradition of observation of planets and a theory thereof as suggested by our analysis of the Rigvedic code helps explain the puzzle why the classical Indian astronomy of the Siddhanta period uses many constants that are different from that of the Greeks[15]. This confirms the thesis that although Siddhantic astronomy from the time of Aryabhata developed in full knowledge of Greek methods, the reason why it retained its characteristic form was because it was based on an independent, old tradition[16]. Analysis of the Siddhantic data by Billard provides still further support for this conclusion[17]. Our work also implies that the belief that observational astronomy began in Babylon during the middle of the first millennium B.C.[18] should be abandoned. The fact that the earliest Vedic ritual was astronomical is attested by textual references within the Rigveda and this provides further support to our analysis of the Rigvedic hymn numbers.

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