

ANCIENT INDIAN ASTRONOMY AND THE ARYAN INVASION THEORY

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Astronomical references in ancient Vedic (*Brāhmaṇa* and *Samhitā*) texts do not support the Aryan Invasion Theory (AIT) as proposed by western Sanskrit scholars more than 150 years ago. We have examined this issue and present a comprehensive analysis relating to the key astronomical references only and find that they consistently lead to 3000 BC, in contrast to AIT dates to 800 BC. Various shortcomings are highlighted in the process as to the western Sanskrit scholars' interpretations of verses on *ekāṣṭaka* leading to 3000 BC: the references to Phālguna full moon marking new year which could only be dated to 3000 BC (new year at winter solstice) or 1200 AD (new year at spring) and nowhere near 800 BC and other facts. The errors in known methods of observations are also examined and estimated.

Key words: Ancient Indian astronomy, *Ekāṣṭaka*, Kṛttikā, Rohiṇī, Gnomon, Measurement, Observation

1. INTRODUCTION

Nineteenth century European scholars recognized the close similarities between Sanskrit and European languages, now called Indo-European languages. Based only on this similarity and without any hard evidence [Klostermaier 2007], they proposed the Aryan Invasion Theory which claimed that Aryan tribes invaded India about 1500 BC. The *Ṛg Veda* is the oldest text. Later Vedic texts, *Samhitās* and *Brāhmaṇas* are dated to 1000-800 BC. AIT has always been controversial and many scholars from the 19th century onwards have opposed it [Bryant 2001, Klostermaier 2007]. AIT continues to be dominant among western

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Sanskrit scholars and others who rely on their authority. No evidence has been found in 150 years for any invasion. Klostermaier [2007, p. 21] states,

“The AIT is based purely on linguistic conjectures which are unsubstantiated.”

To overcome the lack of evidence for an invasion an even more speculative Aryan Migration Theory, with similar dates, has been proposed. Most scientists, archaeologists [Bryant 2001, 2005, Biswas 2004, Chakrabarti 2006] and geologists [Valdiya 1996, 2002, Gupta 2004] oppose AIT/AMT as hard evidence points against it instead of supporting it.

Astronomical references offer a direct method to date Vedic texts. Weber (1861) was the first (Sanskrit) scholar to recognize the importance of this method. The key verses are in *Kausītakī* [Keith 1920], *Śatapatha* [Eggeling 1882-1900] and *Pañcaviṃśā* [Caland 1931] *Brāhmaṇas* and in *Taittirīya Saṃhitā* [Keith 1914]. Thibaut’s article [Thibaut 1895] is influential to this day among western Sanskrit scholars (or Sanskrit scholars henceforth). Weber and Thibaut dated key verses to 800-1000 BC. Their interpretations gained acceptance amongst Sanskrit scholars and other supporters of AIT.

In contrast, in 1893-94, Jacobi [1894] and Tilak [1893] interpreted key references to 4000 BC and were supported by Buhler [1894]. Tilak [1893, Ch.5 and p. 213] interpreted an astronomical myth in *Aitareya Brāhmaṇa* to imply that it referred to the shifting of the equinox from Mṛgaśīrṣa to Rohiṇī *nakṣatra*. That is, sun in Mṛgaśīrṣa marked equinox in an earlier period (4000 BC) and sun in Rohiṇī marked equinox in the *Brāhmaṇa* period (3000 BC). Dikshit [1895] interpreted verses in *Śatapatha Brāhmaṇas* as Kṛttikā rising on true east and dated it to 3000 BC. Since then, most scholars with scientific backgrounds have proposed similar dates for these and other astronomical references. Sanskrit scholars have strongly disagreed and questioned these interpretations.

We present the correct interpretations and analyses of key astronomical references and show that they consistently lead to 3000 BC. This also allows us to examine the interpretations and analyses of Sanskrit scholars. Some of the shortcomings are due to unfamiliarity with scientific analysis. At other times, they have no understanding of the consequences of their own interpretations. For example, Sanskrit scholars are completely unaware that they have correctly interpreted verses on *Ekāṣṭaka* to 3000 BC for the last 80 years.

2. NATURE OF THE SCHEME OF NAMING MONTHS AFTER NAKṢATRAS

We first determine the correct lunar month scheme used in the Vedic period. At present, there are two lunar schemes in vogue where months are named after *nakṣatras*. In the *pūrṇimānta* (*pūrṇima-anta* or full-moon ending) scheme prevalent currently in northern India, the dark fortnight of waning moon is followed by the bright fortnight of waxing moon, lunar months end on full-moon and new-moon of every month is 15 days before full-moon. In the *amānta* (*amāvasya-anta* or new-moon ending) scheme prevalent in Andhra Pradesh, Karnataka and Maharashtra, the bright fortnight of waxing moon is followed by the dark fortnight of waning moon, lunar months end on new-moon and hence, new-moon of every month is 15 days after full-moon.

For example, the month of Māgha implies a full-moon near Māgha *nakṣatra* in both schemes. *Amānta* Māgha month ends on the new-moon that is 15 days after Māgha full-moon and *pūrṇimānta* Māgha month ends on Māgha full-moon. *Pūrṇimānta* Māgha new-moon is 15 days before Māgha full-moon and is the same as *amānta* Pūṣya new-moon. Sanskrit scholars interpreted *pūrṇimānta* and *amānta* Māgha new-moons to be those that precede and follow Māgha full-moon. The longitude [Abhyankar 1991] of Māgha λ (1950) is 149° and the position of sun at Māgha full-moon would be 180° away at 329° . Since the sun travels approximately 1° every day (360° in 365.25 days), the position of sun at *pūrṇimānta* Māgha new-moon would be 15° less at 314° and at *amānta* Māgha new-moon would be 15° more at 344° . As the position of sun at winter solstice is 270° , *pūrṇimānta* Māgha new-moon at winter solstice implies a precession of 44° and dates to 1100 BC, while *amānta* Māgha new-moon at winter solstice implies a precession of 74° and dates to 3300 BC.

Vedic and post-Vedic texts unambiguously refer to the *amānta* scheme. Contemporary references to the *amānta* scheme are *ŚB* 11.1.1.7¹ and verses on *ekāṣṭaka*. *ŚB* 11.1.2.13² and *TS* 7.5.6³ taken together also lead to the same conclusion. Later texts, *Mahābhārata* (*MB* 14.44.2), *Vedāṅga Jyotiṣā*, *Arthaśāstra* and others refer only to the *amānta* scheme. They were all composed in northern India. It is clear that the *amānta* scheme was in vogue in the Vedic and post-Vedic period in north India. The lunar New Year begins (*Ugādi*) to this day on the first day of the bright fortnight of Caitra in north and south India. It indicates that when this (*Citrāpakṣa*) calendar was adopted ~ 285 AD, the *amānta* scheme was in vogue. It is also supported by the fact that the *amānta*

scheme is referred to as *mukhyamāna* (primary) while the *pūrṇimānta* scheme is called *gaunamāna* (secondary). The *pūrṇimānta* scheme currently prevalent in north India is of recent origin, i.e. later than 300 AD.

There was an earlier lunar full-moon ending scheme with two full and new moon days in a month. Month names Tapas, Tapasya (Śísira) Madhu, Mādhava (Vasanta), Śukra, Śuci (Grīṣma), Nabha, Nabhasya (Varṣā), Iṣa, Ūrja (Śarad) and Saha, Sahasya (Hemanta) are found in *ŚB* 4.3.1.14-19, *ŚB* 8.2-8.7, *TS* 4.4.11 etc. This was a lunar (not solar) scheme as is clear from the 5-year *yuga* in *ŚB* 8.1.4.8. A solar scheme would not begin new year after full-moon, a lunar marker, and has a 6-year *yuga* (*TB* 3.10). *TS* 7.5.6 and *ŚB* 11.1.2.10-13 show that both (full-moon ending and *amānta*) schemes co-existed for some time.

A basic difference exists between the earlier full-moon ending scheme in *TS* and *ŚB* and the *pūrṇimānta* scheme currently prevalent in north India. In the former, new-year and the first lunar month began together after full-moon while in the latter, new year begins after new-moon in the middle of the first lunar month, which has already begun after full-moon. There is no evidence in Vedic texts for the new-year and months to begin at different times. Sanskrit scholars have created confusion by incorrectly interpreting Vedic verses in the *pūrṇimānta* scheme currently prevalent in north India. See also discussion on *KB* 19.3 later.

The *pūrṇimānta* scheme is also incompatible with ideas of rebirth that Sanskrit scholars believe originated in the *Brāhmaṇas* and was fully developed in the *Upaniṣads*. Keith [1920, p. 27] states “the concept of *punarṁṛtyū* implying the conception of repeated deaths from which the idea of transmigration in due course comes to full development.” The moon played a key role in the origin of this idea. *ŚB* 13.2.6.11⁴ states [Eggeling 1882] “who is it that is born again? - it is the moon, doubtless, that is born again (and again)”. *Aitareya Brāhmaṇa* AB 8.28⁵ [Keith 1920] states “The moon at the conjunction (*amāvasya*, new moon) enters into the sun...He should say at the death of the moon... From the sun is the moon born.” Clearly, the moon died on new-moon day and was reborn after new-moon. *ŚB* 1.6.4.18-20 allegorically refers to the same idea. In the new-moon ending *amānta* scheme, moon dies on the last day of the month and is reborn on the first day of the new month, while in the *pūrṇimānta* scheme, the moon dies in the middle of the month. Only in the *amānta* scheme is the lunar month aligned with the idea of rebirth of the moon. The new scheme was adopted at the same time when ideas of rebirth were gaining in importance. This strongly suggests that it was the *amānta* scheme that was adopted. Later, in the

Chāndogya Upaniṣad [Jha 1942] *ChU* 5.10.1-4⁶ (and *Bṛhadāraṇyaka Upaniṣad* 6.2.15-16), the day, bright fortnight and the northern course of the sun are the path to the world of Gods and the night, dark fortnight and the southern course of the sun are the path to the world of Fathers. Only in the *amānta* scheme, do the 1st half of all time elements, day, month and year, (day/night, bright/dark fortnight and northern/southern course of sun) correspond to *devāyaṇa* and the 2nd half correspond to *pitṛāyaṇa*. The *pūrṇimānta* scheme is in conflict with ideas of rebirth in the *Brāhmaṇas* and *Upaniṣads*. This explains the lack of evidence for the *pūrṇimānta* scheme of naming months after *nakṣatras* in Vedic texts.

3. INTERPRETATION AND ANALYSIS OF KEY ASTRONOMICAL REFERENCES IN *SAMHITĀ* AND *BRĀHMAṆA* TEXTS

The key astronomical references in Vedic texts are interpreted and analyzed below and, in addition, the interpretations and analyses of various Sanskrit scholars are also examined.

3.1 Example

We describe a simple method to determine the date of the *Brāhmaṇa* period. *Kauśītaki Brāhmaṇa* [Keith 1920] *KB*19.3⁷ states that Māgha new-moon marked winter solstice and *Śatapatha Brāhmaṇa* [Eggeling 1882] *SB* 11.1.1.7 states that Vaiśakha new-moon coincided with Rohiṇī *nakṣatra*. Keith [1920] states “*Kauśītaki Brāhmaṇa*. has several points of contact with the *Śatapatha Brāhmaṇa* (p. 37)” and “It is fair therefore to class these two texts together, especially as they often agree on points of doctrine (p-45)”. As the sequence of lunar months is Māgha, Phālguaṇa, Caitra, Vaiśakha, etc., Vaiśakha new-moon would occur three months after Māgha new-moon. In three months, the sun would have travelled 90° on the ecliptic. Since Māgha new-moon was symbolically at winter solstice (270°), Vaiśakha new-moon would correspond symbolically to 360° or 0°. *ŚB* 11.1.1.7 states that Vaiśakha new-moon coincides with Rohiṇī. Hence, Rohiṇī symbolically marked 0° (or equinox) in the *Brāhmaṇa* period. Currently, it has a longitude [Abhyankar 1991] $\lambda(1950)$ of 70°, which implies that precession of 70° has occurred since *ŚB* 11.1.1.7. At the rate of 1° precession every 72 years, *ŚB* 11.1.1.7 is 5000 years removed from present times and can be dated to 3000 BC. This method relies only on the fact

that the Māgha and Vaiśakha new-moons are three months apart. It does not depend in any manner on awareness of equinoxes. Thus, Tilak's conclusion that Rohiṇī marked equinox in the *Brāhmaṇa* period is independently confirmed.

3.2 *Kauśītakī Brāhmaṇa KB 19.3*

This verse states that winter solstice is marked by Māgha new-moon. Oldenberg [MacDonnell 1914] interpreted it in the *amānta* scheme and it is unclear if he was aware that it led to 3000 BC. Weber [MacDonnell 1914], Thibaut [1895] and Keith [1920] interpreted it as *pūrṇimānta* scheme based on the later commentary of Vināyaka. For the credibility of this method, MacDonnell and Keith [1914, p. 160] state "The references to...*pañcaka yuga*, cited by him (Zimmer) from the *Pañcaviṃśa Brāhmaṇa*, occurs only in a quotation in a commentary, and has no authority for the text itself." That is, he dismisses an opinion based on a commentary as "it has no authority for the text itself". Hence, one would imagine that Sanskrit scholars would give evidence from Vedic texts for the *pūrṇimānta* scheme. Till date none has been presented as none exists. Also, in such a case *TS 7.5.6* would not refer to both full and new moon ending months as only the full-moon ending months would suffice for both calendrical (Tapas... and Māgha...) schemes.

ŚB 11.1.1.7 states that Vaiśakhā new-moon coincided with Rohiṇī (70° , $\lambda(1950)$). If interpreted in the *pūrṇimānta* scheme, the position of sun at Vaiśakha full-moon, 15 days later, would be at 85° [Abhyankar 1991] and the position of full-moon would be at 265° , while Vaiśakhā *nakṣatra* is at 225° . That is, in the month of Vaiśakha, when the full-moon is to be near Vaiśakha *nakṣatra*, it is 40° or 80 moon diameters away which is clearly unacceptable. Thus *KB 19.3* should have been interpreted in the *amānta* scheme since Sanskrit scholars were aware of the similarities between *ŚB* and *KB*. Other evidences are described further below. Instead, they relied on Vināyaka's later commentary without providing any evidence for the *pūrṇimānta* scheme.

In 1931, Caland [1931] implicitly interpreted *KB 19.3* in the *amānta* scheme in his comments on *ekāṣṭaka*. Witzel [2001, p. 73] stated "*KB 19.2-3, however, already has amānta months*". Here is an explicit statement by a Sanskrit scholar that *KB 19.3* must be interpreted in the *amānta* scheme. This leads to 3000 BC of which Witzel is clearly unaware.

3.3 Origin of *Mahāśivarātri*

The night between the 28th-29th day of every *amānta* month is called *māsa-śivarātri* [Abhyankar 1998]. The crescent moon rises before sunrise and is its last visibility before new-moon. Observing the *nakṣatra* of the crescent moon implies that new-moon occurs in the next *nakṣatra*. The *nakṣatra* of new-moon (and sun) could be determined even though the moon was invisible. Abhyankar concludes that *Mahā-śivarātri* or *amānta Māgha śivarātri* would be the longest *śivarātri* [Abhyankar 1998] or closest to winter solstice. That is, new year began with *amānta Phālguna* month when *Mahāśivarātri* was initiated in 3000 BC.

We reach the same conclusion. *Mahāvratā* was the second last day of the year, before a full-moon or a new-moon near winter solstice. When new year was changed to begin after new-moon, as in *KB* 19.3, some *śivarātri* would precede (be the night before) *Mahāvratā* day and hence, would be *Mahā-śivarātri*. Thus, *amānta Māgha śivarātri* would precede *Mahāvratā* day. Also, to this day, *Mahāśivarātri* is considered to be a “*Mahā Vratā*”, i.e. major fast or vow day. Thus, *KB* 19.3 refers to *amānta Māgha* new-moon leading to 3000 BC. A definitive explanation follows. Keith [1920, p. 26-27] states,

“There is therefore no doubt that Aufrecht is right in his declaration that the period of the *Brāhmaṇas* was one when the old polytheism was in a condition of decline and the new faith which presents itself in Indian religious history as Śaivism was gaining ground. It is impossible not to feel in both (*Aitareya* and *Kauśitakī*) *Brāhmaṇas*, as also in the *Śatapatha*, that the figure of Rudra has a very different reality from that possessed by the more normal members of the pantheon ... The position of Rudra in the *Aitareya* is one of high importance, but more significance attaches to the names given to the god in the *Kauśitakī*. There are two of these of special importance, Mahan Deva and Isana, which, as Weber long ago pointed out, involves quite a special prominence of the deity as compared with the other gods and indeed indicates a sectarian worship.”

Clearly, Sanskrit scholars believe that Śaivism originated from Rudra in the *Brāhmaṇa* period. As *Śatarudrīya* was the most important litany to Rudra, it follows that *Mahāśivarātri* would be on the same day. “(*Śatarudrīya*) displays many features of classical Śaivism” is a recent view [Klostermaier 2007, p. 222]. Long [1972, 1983] has highlighted the bipolar nature of Rudra in *Śatarudrīya* and also of the symbolism of *Mahāśivarātri*. Even now *Śatarudrīya* is recited repeatedly [Long 1972] on *Mahāśivarātri* in Śiva temples. *ŚB* 9.1.1.44⁸ and *ŚB*

10.2.5.15⁹ show that *Śatarudrīya* was on *Mahāvratā* day. Thus, *Mahāśivarātri* or *amānta* Māgha *śivarātri* would be (the night preceding) *Mahāvratā* day in the *Brāhmaṇa* period leading to 3000 BC. (Later, *Mahāvratā* changed with the calendar, but as *Mahāśivarātri* was dedicated to Śiva, not the calendar, it has remained unchanged.) *Mahāśivarātri* didn't exist in the earlier scheme (*Tapas, Tapasya*) when new-year began after full-moon as no *śivarātri* would have preceded *Mahāvratā* day.

Long, a Sanskrit scholar, states [Long 1972, p. 34] “(*Mahāśivarātri*) is the darkest time of the year in that it comes at the darkest time of the month and at the end of the lunar year. Mythologically speaking, it is the dark night which immediately precedes the dawn of a new day, the death of the old world and the birth of the new”. Clearly, “the darkest time of the year... comes at the end of the lunar year” implies *amānta* Māgha (*Mahā-*) *śivarātri* and new-moon at winter solstice and leads to 3000 BC. Long places new year at the *Śiśira/Vasanta* transition, two months after winter solstice, which is clearly not “the darkest time of the year”. Also, new-year never started at this point in the period he suggests. His symbolism is consistent if *Mahāśivarātri* was at winter solstice and not two months later. The incorrect attribution of calendrical features to the symbolism of *Mahāśivarātri* is due to the neglect of astronomy, changes in calendrical schemes and of 19th century scholarship discussed above.

3.4 *Ekaṣṭaka*

Pañcaviṃśā Brāhmaṇa [Caland 1931] PB 5.9.1-6 and *Taittiriya Saṃhitā* [Keith 1914] TS 7.4.8 discuss the difficulties in starting *dikṣā*, consecration, lasting 12 days, on *ekāṣṭaka*. *Aṣṭaka* is the 8th day after every full-moon and *ekāṣṭaka* is the 8th day after Māgha full-moon.

Tilak's [1893, p. 47] interpretation of *ekāṣṭaka* is confusing and incorrect. He states “*ekāṣṭaka* is the day to commence the *Satra*, which lasts for one year” even though he translates the said verses to mean consecration (*dikṣā*) on *ekāṣṭaka* day. This is incorrect, as the year-long *Satra* begins 24 days after *ekāṣṭaka*, there being 12 *dikṣā* and 12 *upasad* days [Keith 1914, Caland 1931].

Thibaut [1895, p. 93] states,

“The *ekāṣṭaka* the commentators declare to be the eighth day of the dark half of Māgha, i.e. eighth day after full-moon in Māgha, the months being counted as beginning with the light half... Sūtra texts, which define

ekāṣṭaka, not merely as the eighth of the dark half of Māgha, but more definitely as the eighth day after Māgha full-moon.”

He also states (p. 93) that according to the commentators the terms “*vyasta*” and “*vicchinna*” in *TS* 7.4.8 and *PB* 5.9.1-6 “refer to the turn of the year connected with winter solstice”. From his comments on the Sūtra texts, he could have reached the obvious conclusion that new-year began after *amānta* Māgha new-moon at winter solstice. Instead, he gave two interpretations, one beginning with “If the year is viewed as beginning with Phālguni full-moon...”. This is incorrect as Phālguna full-moon at new-year belongs to the earlier scheme. His second interpretation begins with “If, as said just now, months are counted from full-moon to full-moon...”. In both interpretations, he tries to interpret verses on *ekāṣṭaka* into preconceived hypotheses (“*If...*”) and not on merits. In our view, this is an indication that he was aware of the consequences of interpreting *ekāṣṭaka* on merits. He also states (p. 93),

“As to the latter explanation I, however, must remark that it is contradicted by those Sūtra texts, which define the *ekāṣṭaka*, not merely as the eighth day of the dark half of Māgha, but more definitely as the eighth day after Māgha full-moon”.

Even as he acknowledged that Sūtra texts contradicted his (*pūrṇimānta*) interpretation, thereby accepting their authority, he would not mention dates they implied, which is truly surprising.

Clearly, he was aware that Sūtra texts implied an *amānta* interpretation of *ekāṣṭaka* and led to 3000 BC. He was the Sanskrit scholar most familiar with mathematics and astronomy and had translated the *Śulvasūtras* and Varāhamihira’s *Pañcasiddhāntikā* (astronomical treatise). He translated the *Śulvasūtras* in 1875. Seidenberg [1978, p. 304] states,

“Thibaut himself never belaboured or elaborated these views; nor did he formulate the obvious conclusion, namely, that the Greeks were not the inventors of plane geometry, rather it was the Indians. At least this was the message Greek scholars saw in Thibaut’s paper. And they didn’t like it.”

In 1899, he finally dated the *Śulvasūtras* (which codified older mathematics) to 400 BC and underplayed their mathematics. Seidenberg [1978, p. 306] states “the damage had been done and the *Śulvasūtras* have never taken the position in the history of mathematics that they deserve”.

Clearly, Thibaut deferred to the prevailing opinions of the day on the most crucial issues. His interpretation of *ekāṣṭaka*, especially, will diminish his high standing as a scholar.

Keith [1914, p. 607] interprets *ekāṣṭaka* as “the eighth day of the dark (second) half of Māgha... and this seems clearly right”, i.e. in the *amānta* scheme. However, he states “months Pūṣya and Māgha in the season Śísíra; cf Weber”. Therefore, in Keith’s interpretation (following Weber), consecration (lasting 12 days) would be spread over the *amānta* months of Māgha (in Śísíra) and Phālgua (in *Vasanta*). In this case, *Vasanta*, spring, which would be the last season of the year for which there is no evidence in Vedic texts. Also, the final bath, *avabhrata*, would be in *Vasanta*, which contradicts *JB* 2.373 that states that it would be in Śísíra. In addition, placing Phālgua in spring leads to 1200 AD.

Caland’s correct interpretation which can be inferred from his comments accompanying his translation [Caland 1931] of verses on *ekāṣṭaka* is presented below:

(a) एकाष्टकायां दीक्षेरन् (PB 5.9.1)

On the *aṣṭaka* par excellence they should undergo the consecration (*dikṣā*)

Caland’s comment (CC) - *ekāṣṭaka*- after each full-moon the eighth day is an *aṣṭaka*; the *aṣṭaka* par excellence is that *aṣṭaka* which falls after the *Māghī paurnamāsī*, i.e. one week before the beginning of the new year. Inference - New Year began after *amānta* Māgha new-moon.

(b) तस्य सानिर्या यदपोऽ नभिनन्दन्तोऽभ्यवयन्ति (PB 5.9.3)

Of this there is a defective feature that they descend into the water without delight

CC – at the *avabhrata*, the lustral bath which would fall after a year, in winter time. *JB* 2.373-*seva tu paricakṣa yad apo nabhibandantaḥ śísíre avabhrathamabhyavayanti*. Inference -final bath in Śísíra

(c) विच्छिन्नं व एते संवत्सरस्याभिदीक्षन्ते य एकाष्टकायां दीक्षन्तेऽन्तनामानावृत् भवेते (PB 5.9.4)

In regard to (a part) of the year that has been torn as under they undergo the consecration, who undergo the consecration at the *aṣṭaka* par excellence

CC-Because the *dīkṣā* would fall partly in the old, partly in the new year, the *dīkṣā*-days being twelve. Inference- *dīkṣā* would be spread over the *amānta* months of Māgha (old year) and Phālgūṇa (new-year).

(d) आर्तं वा एते संवत्सरस्याभिदीक्षन्ते येऽन्तनामानावृत्तौ अभिदीक्षन्ते
(PB 5.9.5)

They are the two seasons that are called the last (of the year) in regard to (a part) of the year that is unhappy they undergo the consecration, who undergo the consecration with regard to the two seasons that are called the last of the year.

CC-The *dīkṣā*, undertaken on the *ekāṣṭaka*, falls in the last two seasons of the year, which are to be regarded as one whole. Inference- Consecration (lasting 12 days) is spread over Hemanta and Śīśīra seasons.

In Caland's correct interpretation, *ekāṣṭaka* is the eighth day after Māgha full-moon and "one week before the beginning of the new year". This clearly shows that new-year would begin after *amānta* Māgha new-moon. Consecration, started on *ekāṣṭaka* and lasting 12 days, would be spread over the *amānta* months of Māgha and Phālgūṇa that were in seasons Hemanta and Śīśīra. He did not mean Śīśīra and Vasanta (as Keith did) and is clear from his comment on PB 5.3.9 where he quotes *Jaiminīya Brāhmaṇa JB 2.373* which states "śīśīre avabhratam", i.e. the final bath is in Śīśīra. He also quotes KB 19.3 in his comment on PB 5.9.3 and equates the coldness of water in both. Clearly, the two seasons he combines, as in Vedic texts (e.g. AB 1.1 [Keith 1920]" the seasons five through the union of winter and the cool season") are Hemanta and Śīśīra. Thus, new-year began in Śīśīra with the bright half of Phālgūṇa after *amānta* Māgha new-moon. SB 5.5.2.1-5 (Kanva SB 7.4.3.1-5) shows that Śīśīra began at winter solstice in the *Brāhmaṇa* period and even earlier [Eggeling 1882]. Hence, Caland's interpretation of *ekāṣṭaka* leads to *amānta* Māgha new-moon at winter solstice, i.e. to 3000 BC. His interpretation is also entirely consistent with the views of all Sūtra commentators.

Witzel [1984] in foot-note no.67 states "Au moment du solstice, cf. PB 5.9.1 (*ekāṣṭaka*) – traduction de Caland -, et TS 7.4.8 – traduction de Keith". Both Caland and Keith agree that *ekāṣṭaka* refers to the eighth day after Māgha full-moon and before Māgha new-moon. Both of them interpret the month of Māgha in the *amānta* scheme and consecration (lasting 12 days) to be spread over the *amānta* months of Māgha and Phālgūṇa. However, consecration is

spread over Hemanta and Śísira in Caland's interpretation and over Śísira and Phālgūṇa in Keith's interpretation. It is clear from the footnote that Witzel is unaware that Caland's (3000 BC) and Keith's (1200 AD) interpretations are different. Witzel explicitly links *ekāṣṭaka* with winter solstice which is the correct (and now unanimous) interpretation of Sanskrit scholars. That is, he places winter solstice at *amānta* Māgha new-moon which gives a date of 3000 BC. Later, he interpreted *KB* 19.3 in the *amānta* scheme [Witzel 2001] that is entirely consistent with this footnote. Over the last 25 years, Witzel's correct interpretations of *ekāṣṭaka* and *KB* 19.3 lead to 3000 BC of which he is clearly unaware. Einoo [2005, p. 102] states that "three or four *aṣṭaka* rites can be reduced to one day called *ekāṣṭaka* and coincides with the winter solstice". In his footnote #6, he states "See Falk (1986: 144-153)". It is clear from Einoo's comments that Falk, in 1986, placed *ekāṣṭaka* at winter solstice. Their interpretation leads to 3000 BC of which they seem to be unaware.

Starting from Caland (1931) to date, Sanskrit scholars have, for the last 80 years, correctly interpreted *ekāṣṭaka* to imply that *amānta* Māgha new-moon marked winter solstice. Yet, no one seems to have recognized that it leads to a date of 3000 BC. On the contrary, they believe that their interpretations are consistent with a date of 800 BC. They are also unaware that they don't subscribe to Thibaut's interpretation of *ekāṣṭaka*.

The verses on *ekāṣṭaka* are so specific that it is impossible to interpret them in any other manner. If new-year were interpreted to begin after *pūrṇimānta* Māgha new-moon, then consecration (lasting 12 days) begun on *ekāṣṭaka* would lie entirely in the *pūrṇimānta* month of Phālgūṇa and also lie entirely in the first season of the new-year. It would not span two seasons and two years as specifically stated in *PB* 5.9.1-6 and *TS* 7.4.8. Hence, verses on *ekāṣṭaka* can never be interpreted in the *pūrṇimānta* scheme. This is the reason all Sanskrit scholars have interpreted *ekāṣṭaka* in the *amānta* scheme in a manner that the *amānta* months of Māgha and Phālgūṇa belong to different seasons.

It is extremely important to note that verses on *ekāṣṭaka* are independent references to winter solstice at *amānta* Māgha new-moon. That is, even if *KB* 19.3 didn't exist, verses on *ekāṣṭaka* unambiguously imply that new-year began after *amānta* Māgha new-moon at winter solstice and leads to 3000 BC. To be consistent with *ekāṣṭaka*, *KB* 19.3 must be interpreted in the *amānta* scheme. None of the Sanskrit scholars (except Caland?) seem to be aware that both

ekāṣṭaka (implicitly) and *KB19.3* (explicitly) refer to the same new year. In the correct interpretation of *ekāṣṭaka*, *Mahāśivarātri* would precede *Mahāvratā* day in the *Brāhmaṇa* period, which confirms the conclusion reached earlier in section 3.3.

3.5 *Kauṣītaki Brāhmaṇa KB 5.1*¹⁰ and *Śatapatha Brāhmaṇa ŚB 6.2.2.18*¹¹

These verses state that Pūrva Phālgunī full-moon was the last day of the year and Uttara Phālgunī full-moon was the first day of the new-year. The former marked full-moon day (see section 4.4). According to Sanskrit scholars (e.g. Eggeling 1882), *Śatapatha Brāhmaṇa* is a composite text and Books 1-5 and 6-9 are different sets and are attributed to Yajñavalkya and Sandilya respectively. *ŚB 8.7.1.8 (Bk 8)* states that Śīsira is the head of the year. Since Śīsira always began at winter solstice, it implies that *new-year* began after winter solstice in *ŚB 6-9*. Thus, Pūrva Phālgunī full-moon in *ŚB 6.2.2.18* (part of *ŚB 6-9*) marked winter solstice. (Only in the later *ŚB 10.4.5.2* is spring the head of the year). The position of sun at Pūrva Phālgunī full-moon would be 340° or 180° from Pūrva Phālgunī at 160° , λ (1950) [Abhyankar 1991]. At winter solstice the position of sun is 270° . That is, a precession of 70° has occurred and at the rate of 1° precession every 72 years, these verses date back 5000 years or to 3000 BC.

Contemporary references prove that new-year in *KB 5.1* and *ŚB 6.2.2.18* began at winter solstice. *JB 2.373* (quoted by Caland [1931] on *ekāṣṭaka*) clearly implies that the month of Phālgunā began at winter solstice. From *ŚB 11.1.1.7*, as seen earlier, the longitude of sun at Vaisākha new-moon would be the same as Rohiṇī *nakṣatra* λ (1950) at 70° . The position of sun at Māgha new-moon in *KB 19.3* that would be three months earlier would be 90° less at -20° or 340° . As seen above, the position of sun at Pūrva Phālgunī full-moon is 340° . That is, both give the same position of the sun. Since *KB 19.3* clearly refers to Māgha new-moon at winter solstice, it follows that Pūrva Phālgunī full-moon also was at winter solstice. Thus, it is possible to prove from contemporary references, *JB 2.373* and *ŚB 11.1.1.7*, that Pūrva Phālgunī full-moon in *ŚB 6.2.2.18* and *KB5.1* coincided with winter solstice.

We can now understand why there are two different references to new-year beginning at winter solstice. *KB 5.1* and *ŚB 6.2.2.18* refer to two full-moon days which clearly indicates that the reference to Pūrva Phālgunī full-moon marking

new-year belonged to an earlier scheme when months were named *Tapas*, *Tapasya* etc. However, it had no meaning when the new scheme of naming months after *nakṣatras* was adopted. It became necessary to have a new reference (Māgha new-moon in *KB* 19.3) to mark new-year. This explains why there are two different references to new-year which refer to the same position of the sun.

Mainstream Sanskrit scholars (e.g. weber) have interpreted *KB* 5.1 and *ŚB* 6.2.2.18 to imply new-year began at spring. They are unaware that it would lead to a date of 1200 AD. At beginning of spring, two months after winter solstice, the longitude of sun would be 330° while the longitude of sun at Pūrva Phalguṇi full-moon is 340° in 1950 AD [Abhyankar1991]. That is, a precession of 10° has occurred by 1950 and the verses were composed 720 years ago around 1200 AD. Clearly, this date is wrong. It also contradicts their interpretation of *ekāṣṭaka* and especially *JB* 2.373 according to which the month of Phalguṇa is the first month of Śísira (after winter solstice) and not spring. Yet another flaw is that it implies that sun was in Uttara-Āṣāḍa *nakṣatra* at winter solstice. But sun was in Dhañiṣṭhā at winter solstice in *Vedāṅga Jyotiṣa*. That is, *Brāhmaṇa* texts would be centuries later than *Vedāṅga Jyotiṣa* of which there is no possibility. It follows that Pūrva Phalguṇi full-moon marked winter solstice and not spring. A very important fact that emerges is that it is impossible to date *KB* 5.1 and *ŚB* 6.2.2.18 anywhere near 800-1000 BC and the only choices are 3000 BC (winter solstice) or 1200 AD (spring). This completely rules out the conventional date of 800 BC for *Brāhmaṇa* texts.

3.6 Śatapatha Brāhmaṇa ŚB 2.1.2.3¹²

This verse states “Kṛttikās do not deviate from the eastern direction while all other *nakṣatras* deviate from the eastern direction”. Dikshit [Dikshit 1895, pp. 245-46; Achar 2000] states,

“Now, since in popular language all *nakṣatras* rise in the east and set in the west, we cannot understand the above description of the Kṛttikā in the popular sense; for in that case their appearance in the east cannot be contrasted with the other *nakṣatras*. We must, therefore, interpret the passage to mean that the Kṛttikā were always seen due east; while other *nakṣatras* were observed either to the right or to the left of this point. Translated into modern astronomical language this means a great deal. It means that in those days the Kṛttikā were on the equator, or that their declination was nil, when the passage was composed”.

This leads to a date of 3000 BC (zero *declination*) and not 2300 BC (zero *longitude*). *Taittiriya Brāhmaṇa TB* 1.1.2.1 states that Kṛttikā is the “mouth of the *nakṣatras*”. *TB* 1.5.2.7 describes Kṛttikā to Viśākha as Deva *nakṣatras* and from Anurādhā to Bharanī as Yama *nakṣatras*.

Filliozat [1969, p. 125] has discussed similar divisions found in Buddhist texts and suggested that they are memories of an ancient era when Kṛttikā was indeed on true east. He states,

“It is certain, as S.B. Dikshit and B.G. Tilak have amply emphasized, that it is only thus that one can interpret the statement in *ŚB*. In spite of the systematic doubt from Thibaut, Whitney ... and other authors, who have refused to accept a conclusion arrived at by Dikshit and Tilak, the ancient dates attributed to some Vedic texts, referring to the Pleiades [Kṛttikā], and not only the text of the *ŚB*, but also the Buddhist lists ... point to a real determination of the vernal equinox and of the movement of the Sun through Pleiades.”

Thus Filliozat concludes that *ŚB* 2.1.2.3 indeed reflects Kṛttikās on true east. He continues that centuries later, when Kṛttikās were no longer in true east, “The substitution of mathematical *nakṣatras* in place of real constellations masked for a time the out of date character of the traditional conjunctions”. Clearly, he also accepts the reference in *Viṣṇu Pūrāṇa* 2.8 that states that equinox occurred in an ancient past (i.e. with respect to *Viṣṇu Pūrāṇa* period) when the sun was in the Kṛttikā segment, which is clearly a memory of past observations.

As is well known, the religious tradition is unconcerned about dates. For the religious tradition, commentaries of Sāyana (~ 1400 AD, Vijayanagar empire) are the most authoritative, even the last word. Western scholars relied heavily on Sāyana’s commentaries when they translated Vedic texts into European languages. Kochhar [1997, p. 22] calls his commentaries a “pre-science age interpretation” and states “Such works as Sāyana’s are of great value today because they were composed in unselfconscious times”. That is, Sāyana’s interpretations were based on the religious traditions and he was unaware of their (later) scientific uses. While Kochhar’s comments are in regard to Sāyana’s commentary on *Rgveda*, clearly they are also applicable to his commentary on *Śatapatha Brāhmaṇa*. Regarding *ŚB* 2.1.2.3, Sāyana [Achar 2000] states “*śuddha prācyam avodyanti*” i.e. they rise in the true east. This indicates that the religious tradition has always interpreted *ŚB* 2.1.2.3 in a manner that leads to 3000 BC while being unaware and unconcerned about dates.

The response of early Sanskrit scholars was to raise doubts that Kṛttikās were on true east as there was no explicit evidence of equinoxes. Later scholars ignored Filliozat's paper. There are also non-serious proposals that the eastern direction is to be interpreted as any direction from north-east to south-east. They have not proposed a convincing explanation for ŚB 2.1.2.3 or the list of *nakṣatras* starting with Kṛttikā in various texts.

We confirm that Kṛttikās were on true east. The special status of Kṛttika is evident from several verses in *TB* (quoted above). Also *TS* 4.4.10¹³ states [Keith 1914] "(Thou art) Kṛttikās, the *Nakṣatra*, Agni, the deity; ye are the radiances of Agni, of Prajāpati, of the creator, of Soma; to the Re thee, to radiance thee, to the shining thee, to the blaze thee, to the light thee. (Thou art) Rohiṇī the *Nakṣatra*, Prajāpati the deity, Mṛgaśīrṣa the *nakṣatra*, Soma the deity..." An entire verse is dedicated to Kṛttikā. For all other *nakṣatras*, only the deity is mentioned. The special status of Kṛttikā is clear beyond doubt and only its nature needs to be determined. Kṛttikās are the radiances of not just *Agni*, the deity of Kṛttikā, but other Gods (Prajapati, Soma etc.) as well, even though they are deities of other *nakṣatras*. This is only possible if Kṛttikās were considered to be heaven, where Gods other than Agni were also present and contributed to its radiance, light etc. This is confirmed by *TS* 5.3.9¹⁴ that states [Keith 1914]" For all the Gods is the fire piled up... By the fire the Gods went to the world of heaven; they became yonder Kṛttikās". *TS* 5.3.9 explicitly states that all the Gods went to Kṛttikās. The special status of Kṛttikā is now clear; it was Heaven in *Taittirīya Saṃhitā*.

Vedic ritual fire altars were built symmetrically about the east-west axis, *prāci*. This was of great importance and Heesterman [1993, p. 51] states "the west-east line from *gārhapatyā* to *ahāvaniyā*... is the line leading straight to heaven". For going to heaven, the altar (shown schematically in Fig.1) in the form of "the shadow of a falcon about to take wing" was preferred [Seidenberg 1978, p. 320] because (*TS* 5.4.11) "He who desires heaven may construct the falcon shaped altar; for the falcon is the best flyer amongst the birds; thus he (the sacrificer) having become a falcon himself flies up to the heavenly world". It is clear that the bird that is "about to take wing" would symbolically fly eastwards along the east-west axis to heaven. It is now important to remember that *TS* 4.4.10 and *TS* 5.3.9 state that heaven was Kṛttikā. That is, the bird would symbolically fly along the east-west axis to Kṛttikā. Hence, Kṛttikā was on true

east in the *Samhitā* period. This is an independent confirmation of the interpretation of *SB* 2.1.2.3 as *Kṛttikā* rising on true east, leading to a date of 3000 BC.

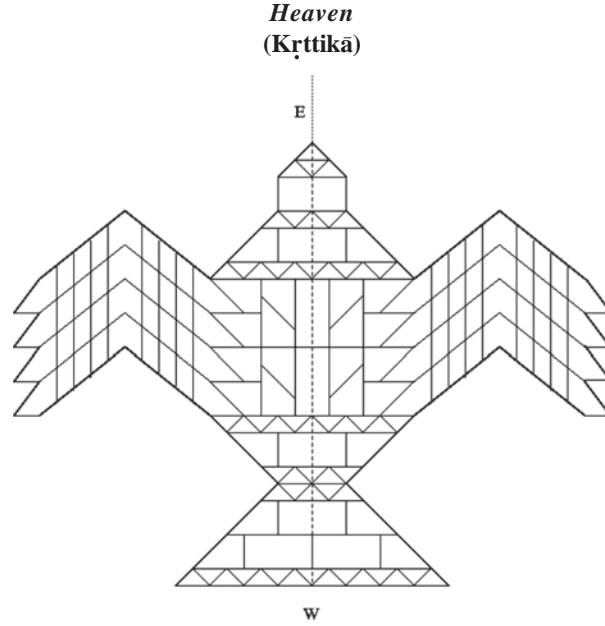


Fig. 1. Schematic of a bird shaped altar. For a better perspective of the basic and bird shaped altars, see Vatsyayan [1983] Fig.5 and Fig.6 respectively

We summarize the deficiencies in the interpretations of Sanskrit scholars.

- 1) They are unaware that *KB*19.3 and *SB* 11.1.1.7 together show that *Rohiṇī* symbolically marked vernal equinox (0°) in the *Brāhmaṇa* period and leads to 3000 BC.
- 2) They have interpreted *Māgha* new-moon in *KB* 19.3 in the non-existent *pūrṇimānta* scheme without providing any evidence from contemporary texts. In contrast, *SB*11.1.1.7 and verses on *ekāṣṭaka* are clear contemporary evidences for the *amānta* scheme.
- 3) Given their consensus that *Śaivism* originated in the *Brāhmaṇa* period, they have not discussed the origin of *Mahāśivarātri*. The origin of *Mahāśivarātri* can be dated to 3000 BC based on its symbolism as well as on astronomical grounds.
- 4) They are unaware that their correct interpretation of *ekāṣṭaka* leads to 3000 BC.
- 5) They are unaware (except for Caland?) that verses on *ekāṣṭaka* and *KB* 19.3 are independent references to the same event, i.e. winter solstice at *amānta* *Māgha* new-moon.
- 6) They are unaware of the contradiction in their interpretation of *KB* 19.3 and *ekāṣṭaka* where they

place *pūrṇimānta* and *amānta* Māgha new-moons respectively at new-year. 7) They are unaware that they don't subscribe to Thibaut's interpretation of *ekāṣṭaka* even as they refer to his work to date verses to 800 BC. 8) They are unaware that Caland's unanimously accepted and correct interpretation of *ekāṣṭaka* implies that Pūrva Phālgunī full-moon in *KB* 5.1 and *ŚB* 6.2.2.18 marked winter solstice and not spring. 9) Their interpretation that Pūrva Phālgunī full-moon marked spring leads to 1200 AD and makes *Brahmaṇa* texts centuries later than *Vedāṅga Jyotiṣa*. 10) They are unaware that *KB* 5.1 and *ŚB* 6.2.2.18 can only be dated to either 3000 BC or 1200 AD and it is impossible to date them to 800-1000 BC. 11) They have denied the natural interpretation of *SB* 2.1.2.3 without proposing a convincing alternative. 12) Their interpretations of various astronomical references give dates that range from 3000 BC to 800 BC to 1200 AD while they believe that they lead to 800 BC.

4. UNCERTAINTIES IN OBSERVATIONS

Nowhere is the lack of scientific background of Sanskrit scholars more acutely evident than in estimating errors in observations. The wrong impression created by them, which persists even today, bears no resemblance to reality. They were of the view that observations were of no great importance in the Vedic period and consequently suggested large errors in measurements, without actually quantifying these errors. For example, Thibaut [1895, p. 99] states,

“Of what accuracy of observation the early Hindus may be supposed to have been capable... anything, like a fairly accurate fixation of the sun's place among the stars at the winter solstice, cannot be imagined to have been accomplished by people who had no approximately correct notion of the length of the year; the knowledge of one cannot be separated from that of the other”.

Similar comments persist in the views of western scholars till date and will be discussed in detail here and later.

Firstly, it equates the length of the year used in rituals with that actually measured and even then it is incorrect as seen below. Secondly, because they used the length of the year used in rituals, no attempt was made to estimate errors in the known methods of observations, which is the correct method. Thirdly, their views completely ignore the great importance of measurements in Vedic ritual and are contradictory to the views of various specialists.

4.1 Accurate length of the year in rituals

Kak [1993] has highlighted the accurate length of year in book 10 of *ŚB* on *Agnirahasya*. *ŚB* 10.2.4.1 states [Eggeling 1882] “Prajāpati, indeed, is the year”. *ŚB* 10.2.4.3 states “this year is the yonder sun”.

ŚB 10.2.3.18 states [Eggeling 1882, p. 312]

“Sevenfold, indeed, was Prajāpati created in the beginning. He went on constructing (developing) his body, and stopped at the one hundred and one fold one. He who constructs one lower than a 7-fold one cuts Father Prajāpati in twain: he will be the worse for sacrificing as one would be by doing injury to his better. And he who constructs one exceeding the 101-fold steps beyond the universe, for Prajāpati is this universe. Hence, he should first construct the 7-fold altar, then the next higher up to the 101-fold, but he should not construct one exceeding the 101-fold one, and thus, indeed, he neither cuts this Father Prajāpati in twain, nor does he step beyond this universe”.

ŚB 10.2.4.7 states “101-fold passes into the 7-fold one and the 7-fold one passes into the 101-fold”. Since Prajāpati is explicitly referred to as the solar year and the 7-fold Prajāpati passes into the 101-fold and vice versa, they undoubtedly refer to a 95 solar year cycle as pointed out by Kak [1993]. The severe admonition that one should not construct less than 7-fold or more than 101-fold Prajāpati highlights the great significance of the 95-year cycle. The single solar year, Prajāpati, is linked to a 95-year cycle, which appears curious at first. As is well known, the 5-year cycle was used to reconcile lunar months with the solar year by adding intercalary months. The 95-year cycle reconciles lunar months with the solar year and gives an accurate length of the year (~365.25 days), same as the 19-year Metonic cycle (~400 BC), only about 2500 years earlier.

Abhyankar [2002] has pointed out that the 95-year cycle was derived as a correction to the 5-year cycles. The 19-year cycle is unknown in Vedic rituals.

However, we stress that it does not definitively follow that it was unknown in the Vedic period. Incorporating the 19-year cycle in rituals would imply discarding the 5-year cycle that would be difficult because of its ritual importance. The only way to incorporate both would be through the 95-year cycle. Hence, the question of whether the 19-year cycle was observed will remain unanswered as *ŚB* book 10 only refers to the 95-year cycle.

4.2 Error in solstices and true east from observations of sunrise

From the symmetry of the *Gavāmayana* [Eggeling 1882, Keith 1920], it is clear that solstices were placed in the middle of the period when the sun was observed to be stationary. That is, solstices were determined by observing the course of the sun, which could be by observing sunrise and/or the shadow cast by the sun. Importantly, from *KB* 19.3, which records the movement and also the stationary positions of the sun, it is clear that the position of sunrise was observed relative to a marker. The position of sun at sunrise can be determined by the well-known formula $\cos A = \sin \delta / \cos \phi$, where A is the azimuth, δ is the declination of the sun and ϕ is the latitude. Using tables that give the declination of the sun [Sanford] allows the rising point of sun to be determined on every day of the year. For example, on Dec.7 the rising point is 26.26° south of east. On Jan.2, it is 26.80° south of east, which is one sun diameter away from the position on Dec.7. With this error, winter solstice is determined as Dec.19 or Dec.20. Thus, even a large error of the diameter of the sun in observing the return position of the sun leads to an uncertainty of 2 days in determination of winter solstice. Readers (especially scholars who suggest large errors without substantiation) are welcome to determine winter (or summer) solstice by direct observation of sunrise (or sunset) to convince themselves that it is impossible to determine solstices to an error of more than 3 days. Sunrise 91 days later would be true east in this method. Observations of sunrise only for a few months lead to true east within 2° . Errors in observations cannot shift a date of 3000 BC to 800 BC which requires 30 days error in determination of winter solstice or 12° error in determination of true east. Sanskrit scholars are completely unaware that their suggestions demand impossibly large errors.

4.3 Evidence for the use of gnomon in the *Brāhmaṇa* period

Another disputed issue is the use of the gnomon in the *Brāhmaṇa* period, which would lead to accurate measurements. *AB* 4.18¹⁵ states [Keith 1920] that the sun was at the highest point in the sky on summer solstice. It is impossible to conclude that the sun was at the highest point by looking at it directly. It can only be concluded by observing the shadow cast by the sun, which would be the smallest on summer solstice. For this reason, *AB* 4.18 was interpreted to imply the existence of a gnomon by P.C. Sengupta, Meghnad Saha and others. Yet scholars who support AIT have denied its existence without explaining *AB* 4.18.

Some of the confusion seems to be due to the gnomon's close association with the Indian Circle method [Malville 2008] used to determine cardinal directions. This method allows true east to be determined on any given day using a gnomon. There is no evidence for this method in *Brāhmaṇa* texts. However, the development of the Indian circle method presupposes the use of a gnomon and observation of its shadow. We present new evidences that leave no doubt that the gnomon was used to track the course of the sun in the *Brāhmaṇa* period, including in *AB* 4.18. This does not imply knowledge of the Indian circle method in this period.

The association of the *yupa* with the sun is well known in *Ṛgveda* and *Brāhmaṇa* texts. For example, *AB* 5.28¹⁶ states [Keith 1920] that “the sacrificial post (*yupa*) is the yonder sun”. A similar statement “*ādityo yupaḥ*” is made in *TB* 2.1.5.2. Irwin [1976, p. 740] states,

“In the *Ṛgveda* and *Brāhmaṇas*, the idea of the sun uniting with the top of the cosmic pillar at midday is implied rather than stated – for instance, by the crowning of the *yupa* with a sun-symbol in the form of a wheel-like headpiece called *caśala*, which can be proved to be a sun-symbol by later inscriptions”.

This symbolism could only have been developed if the course of the sun was observed with a post and confirms the use of gnomon in *AB* 4.18. Snodgrass [1985 p. 164] states “The sacrificial post which is specifically identified with the Dawn...” which clearly implies that it was used to observe sunrise. The most direct evidence, however, comes from *Atharva Veda AV* 4.24.4¹⁷ that is dedicated to Indra and “for whom, as sun-finder, the sacrificial stakes are erected” [Proferes 2003, p. 345] which leaves no doubt that the *svaru* (stake/pillar) was used to track the course of the sun. Proferes [2003] further states “...whatever ritual elements are mentioned alongside the *AV* occurrences of *svaru* are attested at an earlier stage than the extant *Yajur Veda saṃhitā*, *brāhmaṇa* and *sūtra* rites”. Thus, there is no doubt whatsoever that a gnomon/pillar was used to determine the course of the sun in the *Brāhmaṇa* period.

It is well known that the gnomon would lead to very accurate measurements [Malville 2008] (see section-5). The shadow of the pillar/post near or on summer and winter solstice days would be 27° south and north of east. Taking the mid-point, which was possible from the knowledge of geometry in *Brāhmaṇa* texts, would lead to a determination of true east to within 1°, especially as the shadows at solstices would be stationary for days near solstices. In contrast, an error of 12°, approximately half the sun's movement of 27°, in determination of true east leading to a date of *ŚB* to 800 BC can be easily ruled out.

4.4 Evidences for careful observations and non-obvious inferences

There are also several evidences of careful observations and non-obvious inferences. In the earlier *Brāhmaṇa* period with months named Tapas, Tapsaya etc. there were two new and full moon days in a month. They have been described [Ohashi 1993, p. 195] in *Sankhyayana Srauta sūtra* (SSS 1.3.3-6) as

“There are two days of full moon and two days of new moon. The two days of full moon are: (1) the day on which the moon appears full about the setting of the sun and (2) the day on which (it appears full) after the setting of the sun... The two days of new moon are (1) the day on which they remark ‘tomorrow it will not be visible’ and (2) the day on which it is not visible”

Clearly, the second new moon day corresponds to new moon (conjunction) and the first full moon day corresponds to full moon (moon 180° opposite to the sun). See also footnote on *ŚB* 6.2.2.18 [Eggeling 1882]. Ohashi [1993, p. 196] states,

“we can see that the date of new and full moon was determined very carefully. Especially the date of full moon was determined by the observation of the rising time of the moon as well as the lunar phase. Therefore, the date of full moon could be determined fairly accurately. It is also seen from the determination of new-moon that the vanishing crescent moon was carefully observed at dawn.”

Several other evidences are given below. Tilak [1893] pointed out that *TB* 1.5.2.1 showed that the heliacal rising of *nakṣatras* was observed. We provide additional confirmation from *TB* 3.1.3 that states [Dumont 1954] “Along (with Dawn and Sun) ascending, the *nakṣatra* is ascending, at the shining forth of thee, O Dawn, and of the Sun”. The basic approach is described [Iyengar 2005, p. 147] in *TA* 1.2.1 as “Memory (of past records), direct observation, anecdotes and inference form the quartet. With these, Sun’s circle is understood by all”. The 95-year cycle in *ŚB* Book-10 is proof of careful observations over long periods.

Some non-obvious inferences are *TS* 3.4.7 [Kak 1993] that refers to the moon as *sūrya raśmi* (lit by sunlight) and *AB* 3.44 “the sun never really rises or sets”. Speyer [1906, p.727] states on the latter,

“The interest of it consists in the fact that we have here a very early endeavour of Indian thought to explain physical phenomena by means of pure reasoning, by *tarka*, without the usual metaphysical or theosophical bias.”

We present another such example. *KB* 3.1¹⁸ states [Keith 1920] “He should fast on the second (new moon day), on the second the ocean swells in accordance with the moon, its deity.” As seen above, the second new moon day corresponds to the conjunction. Thus, *KB* 3.1 is a reference to spring tides that is attributed to the moon. If the swell of the ocean was linked to the phases of the moon with the maximum at full-moon, as in *Viṣṇu Purāṇa* (*VP* 2.4), it would have been less surprising as the moon was visible. In *KB* 3.1 spring tide at new moon is attributed to the moon even though it is invisible. It is a non-obvious inference and is superior to that in the much later *VP* 2.4 whose hypothesis implies that ocean would not swell at new moon. It is another evidence of explaining natural phenomena without the theosophical bias. This becomes clear since theologically the moon died on new-moon day. More broadly, the moon’s influence on the oceans has been recognized by making it their deity. The above evidences point to a tradition of careful observations and inferences as stated in *TA* 1.2.1 [Iyengar 2005]. The opposite views of Sanskrit scholars indicate a lack of awareness.

4.5 A new method to date the *Brāhmaṇa* period by including uncertainties in observations

We describe another method to estimate the dates that includes uncertainties in observations. The ecliptic longitudes λ (1950) of Māgha, Pūrva Phālgunī and Uttara Phālgunī are $149^\circ 08'$, $160^\circ 37'$ and $170^\circ 55'$ respectively [Abhyankar 1991]. That is, the differences are $\sim 11^\circ$ between Māgha and Pūrva Phālgunī and between Pūrva and Uttara Phālgunī. In *KB* 5.1 and *ŚB* 6.2.2.18 (section-3.5), Pūrva Phālgunī full moon was the last day of the year. Let us consider one year (option-1) where full-moon-1 would be in conjunction with Pūrva Phālgunī. Then full-moon-2 would be very close to Uttara Phālgunī as the moon travels slightly more than 13° every day. One lunar year or 354 days later, full moon-1 and full-moon-2 would occur 11° away. But this means (option-2) that full-moon-1 would be in conjunction with Māgha and full-moon-2 would be close to Pūrva Phālgunī. This is a crucial point. The decision between the two options had to be made consciously. In all Vedic texts only the first option is mentioned. This can only be understood if it is recognized that winter solstice was independently determined. At winter solstice, Pūrva Phālgunī would have been observed to rise at sunset. Whenever a full-moon was observed close to Pūrva Phālgunī, it would be very close to winter solstice. On the other hand, whenever a full-moon was observed close to Māgha, it was not winter solstice. Since the difference in

longitudes is 11° , it implies a maximum uncertainty of $5\frac{1}{2}^\circ$. If more, Māgha full-moon would be closer to winter solstice than Pūrva Phālgunī full-moon and the option-2 would be preferable. This results in a combined maximum error of $6\frac{1}{2}^\circ$ or 450 years from the exact date. Since Pūrva Phālgunī full-moon at winter solstice in *KB* 5.1 and *ŚB* 6.2.2.18 leads to 3000 BC, this method dates the *Brāhmaṇa* period to 2500-3500 BC.

5. IMPORTANCE OF MEASUREMENTS

Sanskrit scholars are unaware that errors have to be impossibly large to shift dates from 3000 BC to 800 BC. They have also overlooked the ritual need for exact measurements. The fire altars for the *Agnicayana* ritual, *ŚB Bk6-10*, were built with great precision. Staal [1983, p.16] states that

“the extent of specialized knowledge needed to put the altar together ritually is on a par with the technical knowledge required to build an aeroplane”. Seidenberg [1978] states “the *Śatapatha Brāhmaṇa* shows that it is concerned with, or rather, takes for granted, exact constructions ... The ritual in general was to be carried out exactly.”

The obsession with exactness can be seen from his (a Professor of Pure Mathematics) comment [Seidenberg 1978] “The excess, though minute, is just the kind of difference that would loom large in the eyes of a modern mathematician and of an ancient ritualist”.

Malville [2008, p.48] states

“The achievement of such extraordinary accuracy in locating the north-south axis of certain Hindu temples and cities results from two reinforcing themes in Indian architecture. Not only were techniques developed for precision measurement of the sun, but there was a robust religious support for such precision. The very act of measurement was understood to be a re-enactment of creation. In Hindu tradition, Prajāpati, who is the Year, measures the world, both in space and time, with his eye, the sun... Recognition of the role of measurement in cosmogony extends far back into the past time of India. The Vedic altar was reconstructed each year... as a symbolic reconstruction of Prajāpati, the Year... The importance of precise orientation and measurement in construction of the temple reveals the cosmogonic symbolism involved in the act... In the gnomon we encounter the remarkable union of a technical device used to determine true cardinality with a powerful cosmogonic symbol”.

They occur in a section titled “Measurement as Ritual” which alone highlights the great importance of measurement in Vedic ritual. He also states [Malville 1995] “Not just temples, but cities in India have been built mindful of the importance of precise measurement.”

Vatsyayan [1983, p. 23-27] states,

“The Vedic and *Brāhmaṇaical* concept of *Yajña* (i.e. *Agnicayana*)...we encounter here the same concern with the cosmos, the microcosm and macrocosm, with the ultimate objective of establishing a communication between the finite and infinite, the precisely measured defined by shape and form and that beyond definition, the formless... *Yajña* is not a simple sacrifice but is instead a meticulously and assiduously constructed system of correspondence and identifications between concrete physicality and abstract metaphysics...Measurement is of essence and it assumes a symbolic value throughout the *Yajña* both in ground space and in structures requiring elevation. Through the finite measure correspondences are established between annual time and cosmic time...There can be no place here (*Agnicayana*) for subjectivity per se...”

Clayton [2000, p.12] states,

“Indian music theory historically shows a strong preference for the accurate and unambiguous measurement of time. This principle seems to derive from the role of music as a religious act analogous to and to some extent derived from the Vedic ritual”. He quotes Rowell [1988, p. 141] as “Like earlier Vedic rituals, from which it may have sprung, the performance of *gandharva* was considered a sacrifice. The ritual actions, text, poses, dancing, miming and music were specified in unusual detail, and precise performance was required in order for the production to achieve its objective – *adr̥ṣṭa phala* (unseen benefit)...”

Clayton [2000, p. 13] continues

“according to traditional Hindu philosophy, the production of sound and the measurement of time are inextricably linked to each other and to the functioning of the universe. Little wonder then that the measurement of time has played an important part in Hindu ritual, or that music theorists through the ages should have given such a prominent place to questions of time measurement”.

These are views of scholars with different interests, from mathematics and astronomy to architecture, sculpture and performing arts. They are all in agreement that the Vedic ritual [esp. *ŚB* Bk 6-10, *Agnicayana*] demanded that measurements be exact and its importance was such that “Measurement (w) as Ritual [Malville

2008]”. Hence, the clear references to a 95-year cycle [Kak 1993] in *ŚB* Bk10 (section-4.1) imply a very specific objective. Nothing in *ŚB* Bk10 is without a specific purpose. As Vatsyayan [1983] states “There can be no place here for subjectivity per se ...” The only possible conclusion is that it refers to a year of 365.25 days. Thus, it is clear that the accurate year of 365.25 days was not an aberration or an exception but a consequence of the ritual emphasis on exactness, others being origin of mathematics etc. Sanskrit scholars suggest the opposite extreme i.e. impossibly large errors. This is due to a lack of appreciation of the importance of measurement in Vedic ritual in addition to an inability to scientifically assess uncertainties in observations.

6. DISCUSSION

Clearly, Sanskrit scholars have no real understanding of astronomical references in Vedic texts. Their interpretations lead to dates from 3000 BC to 800 BC to 1200 AD. They have also wrongly suggested extremely large errors without assessing errors in known methods of observations. Klostermaier [2007, Ch1, p. 25], states,

“Traditionally trained philologists, that is, grammarians, are generally not able to understand technical language and the scientific information contained in the texts they study”.

Sanskrit scholars must collaborate with scientists and propose consistent interpretations.

On *Kṛttikā*s being on true east, Witzel [2001, p. 72] raises another objection as,

“However, even if one admits that the sentences quoted above refer to contemporary observation and have been transmitted as such over several millennia, a serious problem remains: the advocates of the autochthonous theory, unwittingly, commit the rather common but no less serious mistake of dating a text according to a single early fact mentioned in it... Texts contain reminiscences and archaic words and concepts; we can only date them by their latest, not their earliest datable features... If *ŚB* 2.1.2.3 indeed would indicate the spring equinox in *Kṛttikā*, then this may very well be a popular or learned remembrance of times long past...”

As shown in section-3.6, *TS* 5.3.9 and *TS* 4.4.10 refer to *Kṛttikā* as heaven, which was always along the east-west axis. Clearly, *Kṛttikā* was on true east in the *Samhitā* period. *Kṛttikā* would not be referred to as heaven in 800

BC when it would rise 12° off true east, especially in the context of *Agnicayana*, well known for its obsession with exactness. As Thibaut stated [Seidenberg 1978, p. 304]

“what-ever is closely connected with the ancient Indian religion must be considered as having sprung up among the Indians themselves, unless positive evidence of the strongest kind point to a contrary conclusion”.

The second evidence is the change of the lunar month scheme from one that was counted from full-moon (*Tapas, Tapasya ...*) to one that was counted from new-moon (Māgha, Vaiśākha...). Witzel states [2001, p. 73] “in *TS 7.4.8* and *KB 4.4...* the months are *pūrṇimānta*. *KB 19.2-3*, however, already has *amānta* months”. Clearly, the *amānta* scheme was introduced in the late *Brāhmaṇa* period. Hence, it is not “a popular or learned remembrance of times long past” but is the “latest, not earliest datable feature”. Witzel’s own interpretation of *KB 19.3* [Witzel 2001] and *ekāṣṭaka* [Witzel 1984] leads to 3000 BC. The third evidence is that *ŚB 11.1.1.7* states that Vaiśākha new-moon coincides with Rohiṇī. This is in the new *amānta* scheme and shows that Rohiṇī marked equinox (3000 BC) in the *Brāhmaṇa* period. *Mahāśivarātri* can only be understood in the new (*KB 19.3*) scheme and also leads to 3000 BC. Witzel’s comment that *ŚB 2.1.2.3* is a “remembrance of times long past” is incorrect. Several references, which have always been considered contemporary, lead to 3000 BC.

As discussed in detail earlier, verses on *ekāṣṭaka* are very specific and don’t permit any alternate correct interpretations. In addition, they are part of a larger whole where 1) verses on *ekāṣṭaka*, 2) the festival of *Mahāśivarātri* and 3) *Kauśītakī Brāhmaṇa KB19.3* are three independent references to three different days, all of which point to new-year beginning after *amānta* Māgha new-moon at winter solstice (3000 BC). Thus, the conclusion that *amānta* Māgha new-moon marked winter solstice in the late *Brāhmaṇa* period is very robust with three independent references pointing to it. Any alternate interpretation to 800 BC must consistently explain all three references taken together as well, a virtually impossible task. Sanskrit scholars have always considered all the three to be contemporary to the *Brāhmaṇa* period, not ancient memories. Clearly, these and other references conclusively prove that the Aryan Invasion theory is incorrect, especially since it appears virtually impossible to reinterpret them consistently to 800 BC.

7. CONCLUSION

Several astronomical references in *Samhitā* and *Brāhmaṇa* texts consistently lead to 3000 BC. Independent confirmation that Rohiṇī marked equinox and Kṛttikā was on true east in this period is presented. References to Purva Phālgunī full-moon marking new year can only be dated to 3000 BC (new year at winter solstice) or 1200AD (new year at spring) and nowhere near 800 BC. The Aryan Invasion Theory proposed by western Sanskrit scholars is proved to be wrong by their correct and unanimous interpretation of *ekāṣṭaka* to 3000 BC for the last 80 years. Verses on *ekāṣṭaka* are so specific that an alternate correct interpretation is most unlikely and also explains the unanimity among Sanskrit scholars. Verses on *ekāṣṭaka*, *KB* 19.3 and *Mahāśivarātri* all refer to the same feature, *amānta* Māgha new-moon at winter solstice (3000 BC), making it a very robust conclusion. Impossibly large errors are needed to date these references to 800 BC. Western Sanskrit scholars are unaware that their interpretations lead to dates ranging from 3000 BC to 800 BC to 1200 AD. They should have rejected AIT 80 years ago following Caland's correct interpretation of *ekāṣṭaka* but, unfortunately, were unaware that it led to 3000 BC.

ABBREVIATIONS

<i>AB</i>	<i>Aitareya Brāhmaṇa</i>	<i>AIT</i>	Aryan Invasion Theory
<i>AMT</i>	Aryan Migration Theory	<i>AV</i>	<i>Atharva Veda</i>
<i>ChU</i>	<i>Chandogya Upaniṣad</i>	<i>JB</i>	<i>Jaiminiya Brāhmaṇa</i>
<i>KB</i>	<i>Kauṣītakī Brāhmaṇa</i>	<i>MB</i>	<i>Mahābhārata</i>
<i>PB</i>	<i>Pañcaviṃśa Brāhmaṇa</i>	<i>ŚB</i>	<i>Śatapatha Brāhmaṇa</i>
<i>SSS</i>	<i>Sankhayana Srouta Sūtra</i>	<i>TA</i>	<i>Taittirīya Aranyaka</i>
<i>TB</i>	<i>Taittirīya Brāhmaṇa</i>	<i>TS</i>	<i>Taittirīya Samhitā</i>
<i>VP</i>	<i>Viṣṇu Purāṇa</i>		

NOTES AND REFERENCES

1. ŚB 11.1.1.7

योऽसौ वैशाखस्यामावास्या तस्यामादधीत सा रोहिण्या सम्पद्यत आत्मा वै प्रजा रोहिण्यात्मन्धेवैतत्प्रजायां पशुषु प्रतितिष्ठत्यमावास्या वा आग्न्याधेयरूपं तस्मादमावास्यायामेवाग्नी आदधीत पौर्णमास्यामन्वारभेतामावास्यायां दीक्षेत

He may lay down the fires on the new moon which falls in the (month) Vaisākha, for that coincides with the Rohiṇī (asterism); for the Rohiṇī means the self, offspring and cattle: he thus becomes established in a self, in offspring and cattle. But, indeed, the new moon is the form of the *Agnādheya*: let him therefore lay down the fires at new moon;—let him perform the preliminary ceremony at full moon, and the initiation ceremony at new moon.

2. **ŚB 11.1.2.13**

स आजिसृतामेकः य एवं विद्वांस्त्रिंशतं वर्षाणि यजते तस्माद् द्विंशतमेव वर्षाणि यजेत यद्यु दाक्षायणयज्ञी स्यादथो अपि पञ्चदशैव वर्षाणि यजेतात्र ह्येव सा सम्पत्सम्पद्यते द्वे हि पौर्णमास्यौ यजते द्वे अमावास्ये अत्रो एव खलु सा सम्पद्भवति

He who, knowing this, offers (the Full and New-moon sacrifice) for thirty years, becomes one of the race-runners, whence one ought to offer sacrifice for not less than thirty years. But if he be a performer of the Dākṣāyana sacrifice, he need only offer for fifteen years, for therein that perfection is brought about, since he performs (every month) two Full-moon and two New-moon offerings, and thus that perfection is indeed brought about therein.

3. **TS 7.5.6**

षडहैर्मासान्त्सम्पाद्याहुरुत्सृजन्ति षडहैर्हि
 मासान्त्सम्पश्यन्त्यर्धमासैर्मासान्त्सम्पाद्याहुरुत्सृजनत्यर्धमासैर्हि
 मासान्त्सम्पश्यन्त्यमावायया मासान्त्सम्पाद्याहुरुत्सृजन्त्यमावास्यया हि
 मासान्त्सम्पश्यन्ति पौर्णमास्या मासान्त्सम्पाद्याहुरुत्सृजन्ति पौर्णमास्या
 हि मासान्त्सम्पश्यन्ति

Having made up the months with the six-day periods they leave out a day, for they behold the months with the six-day periods. Having made up the months with the half-months, they leave out a day for they behold the months by the half-months. Having made up the months by the new moon night, they leave out a day, for they behold the months by the new moon night. Having made up the months by the full moon night, they leave out a day, for they behold the month by the full moon night.

4. **ŚB 13.2.6.11**

क उ स्विवज्जायते पुनरिति चन्द्रमा वै जायते पुनरायुरेवास्मिंस्तद्धतः

‘Who is it that is born again?’—it is the moon, doubtless, that is born again (and - again): vitality they thus bestow on him.

5. **AB 8.28**

चंद्रमा वा अमावस्यायामादित्य-

मनुप्रविशति सोऽतर्वीयते तत्र निर्जानन्ति यदा वै म्रियते अर्थात्

धीयते उथेनं न निर्जानाति स ब्रूयाच्चंद्रमसो मरणे द्विषन्मे म्रियतां सोतर्धीयतां तं मा निर्जासिषुरिति

The moon at the conjunction enters into the sun; it is concealed; men do not perceive it. When a man dies, then he is concealed, then men do not perceive him. He should say at the death of the moon 'Let my enemy die, let him be concealed, may they not perceive him.' ...

आत्यादित्याद्वै चंद्रमा जायते तं दृष्ट्वा ब्रूयाच्चंद्रमा जायतो मा मे

द्विषन् जन्यत एवं पराङ् प्रजिध्यत्वित्यतो हैव पराङ् मजिध्याति

From the sun is the moon born. Having seen it he should say 'let the moon be born; let not my enemy be born; far hence may he hasten away.' Far hence he hastens away...

6. **ChU 5.10.1-4**

तद्य इत्थं विदुः ये मेचेऽरण्ये श्रद्धा तप इत्युपासते तेऽर्चिषं अभिसंभवन्ति अर्चिषोऽहः अह्ना अपूर्यमाणपक्षं आपूर्यमाणपक्षाद्यान्षडुदङ्ङिति मासांस्तान्

Those who know this, and also those who, in the forest, meditate upon faith and penance, go to light; from light to day; from day to the Bright Fortnight; from the Bright Fortnight to those six months during which the Sun rises northwards.

मसोभ्यः संवत्सरं संवत्सरादादित्यं आदित्याच्चन्द्रमसं चन्द्रमसो विद्युतं तत्पुरुषेऽमानवः स एनान्ब्रह्म गमयति एष देवयानः पन्था इति

From these months to the Year ; from the Year to the Sun : from the Sun to the Moon; from the Moon to Lightning.- There lies a Person, not human; he carries them to *Brahman*, This is the Path of Divinities.

अथ य इमे ग्राम इष्टापूर्ते दत्तं इत्युपासते ते धूमं अभिसंभवन्ति धूमाद्रात्रिं रात्रेरपरपक्षं अपरपक्षाद्यान्षडदक्षिणैति मासांस्तान् नैते संवत्सरं अभिप्राप्नुवन्ति

And those who, living in villages, meditate upon sacrifices and works of public utility and charity, -pass on to Smoke; from Smoke to Night; from Night to the Darker Fortnight; from the Darker Fortnight to those months during which the Sun moves Southwards ; from there they do not reach the year.

मासेभ्यः पितृलोकं पितृलोकादाकाशं आकासाच्चन्द्रमसं एष स्३ओ राजा तद्देवानां अन्नं तं देवा भक्षयन्ति

From the months, (they go) to the Region of the Fathers : from the Region of the Fathers to *Ākāśa*; from *Ākāśa* to the Moon. That is Soma the King. That is the food of the Deities. This the Deities eat.

7. **KB 19.3**

स वै माघस्य अमावास्यायाम् उपवसत्य् उदन्न् आवत्स्यन् उप इमे वसन्ति प्रायणीयेन अतिरात्रेण यक्ष्यमाणाः तद् एनम् प्रथमम् आप्नुवन्ति तम् चतुर्विंशेन आरभन्ते तद् आरम्भणीयस्य आरम्भणीयत्वं स षण् मासान् उदन्न् एति तम् ऊ३०र्वैः षडहैर् अनुयन्ति स षण् मासान् उदन्नित्वा तिष्ठते दक्षिणा आवत्स्यन् उप इमे वसन्ति वैषुवतीयेन अह्ना यक्ष्यमाणाः तद् एनम् द्वितीयम् आप्नुवन्ति स षण् मासान् दक्षिणा एति तम् आवृत्तैः षडहैर् अनुयन्ति स षण् मासान् दक्षिणेत्वा तिष्ठत उदन्न् आवत्स्यन् उप इमे वसन्ति माहाव्रतीयेन अह्ना यक्ष्यमाणाः तद् एनम् तृतीयम् आप्नुवन्ति तम् यत् त्रिर् आप्नुवन्ति त्रेधा विहितो वै संवत्सरः संवत्सरस्य एव आह्वयै तद् उत एषा अभिगीयते अहोरात्राणि विदधद् ऊर्णाका इव धीर्यः षण् मासो दक्षिणा आदित्यः षड् उदन्न् एति सूर्य इति षड् ह्य एष मासान् उदन्न् एति षड् दक्षिणा ...

On the new moon of Māgha he rests, being about to turn northwards; these also rest, being about to sacrifice with the introductory *Atirātra*; thus for the first time they obtain him; on him they lay hold with the *Caturviṃśā*; that is why the laying hold rite has its name. He goes north for six months; him they follow with six-day periods in forward arrangement. Having gone north for six months he stands still, being about to turn southwards; these also rest, being about to sacrifice with the *Viśuvant* day; thus for the second time they obtain him. He goes south for six months; him they follow with six-day periods in reverse order. Having gone south for six months he stands still, being about to turn north; these also rest, being about to sacrifice with the *Mahāvra*ta day; thus for the third time they obtain him. In that they obtain him thrice, and the year is in three ways arranged, verily (it serves) to obtain the year. With regard to this this sacrificial verse is sung, 'Ordaining the days and nights like a cunning spider for six months south constantly for six north the sun goeth.' For six months he goes north, six south ...

 8. **ŚB 9.1.1.44**

तदाहुः कथमस्यैतचतरुद्रियं महदुक्थमाप्नोति कथं महतोक्थेन सम्पद्यत इति यान्यमूनि पञ्चविंशतिर्यजूष्यभितोऽशीतीः स पञ्चविंश आत्मा यत्र वा आत्मा तदेव शिरस्तत्पक्षपुचान्यथ या अशीतयः सैवाशीतीनामाप्तिरशीतिभिर्हि महदुक्थमाख्यायतेऽथे यदूर्ध्वमशीतिभ्यो यदेवादो महत अक्थस्योऽर्वमशीतिभ्य एतदस्य तदेवमु हास्यैतचतरुद्रियम् महदुक्थमाप्नोत्येवं महतोक्थेन सम्पद्यते

As to this they say, 'How does this Satarudriya of his attain to (conformity with) the Great Litany?'— how does it correspond to the Great Litany?' Well, those twenty-five formulas which there are on both sides of the eighties, they are the twenty-five-fold body; and where the body (of the altar-bird) is, that (includes) the head, and the wings and tail. And what eighties (of formulas) there are (in the Satarudriya), thereby indeed the (corresponding) eighties (of the *Mahad uktham*) are obtained, for by eighties the Great Litany is recited. And what there is (in the Satarudriya) after the eighties that is for him the same as what there, in the Great Litany, is after the eighties; and in this way this Satarudriya of his attains to (conformity with) the Great Litany; in this way it corresponds to the Great Litany.

9. **ŚB 10.2.5.15**

अथ त्रीण्यहान्युपातियन्ति यदहः शतरुद्रियं जुहोति यदहरुपवसथो यदहः प्रसुतस्तद्यत्तेष्वहः
सूपसदा चरन्ति तानि तस्य मासस्याहोरात्राण्यथ यत्प्रवर्ग्येण तदु तस्मिन्नृतावादित्यं प्रतिष्ठापयत्येतावान्चै
त्रयोदशसु मासेषु कामः सप्तस्वृतुषु तद्यावांस्त्रयोदशसु मासेषु कामः सप्तस्वृतुषु तं
तत्सर्वमात्मानमभिसंचिनुते

And in addition to these there are three days¹, to wit, the day on which he performs the Satarudriya offering, the day of preparation, and the day on which the Soma is pressed. When they perform the Upasad on these days, these (days) are the days and nights of that (thirteenth, or intercalary) month: and when (they perform) the Pravargya, he thereby establishes yonder sun also in that (seventh) season,—so long, indeed, desire (lasts) in the thirteen months and the seven seasons: he thus builds for himself a body so as to obtain all of whatever desire there is in thirteen months and seven seasons.

[After the twenty-eight days of the twelfth month two days remain to make up the year, so that the (first) Sutyā day (pressing day) takes place after the expiry of a full year] (Eggeling's comment)

10. **KB 5.1**

अथ अतश् चातुर्मास्यानां चातुर्मास्यानि प्रयुञ्जानः फाल्गुन्याम् पौर्णमास्याम् प्रयुङ्क्ते मुखम् वा
एतत् संवत्सरस्य यत् फाल्गुनी पौर्णमासी मुखम् उत्तरे फल्गू पुच्छम् पूर्वे तद् यथा प्रवृत्तस्य
अन्तौ समेतौ स्यातां एवम् एव एतौ संवत्सरस्य अन्तौ समेतौ तद् यत् फाल्गुन्याम् पौर्णमास्याम्
वैश्वदेवेन यजेत मुखत एव तस् संवत्सरम् प्रीणाति ...

Next as to the four-monthly sacrifices, he who prepares the four-monthly sacrifices begins on the full moon night in the Phālgunī's. The full moon night in the Phālgunī's is the beginning of the year; the latter two Phalgun's the beginning, the former two the end. Just as the two ends of what is round may unite, so these two ends of the year are connected. In that he sacrifices with the Vaiśvadeva sacrifice on the full moon night in the Phālgunī's, verily thus at the beginning he delights the year...

11. **ŚB 6.2.2.18**

तद्वै फाल्गुन्यामेव एषा ह संवत्सरस्य प्रथमा रात्रिर्यत्फाल्गुनी पौर्णमासी योत्तरैषोत्तमा या पूर्वा मुखत
एव तत्संवत्सरमारभते

And furthermore, at the Phālgun (full moon), for that full moon of Phālgun, that is, the second (Phālgun), is the first night of the year; and that first (Phālgun) is the last (night of the year): he thus begins the year at the very mouth (beginning).

12. **ŚB 2.1.2.3**

एता ह वै प्राच्यै दिशो न च्यवन्ते सर्वाणि ह वा अन्यानि नक्षत्राणि प्राच्यै दिशश्च्यवन्ते
तत्प्राच्यामेवास्यैतद्दिश्याहितौ भवतस्तस्मात्कृत्तिकास्वादधीत

And again, they do not move away from the eastern quarter, whilst the other asterisms do move from the eastern quarter. Thus his (two fires) are established in the eastern quarter: for this reason he may set up his fires under the Kṛttikās.

13. **TS 4.4.10**

कृत्तिका नक्षत्रमग्निर्देवताग्ने रुचः स्थ प्रजापतेर्भ्रातुः सोमस्युर्चे त्वां रुचे
त्वां द्युते त्वां भासे त्वा ज्योतिषे त्वां रोहिणी नक्षत्रमृजापतिर्देवता
मृगशीर्षं नक्षत्रं सोमो देवताद्रा नक्षत्रं रुद्रो देवता पुनर्वसू
नक्षत्रमर्दितिर्देवता तिष्यो नक्षत्रम्बृहस्पतिर्देवताश्रेषा नक्षत्रं सर्पा देवता
मृषा नक्षत्रम्पितरो देवता फल्गुनी नक्षत्रमर्युमा देवता फल्गुनी
नक्षत्रम्भगो देवता हस्तो नक्षत्रं सविता देवता चित्रा नक्षत्रमिन्द्रो देवता
स्वाती नक्षत्रं वायुर्देवता विशाखे नक्षत्रमिन्द्राग्नी देवतानूराधा
नक्षत्रम्पित्रो देवता रोहिणी नक्षत्रमिन्द्रो देवता विचृतौ नक्षत्रम्पितरो
देवताषाढा नक्षत्रमापो देवताषुद्धा नक्षत्रं विश्वे देवा देवता श्रोणा नक्षत्रं
विष्णुर्देवता श्रविष्ठा नक्षत्रं वसवो देवता शतभिषङ्गनक्षत्रमिन्द्रो देवता
प्रोष्ठपदा नक्षत्रमज एकपाद्देवता प्रोष्ठपदा नक्षत्रमर्हिर्बुध्नियो देवता रेवती
नक्षत्रम्पूषा देवताश्वयुजो नक्षत्रमश्विनो देवतापुभरणीर्नक्षत्रं यमो देवता

“(Thou art) Kṛttikās, the Nakṣatra, Agni, the deity; ye are the radiances of Agni, of Prajāpati, of the creator, of Soma; to the Re thee, to radiance thee, to the shining thee, to the blaze thee, to the light thee.

(Thou art) Rohiṇī the Nakṣatra, Prajāpati the deity; Mṛgasīrṣa the Nakṣatra, Soma the deity; Ardra the Nakṣatra, Rudra the deity; the two Punarvasus the Nakṣatra, Aditi the deity; Tisya the Nakṣatra, Bṛhaspati the deity; the Asṛesas the Nakṣatra, the serpents the deity; the Māghas the Nakṣatra, the fathers the deity; the two Phālgunīs the Nakṣatra, Aryaman the deity; the two Phālgunīs the Nakṣatra, Bhaga the deity; Hasta the Nakṣatra, Savitṛ the deity; Citra the Nakṣatra, Indra the deity; Svāti the Nakṣatra, Vāyu the deity; the two Viśākhās the Nakṣatra, Indra and Agni the deity; Anurādhā the Nakṣatra, Mitra the deity; Rohiṇī the Nakṣatra, Indra the deity; the two Viṣṭas the Nakṣatra; the fathers the deity; the Āsāḍas the Nakṣatra, the waters the deity; the Āsāḍas the Nakṣatra, the All-gods the deity; Śrona the Nakṣatra, Viṣṇu the deity; Śraviṣṭhā the Nakṣatra, the Vasus the, deity; Śatabhisaj the Nakṣatra, Indra the deity; Proṣṭhapadās the Nakṣatra, the goat of one foot the deity; the Proṣṭhapadās the Nakṣatra, the serpent of the deep the deity; Revatī the Nakṣatra, Puṣan the deity; the two Aśvayujṣ the Nakṣatra, the Aśvins the deity; the Apabharaṇis the Nakṣatra, Yama the deity.

14. **TS 5.3.9**

सर्वाभ्यो वै देवताभ्योऽग्निश्चीयते यत्सयुजो नोपदध्याद्देवता अस्याग्निं
 वृञ्जीरन्यत्सयुजं उपदधात्यात्मनैवैनं सयुजं चिनुते नाग्निना व्यृध्यतेऽथो
 यथा पुरुषः स्रार्वभिः सन्तत एवमेवैताभिर्ग्निः सन्ततोऽग्निना वै देवाः
 सुवर्गं लोकमायन्ता अमूः कृत्तिका अभवन्वस्यैता उपधीयन्ते सुवर्गमेव
 लोकमेति गच्छति प्रकाशं चित्रमेव भवति मण्डलेष्टका उप दधातीमे वै
 लोका मण्डलेष्टका
 इमे खलु वै लोका देवपुरा देवपुरा एव प्र विशति नार्तिमार्च्छत्यग्निं
 चिक्स्यानो विश्वज्योतिष उप दधातीमानेवैताभिर्लोकाञ्ज्योतिष्मतः
 कुरुतेऽथो प्राणानेवैता यजमानस्य दाधत्येता वै देवताः सुवर्गास्ता
 एवान्वारभ्य सुवर्गं लोकमेति ॥६॥

For all the gods is the fire piled up; if he were not to put (them) down in unison, the gods would divert his fire; in that he puts (them) down in unison, verily he piles them in unison with himself; he is not deprived of his fire; moreover, just as man is held together by his sinews, so is the fire held together by these (bricks). By the fire the gods went to the world of heaven; they became yonder Kṛttikas; he for whom these are put down goes to the world of heaven, attains brilliance, and becomes a resplendent thing. He puts down the circular bricks; the circular bricks are these worlds; the citadels of the gods are these worlds; verily he enters the citadels of the gods; he is not ruined who has piled up the fire. He puts down the all-light (bricks); verily by them he makes these worlds full of light; verily also they support the breaths of the sacrificer; they are the deities of heaven; verily grasping them he goes to the world of heaven.

15. **AB 4.18**

एकर्विशमेतदहरुपयति विषुवंतं मध्य संवत्सरस्यैतेन वै देवा; एकर्विशेनादित्यं स्त्रर्गाय लोकायोदयच्छंस एष इति एकर्विशस्तस्य दशावस्तादहानि दिवाकीर्त्यस्य भवन्ति, दश परस्तान्मध्य एकर्विश उभयतो विराजि प्रतिष्ठित; उभयतो हि वा एष विराजि प्रतिष्ठित स्तस्मादेषोतरेमांल्लोकान्यत्र व्यथते. तस्य वै देवा आदित्यस्य स्वर्गाल्लोकादवपाताद बिभयुस्तं त्रिभिः स्वर्गैर्लोकैरवस्तात्प्रत्युत्तभुवन्स्तोमा वै त्रयः स्वर्गा लोकास्तस्य पराचो उतिपातादबिभयुस्तं त्रिभिः स्वर्गैर्लोकैः परस्तात्प्रत्युत्तभुवन् स्तोमा वै त्रयः स्वर्गा कोकास्त त्रयो अवस्तात्सप्तदशा भवन्ति; त्रयः परस्तान्मध्य एष एकर्विश उभयतः स्वरसामभिर्धृत; उभयतो हिवा एष स्वरसामभिर्धृतस्तस्मादेषोतरेमांल्लोकान्यन् व्यथते. तस्य वै देवा आदित्यस्य स्वर्गाल्लोकादवपाताद—बिभयुस्तं परमैः स्वर्गैर्लोकैरवस्तात्प्रत्युत्तभुवन्स्तोमा वै

परमाः स्वर्गा लोकास्तस्य पराचो उतिपानाद बिअभयुस्तं परमैः स्वर्गै लोकेः परस्तात् प्रत्य-स्तभुवन्स्तोमा वै परमाः स्वर्गा लोकास्त्रयो उवस्तात्सप्तदशा भवन्ति, त्रयः परस्तात् द्वौ द्वौ संपद्यत्रयश्वतुस्त्रिंशो भवन्ति, चतुर्सिंशो वै स्तोमानामुत्तमस्तेषु वा एष एतदध्याहितस्तपति; तेषु हि वा एष-एतदध्याहितस्तपाते. स वा एष उत्तरो उस्मात् सर्वस्माद् भूताद्भविष्यतः सर्वमेवेदमतिरोचते यदिदं किंचोत्सो भवति. यस्मादुत्तरो बुभूषति तस्मादुत्तरो भवति य एवं वेद ॥18॥

They perform the *ekaviṃśā* day, the Visúvant, in the middle of the year ; by the *ekaviṃśā* the gods raised up the sun to the world of heaven ; it is here the *ekaviṃśā*; below this Divākīrtya are ten days, ten above ; in the middle is the *ekaviṃśā* resting on both sides in the Virāj, for on both sides does he find support in the Virāj. Therefore he going between these worlds does not shake. The gods were afraid of this Āditya falling down from the world of heaven ; him with three worlds of heaven from below they propped up ; the three worlds of heaven are the Stomas. They were afraid of his falling away up; him with three worlds of heaven from above they propped up; the three worlds of heaven are the Stomas. Thus below there are three *Saptadaśā* (Stomas), three above; in the middle is the *ekaviṃśā* on both sides supported by the Svara Samans, for he is supported on both sides by the Svara Samans. Therefore he going between these worlds does not shake. The gods were afraid of this Āditya falling from the world of heaven; him with the highest worlds of heaven they propped up from below; the highest worlds of heaven are the Stomas. They were afraid of his falling away up; him with the highest worlds of heaven they propped up from above; the highest worlds of heaven are the Stomas. Thus there are three *Saptadaśā* (Stomas) below, three above. Making them up by twos they are three *Catustrimśas*; the *Catustrimśā* is the highest of the Stomas. Placed over these it gives heat, for he placed over these gives heat. He is higher than all this that has been and will be ; he shines over all this whatever there is here ; he is higher ; thus he becomes who knows thus higher than he than whom he desires to be higher.

16. **AB 5.28**

असौ वा अस्यादित्यो यूपः पृथिवी वेदिरोषध्यो बर्हिर्वनस्पतय इध्मा आपः प्रोक्षण्यो दिशः परिधयो.

The sacrificial post is yonder sun, the altar the earth, the strew the plants, the kindling wood the trees, the sprinkling waters the waters, the enclosing sticks the quarters...

17. **AV 4.24.4**

यय वशास ऋषभास उक्षणे यस्मै मीयन्ते स्वरवः स्वर्विदे ।

यस्मै शुक्रः पवते ब्रह्मशुम्भितः स नो मुञ्चत्वंहसः ॥

To whom (belong) the cows, the bulls, and the oxen, for whom, as sun-finder, the sacrificial stakes are erected, for whom bright (soma) is purified, beautified with formulated speech-let him (Indra) release us from distress.

18. **KB 3.1**

यद् दर्श पूर्ण मासयोर् उपवसति न ह वा अत्रतस्य देवा हविर् अश्नन्ति तस्माद् उपवसति उत मे देवा हविर् अश्नीयुर् इति पूर्वाम् पौर्णमासीम् उपवसेद् इति पैङ्ग्यं उत्तराम् इति कौषीतकं याम् पर्यस्तमयम् उत्सर्पेद् इति सा स्थितिः पूर्वाम् पौर्णमासीम् उपवसेद् अनिर्ज्ञाय पुरस्ताद् अमावास्यायाम् चन्द्रमसं यद् उपवसति तेन पूर्वाम् प्रीणति यद् यजते तेन उत्तरां उत्तराम् उपवसेथ् उत्तराम् उ ह वै समुद्रो विजते सोमम् अनु दैवतं एतद् वै देव सत्यम् यच् चन्द्रमाः तस्माद् उत्तराम् उपवसेथ्

In that he fasts at the new and full moon it is because the gods do not eat the oblation of him who does not perform the fast. Therefore he fasts (desiring) 'May the gods eat my oblation'. 'On the first full moon (day) should he fast' is the view of Paingya; 'on the second' that of *Kauṣītaki*; 'that on which the moon appears full about the setting of the sun' is the rule; he should fast on the second full moon day. In that he fasts on the new moon day not discerning the moon in the east, thereby he delights the first (new moon day); in that he sacrifices, thereby, the second. He should fast on the second; on the second the ocean swells in accordance with the moon, its deity. The moon is the truth of the gods; therefore he should fast on the second.

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