Ancient Indian Astronomy in Vedic Texts

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Preface

Astronomy in popular perception is about stars, planets, sun, moon, eclipses, comets, meteorites and associated observable phenomena. Something of all of these was known to our ancients though not in the same form and detail as it is available now. In the context of India, the question is what was known, in what detail and when. For the *siddhānta* period, roughly starting with the Common Era, (CE) such questions have been fairly well answered. This has been possible since several texts of the period, specifically devoted to astronomy are available for systematic study. But for the more ancient period we have no exclusive texts other than Lagadha's Vedānga Jyotiṣa (c 1400 BCE) which is a calendar with no reference to eclipses or planets. Hence when one talks of Vedic Times several precautions are necessary. Firstly even though for the pre-siddhāntic period many texts are available, they are neither specific to astronomy nor are they by particular authors. Second, the texts were all orally transmitted by memory for generations before they were scripted on palm leafs. This knowledge tradition has come down to us mainly in Sanskrit. Three broad classes of BCE texts can be identified namely Vedic, Purānṇic and Śāstraic. Texts of the first group including the ancillaries such as the Sūtras and the Pariśiṣṭas are preserved unchanged in their original form with practically no variation with time. The same cannot be said about the two Epics, the eighteen and more Purāṇas, Samhitās of Parāśara and Vṛddha Garga which have undergone changes in CE also. Texts on grammar, prosody, dramas of Bhāsa, Kauṭilya's Arthaśāstra, Bharata's Nāṭyaśāstra, Jaina and Buddhist literature making up the third group are relatively late. But these also provide insights into Indian astronomy before CE. In addition to the above clarification it is essential to bear in mind the time frame of development of the above class of literature which spans some three to four thousand years starting from an unknown past to the first millennium BCE. Hence we have to also address the question of chronology consistent with whatever verifiable information that can be found.

It is generally observed that Vedic culture personified celestial objects and their actions. Hence the texts carry a background that has to be deciphered for extracting the archaic models of the visible sky. When we read that a demon (*asura*) fell from the sky and went underground, we can safely infer that this picture should have been probably correlated in

time and space with a meteorite fall. Similarly when it is said that an *āsura* covered Sun, we may suspect this event to be an eclipse. This allegorical approach was known to the Vedic tradition as recorded by Yāska (*c* 700 BCE) who records three types of interpretations for several hymns of the Ṛgveda. These are the *adhiyajña, adhyātma* and the *adhidaiva;* the sacrificial, philosophical and celestial (divine) meanings respectively. For example the *adhidaiva* meaning of the word Soma is Moon, whereas in a Vedic sacrifice as per the *adhiyajña,* Soma is a creeper of that name. In the Upaniṣads the philosophical meaning of Soma is *manas* or mind. The Śatapatha Brāhmaṇa (ŚB) has the esoteric statement:

candramā vai somo devānāmannam tā pourṇamāsyāmabhiṣuṇvanti || (ŚB. 11.1.5)
Moon is Soma the food of gods; they approach him on Full Moon.

But, Yāska, quite clearly says in the Nirukta (11.4-5) that *Soma* is Moon whom no gods literally eat. It is easy to see that the reference in such cases is to the waning moon said to be consumed by gods on a daily basis starting from Full Moon. The Vedic seers personified celestial objects as they beheld some cosmic transcendental unity and pattern through observable natural phenomena. Hence it should not be surprising to find in Vedic sacrifices, Hindu religion and Vedānta philosophy reflections of ancient sky pictures, however hazy they might seem now. This type of modelling sky observations by our Vedic ancestors can be called scientific naturalism. The sky descriptions become more interesting especially when numbers are associated with the celestial divinities. In the following four articles we investigate briefly how comets, meteorites, and eclipses were experienced and pictured in the Vedic texts. Over a long period of time the effect of precession was also felt as with the loss of importance for the constellation *Śiśumāra* (Draco) and shifting of the Pole Star *Dhruva.* The astral descriptions and the religious lore behind the above astronomical entities provided the inspiration for the development of observational and mathematical astronomy in India.

Some portion of the present study has appeared in the Indian Journal of History of Science (2005, 2009, 2010, 2011 and 2012) in the form of papers. However, considerable new information, beyond the published material, can be found in the following pages.

1. Comets and Meteorites in the Ṛgveda

Introduction

The Ṛgveda Samhitā is the most ancient literature of India available for our study. The three other Vedas namely the Yajurveda, Sāmaveda and the Atharvaṇaveda along with their ancillary texts are closely linked to the Ṛgveda in several ways. The remote antiquity of the Ṛgveda and the live tradition of oral transfer of the Vedas by complex linguistic artifices are evidences for the utmost importance attached by Hindus in preserving the original information as precisely as possible. It is an attested fact that even after several millennia, RV containing 10 books (*maṇḍala*) with 1028 hymns (*sūkta*) totaling 10552 verses (*mantra*) is learnt and recited with exactly the same content and sequence all over India. This is the primary source for finding the most ancient celestial observations made in the Indian skies. Even though RV is not a book on astronomy or on natural sciences, it is a collection of hymns covering a large variety of themes ranging from the physical to the spiritual, human to the superhuman, religion to philosophy, individual to the collective, earth to the sky to the universe. It spans several centuries in its compositional spread and represents a wide area of land also in its coverage with names of rivers, mountains, lands and lakes. The language of RV is by definition, Vedic Sanskrit and its style can at best be described as inspired poetry emanating out of spontaneous intuition, revelation or contemplation. Hence explaining the text strictly through analytical methods of grammar, etymology, dictionaries and linguistics will make us miss the forest for the trees.

Any one approaching RV faces the daunting problem of extracting the meanings of the hymns. This difficulty is known since the time of Yāska who already noted that RV hymns can be interpreted in several different ways. Due to the archaic nature of the Vedic language, precise meanings may remain unknown, but the overall contextual implications when read with other similar hymns should be reasonably clear. Hence when a particular event or deity is described more number of times, a clear picture of what the ancient composers meant emerges. To approach RV in this fashion, we have to follow the ancillary texts and the traditional Sanskrit commentaries, instead of going by modern day translations. This helps us to find whether the origin of a later Vedic ritual can be traced to the sky pictures of RV. Among the various editions of RV available, the Mysore Palace edition of the Ṛgveda (*abbr.* MPRV) is versatile[1]. This gives in thirty six volumes an exhaustive introduction, the text, traditional meaning, ritual application, grammatical explanation, and the complete Sanskrit commentary of Sāyaṇa along with the ancillary texts needed to follow the Ṛgveda. The translations and interpretations of the hymns given here follow closely the commentary of Sāyaṇa and the traditional explanations given by the compilers of the MPRV edition.

[1] Ṛgveda Samhitā; edited by a group of ten scholars, published by the Mysore Palace, 1950. This thirty-six volume series in Kannada script is complete with Samhitā and Pada Pāṭha, Khila, Sāyaṇa's commentary, Anukramaṇi, Ṛgvidhāna, Aitareya Brāhmaṇa, the Bṛhaddevatā and the Nirukta with elaborate traditional explanations which are indispensable to follow RV.

Ketu in the Vedas

Astronomy is popularly understood as a subject about the sun, the moon, the planets, eclipses and comets. While the sun and the moon, even when they are lauded as deities, can be easily recognized as celestial objects it may not be so clear for a modern reader whether other objects are described in the Vedic texts. A further difficulty arises as the Hindu socio-religious pluralistic tradition in constant flux tends to attribute different meanings to the same word. A case in point is the word *ketu* that appears some eighty times in the RV with the following distribution in the ten books.

[I:19; II: 0; III:10; IV: 3; V: 8; VI: 7; VII: 8; VIII: 4; IX: 3; X: 18]

What strikes here as significant is the absence of the word in the second book and its increased use in the first and the tenth books. This word is interpreted in the Nirukta as *knowledge, flag, herald, insignia*, and as a *memory trigger.* Hence the RV word *dhūmaketu* which means comet in almost all Indian languages is taken by Sāyaṇa to mean an epithet for the sacrificial fire with a smoke banner. This is a typical example of the *adhidaiva* meaning getting masked in the orthodox *adhiyajña* tradition. The Atharvaṇaveda (AV) has a famous hymn in which *dhūmaketu* is mentioned along with sun, moon and *rāhu*, indicating that in Vedic parlance too the word *ketu* should have primarly referred to a visible celestial object[2]. The text of the RV contains a cryptic statement *yādṛgeva dadṛśe tādṛgucyate* (V.44.6) that is; the seers *say what they saw*. Thus it would be interesting to investigate whether Comets and such other transient celestial objects were the inspiration behind some of the RV hymns.

The specific word *dhūmaketu* meaning literally *smoke-* or *dust-banner* occurs seven times in the RV but, only in I, VIII and X books, which are considered to be relatively later compositions in comparison with the other books. According to traditional interpretation this word qualifies *agni* the (sacrificial) fire. One wonders, if this were to be the unique meaning, why this epithet is absent in the other family books which also profusely refer to *agni.* Is it possible the word *dhūmaketu* with two meanings, fire (*agni*) and anomalous event (*utpāta*), as listed in the Amarakośa could be traced to RV, when in ancient times a comet with a (dusty) smoky extension, like the earthly fire which has smoke for its insignia inspired the composers of some hymns ? The word *utpāta* denoting anomalous natural events does not appear in RV. But the word *adbhuta* which stands for strange and unusual objects or events is used in RV as an epithet for *agni* the fire. Could this *adbhuta* in some sense point to strange fiery transient objects observed in the sky? The Ṣaḍvimśa Brāhmaṇa of the Sāmaveda has a chapter called *Adbhuta Brāhmaṇa*. This deals with special rituals to be observed during unusual events, grouped as *somadevatyāni adbhutāni.* This includes shooting stars, meteorites and comets (*ketavaḥ*)[3]. It is notable that the Nirukta (1.6) interprets *adbhutam* as

[2] *Śam no bhūmirvepyamānaḥ śamulkāhatanca yat| ....śam no grahāhcāndramasāh śamādityaśca rāhuṇā| śamno mṛtyur**dhūmaketuḥ** śam rudrāḥ tigmatejasaḥ ||* Atharvaṇaveda (XIX.9.7-10).

[3] *atha yadāsya tārāvarṣāṇi colkāḥ patanti, nipatatnti, dhūmāyanti| diśo dahyanti, ketavścottiṣṭhanti…….ityevamādini tānyetāni sarvāṇi somadevatyānyadbhutāni….||* Ṣaḍvimśa. Brā. (6.9.2)

abhūtam, that is, *unprecedented*. Thus, *prima-facie* there is a case for *dhūmaketu* to be an unexpected comet or a fireball similar to a strange fire with a smoky extension.

Dhūmaketu

Now we consider the seven RV hymns with the word *dhūmaketu* in the order of the books in which they appear. Hymn (I.27) starts comparing *agni* to a tailed horse[4]. In the second verse of the hymn this object is qualified as having wide motion *(pṛthupragāmā*). In the sixth verse this *agni* is called *citrabhānu,* that is one having varied colors. This fire is qualified in the tenth verse as *rudra*, one with ferocious form. This is followed by a prayer with a specific name for the *fire* in question.

sa no mahān animāno ***dhūmaketuḥ*** *puruścandraḥ |dhiye vājāya hinvatu* || (I.27.11)

May the great, illimitable, brilliant ***dhūmaketu*** *(smoke-banner) be pleased with our rite and inspire us.*

MPRV aptly points out that there can be no special similarity between *agni* and a tailed horse as in this hymn, even as a figure of speech. The hymn is clear that the object of its attention is stationed in the sky. If this *agni* were to have a tail, have perceptible movement, be large without specific measure *(mahān animāno)* and look like a big bright celestial herald (*viśpatiḥ daivyaḥ ketuḥ bṛhadbhānuḥ*| *v.*12) it could as well have been a comet described aptly by the word *dhūmaketu.* The epithet *viśpatiḥ* signifies the object to be closely connected with *marut*s, who are called *viś* in the RV. This point will be considered later.

Next we come across this word in a hymn by Praskaṇva of the Kaṇva family to which belong the authors of the eighth book.

adyā dūtam vṛṇimahe vasum agnim purupriyam | ***dhūmaketum*** *bhārjikam vyuṣṭiṣu yajñānām adhvaraśriyam* || (I.44.3)

We choose today at day break as messenger the good agni, the beloved of many, the smoke-bannered, who shines with his brightness and who is the protector of the doer of sacrifice.

Here the action of selecting *agni* as messenger (*dūtam*) is in the first person. This *agn*i is qualified as *dhūmaketu* and *bhārjika*. The word *bhārjika* means shining according to Yāska[5]. This may mean one who is shining or may mean one who is famous as *Bhā.* This *agni* is addressed in (*v.*4) as *guest* (*atithi*), highlighting his transient nature. In (*v.*10) *agni* is referred also as *purohita* and as *vibhāvasu* who had shone previously at many dawns (*pūrvā anu uṣaso vibhāvaso didetha*). MPRV interprets *purohita* traditionally as, *one (the fire) who is installed in the east of the sacrificial altar in the āhavanīya pit*. This hymn ends in (*v.*14) with a request to the fire-tongued *marut*s to be heard (*sṛṇvantu marutaḥ agnijihvāḥ)*. This hymn

[4] *aśvam na tvā* ***vāravantam*** *vandadhyā agnim namobhiḥ* | *samrājantam adhvarāṇām*|| RV (I.27.1)
[5] *bhārjikaḥ prasiddha-bhāḥ*| *dhūmaketuḥ samidhā bhārjīkaḥ ityapi nigamo bhavati* || Nirukta (6.4)

appears to be closely related with hymns of the 8th book of RV. The transient nature of the fire, named *vibhāvasu* or *bhā* with links to *maruts*, amply hints at this object to be a comet. As per the MPRV explanation, this hymn is an invocation to the celestial *agni,* the comet deity, already deified from previous tradition.

In the RV hymn (I.94) to *agni* every verse ends with the refrain *let us not suffer injury as we have friendship with you. (agne sakhye mā riṣāmā vayam tava).* This is a prayer to *agni* seeking protection particularly from the fiery *maruts.* The first verse refers to *agni* as *jātavedas*. MPRV describes the technicalities of this word quoting the Bṛhaddevatā (BD) an important ancient authority on preserving the tradition of RV[6]. As per this, RV seers call terrestrial fire *agni*, fire in the mid-space *jātavedas* and fire in the sky *vaiśvānara*. There is a mystic meaning to the word *jātavedas*, but the localization of this fire is again mentioned in BD with the extra information that this fire is known to all (or seen by all) created again and again in mid-space[7]. This *agni* is thought about at every syzygy by offerings (*v*.4). The next verse (*v*.5) is interpreted differently by Sāyaṇa and Skandasvāmin. MPRV provides both the meanings, the one by Skandasvāmin reads more realistic. As per this, *agni* is seen all through the nights in different colours and is brighter than even the light at day break *(uṣaso mahān).* In (*v*.7) *agni* is praised as one who is seen to be similar from all places *(viśvataḥ sadṛńg asi*). Even though he is really at a distance (in the sky) he seems to be near. In (*v*.9), *agni* is requested to kill with his weapons the enemies of the devout. The next verse is

yad ayukthā aruṣā rohitā rathe vātajūtā vṛṣabhasyeva te ravaḥ |ādinvasi vanino ***dhūmaketunāgne*** *sakhye mā riṣāmā vayam tava ||* RV(I.94.10)

When you have yoked the wind driven red (animals) to the chariot, your roar is like that of a bull. You cover forest trees by a banner of smoke. Let us not suffer injury as we have friendship with you.

Here the word *dhūmaketu* seems to be used in the sense of a smoke cover. However the *agni* addressed in this hymn has for its background not any ordinary terrestrial fire but the one in mid-space significantly coloured red. The next verse (*v*.11) mentions that the drops of this *agni* eat grass *(drapshāḥ yavasādaḥ)*. The word *yavasādaḥ* literally means one who eats (burns) *yavasa* which is taken to be grass by tradition. But this may as well refer to destruction of grain fields. Sāyaṇa likes to interpret *drapsāḥ* as flames, but in the context of a fire from above, dropping of fiery matter would be apt. This is followed by a request to *mitra* and *varuṇa* to protect the poet from the strange fury of the *marut*s who live in the mid-space. The description of *marut*s is picturesque as,

avayātām marutām heḷa adbhutaḥ|| (I.94.12)

The cry (rumbling sound) of the descending maruts is strange (unprecedented).

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[6] *ihāgnibhūtastu ṛṣibhirloke stutibhirīlitaḥ | jātavedā stutomadhye stuto vaiśvānaro divi||* (BD 1.67):
[7] *vidyate sarvabhūtairhi yadvā jātaḥ punaḥ punaḥ| tenaiṣa madhyabhāgendro jātavedā iti stutaḥ||* (BD2.31)

Sāyaṇa explains this to mean, *the anger of the gods known as maruts moving below the heavens happens to be severe.* In the above hymn the word *dhūmaketu* is not used directly to refer a comet. But the hymn is about *agni* that is between the earth and the visible sky. The prayer is to ward off the danger posed directly by *marut*s, with ritualistic connotations linked to earthly fires ignited by atmospheric agents. The weapons of *agni* that could kill enemies, but from which protection is sought by the poet, can be conjectured to have been showers of stony meteoritic debris. This interpretation would be consistent with the action of *maruts* at other places in RV.

The only family book using the word *dhūmaketu* is the 8th book of the Kaṇvas. The first verse of hymn (VIII.43) declares this to be a laudation to *agni* the uninterrupted doer of sacrifice. The third verse mentions *agni* to be burning the forests. The immediate next two verses are

*harayo **dhūmaketavaḥ** vātajūtā upadyavi | yatante **vṛthag**agnayaḥ ||*

*ete tye **vṛthag**agnayah iddhāsaḥ samadṛkṣata | uṣasāmiva **ketavaḥ** ||* (VIII.43.4,5)

Individual forms of swift wind-impelled smoke-bannered fires move in the sky.

These separated fires shining in the front appear like heralds of the dawns.

In the next verse (*v*.6) the black dust raised by the feet of *jātavedas* as he travels, when fire spreads on earth, is described. The physical implication of the above verses would be that the composer is describing one or more celestial fiery objects with smoke or dust trails seen before dawn. These celestial fires are linked to fire on ground, which may indicate either a cause effect relation or a poetic similarity. The objects are many and said to be emphatically separated and moving. As a physical picture this fits the description of a meteor swarm encountered by earth while passing through the trail of a comet. Here the word *dhūmaketu* is used to indicate swiftly moving objects in the sky. Since the word dawn is used in plural (*uṣasām)*, perhaps this spectacle could be seen for several days before day break in the eastern sky. The next hymn (VIII.44) is also about *agni*. Here in (*v.*7) this *agni* is called ancient (*pratnam*) and invoker (*hotāram*) and the guest of honour in sacrifices (*adhvarāṇām abhiśriyam)*. This ancient *agni* is the object named as *Dhūmaketu Vibhāvasu*.

*vipram hotāram adruham **dhūmaketum vibhāvasum** |yajñānām **ketum** īmahe ||* (VIII.44.10)

Tradition interprets the word *vibhāvasu* as *one having light for wealth* (*dīptidhanam*) and identifies him with *agni*. If here also *dhūmaketu* meant the sacrificial fire of the humans, why once again the composer refers to *agni* as the banner of sacrifices? On the other hand the matter-of-fact meaning would be;

We pray to the wise guileless invoker, the comet (dhūmaketu, the smoke-bannered) vibhāvasu, the banner of (divine) sacrifices.

It is seen that in the 8th book the word *dhūmaketu* refers to visible transient objects that might have included meteors and comets in a general sense. In the tenth book the hymn (X.4) is about *agni* the link between men and gods, who traverses in between (*v*.2). In the next verse

(*v*.3) he is said to be eager to come to sacrifices on earth looking down from above with a desire to return. There appears considerable difficulty in interpreting the 5th verse with the word *dhūmaketu*. MPRV takes the first part as a question and constructs a meaning with which the commentator is not satisfied. The text and the interpretation are as follows.

kūcijjāyate sanayāsu navyo vane tasthau palito ***dhūmaketuḥ*** *|asnātāpo vṛṣabho na praveti sacetaso yam praṇayanta martāḥ* || (X.4.5)

Where is the new agni born? He is present in the old plants, grey haired, smoke-bannered. Though not needing a bath, as he is pure, he rushes to water like a bull….

This interpretation reads strained and forced. The simple meaning based on the context of the preceding and succeeding verses would be of a fire that is white in colour, seen above a forest. Its rush towards water may be a real event of a fireball entering a water body. This matches with *agni* being called *jātavedaḥ* later in (*v*.7), the technical meaning of which is fire in mid-space. Even though the meaning of the word *dhūmaketu* in this hymn remains ambiguous, it is still linked to a fiery object that approaches a water body, from above. The last appearance of the word *dhūmaketu* in RV is in

devo devān paribhūr ṛtena vahā no havyam prathamas cikitvān | ***dhūmaketuḥ*** *samidhā bhārjīko mandro hotā nityo vācā yajīyān* || (X.12.2)

Here, the word is used in the sense of sacrificial fire with no direct relation to the sky except for the qualification *bhārjikaḥ* as in (I.44.3). This completes a brief discussion on the seven occurrences of the word *dhūmaketu* in RV. It is noted that all the above hymns are addressed to *agni*, a prominent deity in RV. Interestingly in the tenth book *agni* is called *bhāsāketu* that means *light-bannered,* which is nearly the opposite of *dhūmaketu,* the *smoke-bannered.*

yamāsā kṛpaniḷam ***bhāsāketum*** *vardhayanti | bhrājate śreṇidan* || (X.20.3)

Sāyaṇa interprets the word *bhāsāketu,* as flame bannered fire or one who gives out light. It is not clear why this should not have been the name of a celestial object, for, in the very next verse this fire is described as *who when he moves up penetrates the ends of the sky, illumining the firmament*. Further the hymn lauds this fire as one that is standing above the sacrificial altar. Traditionally the phrase *sadma minvan puraḥ eti* in (*v*.5) is interpreted to mean that this fire *measures the fireplace by his movements*. This description would be more suitable for a bright celestial object that was stationary for some time and then started moving as though measuring the sky. Sāyaṇa's explanation of this as representing the sacrificial fire amply indicates that the Vedic sacred fire on earth is a symbol or simulation of a visible bright celestial object ritualistically invoked through special hymns. In (*v*.9) this fire is described to *move straight in a big car showing colours, white, black, red and crimson.* A cosmological background is also indicated here, since the car of *bhāsāketu* was fashioned by the Creator. On the whole this hymn is consistent in describing a comet-like celestial object, out of which some aspect of the terrestrial religious fire, as described in the later Yajurveda Samhitā and Brāhmaṇa texts, has been modeled. Similarly the word *vṛṣāketu* may be related with an object

seen in the night sky. This name appears in the hymn RV (X.92) attributed to Śaryāta son of Manu.

yajñasya vo rathyam viśpatim viśām hotāram aktoratithim ***vibhāvasum*** *|śocan śuṣkāsu hariṇīṣu jarbhurad****vṛṣāketu****ryajato dyām aśāyata ||* (X.92.1)

This *ketu* has some connection with *vibhāvasu* who was described in the hymn (I.44) considered previously. Here also *vibhāvasu* is called the guest of the night similar to (I.44). Sāyaṇa interprets the first half as a call to gods for worshipping *vibhāvasu*. His statement *paricarati iti śeṣaḥ* is an assumption. The second half is independently taken to mean *the giver of desires (vṛṣā), the banner (ketuḥ) reposes in heaven.* In line with Sāyaṇa, MPRV gives the meaning of the above verse as

You (gods, adore) the charioteer of the sacrifice, the lord of men, the invoker of the gods, the guest of night, the resplendent (agni). Blazing amid the dry (bushes) preying upon the green, the showerer of desires, the banner (of light), the adorable, reposes in heaven.

Since v*ibhāvasu* is a guest of night *(aktoḥ atithim)* with its location in the sky (*dyām asāyata),* the word *vṛṣāketu* most probably refers to a comet of that name.

Maruts

The above brief review brings out the major physical characters of *agni* called *dhūmaketu,* but clearly in relation with two other celestial objects namely *marut*s and *vibhāvasu*. *Maruts* are well known Vedic deities, taken to be representing *winds and thunder storms inducing rain* by traditionalists as well as by modern scholars. However, their explicit relation with *dhūmaketu* provides a clue to their correct decipherment as *meteoritic storms*. *Maruts* are a group of deities, usually known as the *sons of Rudra* and occasionally directly as *Rudrāḥ*. The key discriminatory feature of *marut*s is that they are a collection of individuals who could be seen and hence countable in some sense. They are said to be separated among themselves. They increase by two and three and their count varies from twenty-one (I.133.6) to forty-nine (VIII.28.5) to sixty-three (VIII.96.8). They could even be seen in waves of thousands (I.168.4). If these properties were to be reconciled with a physically possible natural object, *marut*s have to be taken as a shower of meteors. No doubt there are hymns associated with *marut*s that refer to lightning, rain, wind, thunderous sound and consequent shaking of trees, people and mountains. However, seen in the perspective of a celestial *agni* called *dhūmaketu* being a comet, the above actions of *maruts* are more valid for a swarm of meteors rather than for a monsoon thunder storm.

Maruts are closely associated with Indra in many hymns and these read like recollection of past events for a ritual. There is palpable spontaneity in the hymns to *maruts* with the figures of speech and epithets picturesquely describing a rare spectacle. In all, thirty-three full hymns are devoted exclusively to *maruts* and these deities are mentioned more than five hundred times by name in RV. Hence it is not possible here to discuss all the occurrences and the differing nuances of this word, used always in the plural, spread over the ten books of RV.

Interest here will be limited to descriptions of *marut*s that are graphic and hence appear like direct observations or recollections of some past episodes.

*Marut*s come (to earth) along with *agni* from above. They are brilliant with terrible forms and kill people. *Maruts* sit as deities in heaven, above the luminous vault. They move the mountains and disturb the oceans (I.19.6, 7). Here, following Sāyaṇa, MPRV argues that however strong a wind may be it cannot possibly shake hills, and hence the word *parvatān* should be taken as clouds and not as mountains. But if *maruts* are taken naturally for what they are, namely extra terrestrial objects, they could have shaken mountains with air blasts and impacts. In the next verse *marut*s are described as widening with their light *(raśmibhiḥ tanvanti*| I.19.8) and storming the oceans with their power. The earliest *aṅgiras* was *agni*, to support whom *marut*s were born with their glittering spears (I.31.1). Here traditionalists take *maruts* to be winds with the assumption that the word *raśmibhiḥ* should mean *sūryaraśmibhiḥ*. That this is an uneasy explanation is clear when we note that MPRV says that *vāyu* and *maruts* are distinctly different deities not only in the text of RV but also in the practice of Vedic rituals.

Three hymns (I.37-39) dedicated to *maruts* highlight their meteoritic nature, as being self luminous and spotted. The poet says in first person that he can hear from where he is located, the roaring sound of *maruts* (I.37.1-5). In the next verse the poet wonders, who could be the strongest among the *marut*s, since they shake heaven and earth like mere trees? The common man is said to be protecting his dwellings from the (impact of) *maruts*.

nivo yāmāya mānuṣo dadhra ugrāya manyave | jihīta parvato giriḥ || (I.37.7)

To withstand your ferocious journey man has strengthened his dwelling with columns. Even rugged hills get crushed (at your approach).

Maruts have mowed down men on earth and have made mountains fall. Wherever the group of *maruts* goes, everyone is sure to hear their roaring sound (I.37.12, 13). *Maruts* come from the sky to the earth, but not the other way round (I.38.2). That *maruts* could not go back from earth is ingeniously expressed as,

yadyūyam pṛśnimātaro martāsaḥ syātana | stotā vo amṛtaḥ syāt || (I.38.3)

Children of Pṛśni! You may become mortals, but let those who laud you remain not dead.

Maruts are sure to bring airless showers to deserts (I.38.7). MPRV wonders why the word airless (*avātām*) has been used to describe showers (*miham*). This doubt arises if *miham* is taken as ordinary rain. An intense meteoritic shower can make the target region airless for some time, which fact was known to Vṛddha Garga a later astronomer[8]. It is repeatedly said that people were afraid of *marut*s. If these deities were really harbingers of monsoon rainfall, the following descriptions read out of place.

[8] *patanti gagane colkāḥ sanirvātā diśo daśa*| *sajvālāngāradhūmādyāḥ sūryasyābhimukhā iva* || (Unpublished Manuscript No.1402, RORI, Alwar. Also quoted by Ballālasena in his Adbhuta Sāgara.)

adha svanāt marutām viśvam ā sadma pārthivam | arejanta pra mānuṣāḥ || (I.38.10)

At the roar of the maruts, every house on the earth shook. The people also trembled.

parāha yatsthiram hatha naro vartayathā guru| vi yātana vaninaḥ pṛthivyā vyāśāḥ parvatānām|| (I.39.3)

When you overthrow what is stable and whirl away what is heavy, your course is through the forests and the mountains.

ā vo makṣū tanāya kam rudrā avo vṛṇīvahe |gantā nūnam no'vasā yathā puretthā kaṇvāya bibhyuṣe || (I.39.7)

Sons of Rudra! We pray to you for the quick protection of our progeny. Like you came once previously, come for the sake of frightened Kaṇva.

Nodhā Gautama in hymn (I.64) describes *maruts* as having fearful forms. They are drop-like (falling objects) and shining like suns (*asurāḥ ghoravarpasaḥ drapsiṇaḥ sūryā iva śucayaḥ* | I.64.2). It is indicated that *maruts* induced winds and rains before their arrival. This seems to have been the reason for the traditional interpretation of *maruts* as storm deities before rainfall. In the hymns (I.86, 87 & 88) Gotama Rāhugaṇa mentions that *maruts* were worshipped by people since many years seeking protection. *Marut*s are described as having wheels of gold and rushing like boars with tusks of iron (*ayodamṣṭrān vidhāvato varāhūn*). The epithet *asurāḥ* above does not indicate any ethnic group but just that *marut*s as deities in the sky threw stones and other objects towards earth. The word *asura* is derived traditionally, as explained by Sāyaṇa, from the root *asu kṣepaṇe* (to throw).

Hymns (I.166) onwards by Agastya further reveal the physical side of *maruts*. All creatures on earth along with their dwellings shake in fear that they might get hit by the weapons of *maruts*. The tearing weapons of *maruts* hit animals like well aimed darts. *Marut*s are visible at a distance shining like stars (*dūre dṛśo ye divyā iva stṛbhiḥ*| I.166.11). Their visible hair-like extension is figuratively described as *Rodasī*, their companion with disheveled hairs (*viṣita stukā* I.167.5). *Marut*s, although formless, seemingly have a form. They are self born and always tremble in their path. They come in thousands like waves on water (I.168.4). They came down to earth together effortless, with burning looks and shook the mountains (*svayuktaḥ divaḥ vṛthā ava āyayuḥ…bhrājadṛṣṭayaḥ dṛḷhāni cit acucyuvuḥ* || *v*.5). The next verse, indirectly mentions that they enter the sea. *Marut*s on their approach gleam like serpents *(ahi bhānavaḥ*). The material of the weapons of *marut*s is made clear by Agastya as,

Far be from us, your impetuous shaft. Far from us be the stone you hurl (1.172.2)

In the second book, sage Gṛtsamada prays to *Rudra*

…….mā naḥ sūryasya sandṛśo yuyothāḥ…….||

pariṇo heti rudrasya vṛjyāḥ paritveṣasya durmatirmahī gāt|| (II.33.1 & 14).

....O, father of maruts, do not exclude us from seeing the sunlight…. Let not Rudra's quoits have us as targets. Let his frightening anger avoid us.

Even though *marut*s poured in, the material they rained is not said to be ordinary water. It is described as *Soma*, ghee, milk, honey or a liquid coloured like honey. *Marut*s showered medicines which were accepted by Manu the ancestor of the poet (II.33.13).

If one agrees to the principle of internal consistency as an approach to understand RV, one can not assign different meanings to the same word used in very similar contexts. Doubts arise about the words *parvata* and *giri* occurring in connection with *maruts*. Traditionalists take this to be mountains in some verses but as clouds in other places. A typical example of this ambiguous interpretation is in hymn (III.26) attributed to Viśvāmitra. Sāyaṇa assumes *maruts* produce a rain of water and hence takes the word *parvatān* to mean clouds, where as there is nothing in the three verses (III.26.4-6) to indicate ordinary rainfall. The statement *marutaḥ pravepayanti parvatān* should normally mean *maruts shake the mountains.* This remains consistent in all places if *maruts* are understood to be representing meteorites or fragments of extra terrestrial objects falling on earth.

Ten of the thirty-three hymns devoted to *maruts* are found in the 5th book. These are important since tradition holds hymns (V.52-61) to be the inspired composition of seer Śyāvāśva. Hymn (V.52) is a laudation in which *marut*s are said to be capable of exceeding the nights in their travel, which means they were visible in day light also. In (V.52.7) they are praised as seen in the sky, on earth and in the rivers. Specifically they are found in River Paruṣṇī *(v.9)*. *Marut*s dug a well for Gotama (*v*.12), as in RV (1.85.10-11) which in physical terms would mean creation of an impact crater. This hymn ends in (52.17) referring to River Yamunā. The next hymn (V.53) starts wondering *who knows the origin of maruts?* They release their treasury for their devotee (*v*.6) and help release *parjanya* (rain water?). Further, in (*v*.9) six more rivers Rasā, Anitabhā, Kubhā, Krumu, Sindhu and Sarayū are linked with *maruts.* The prayer in (*v*.13, 14) is for the material showered by *maruts* namely, seeds (*bījam*) and water (*āpaḥ*). Hymn (V.54) is a laudation to the force or power behind the group of *maruts*, who with stony weapons (*aśma didyavaḥ*) disturb mountains. They, children of Rudra, shake everything like a boat on water, day and night, and disturb forts difficult to enter *(durgāṇi).* Hymn (V.55) is a prayer in which *marut*s are described to make a shower out of the sea (*samudrataḥ*). The material carried by them is called *purīṣa*, which is not rain water, but assumed to be so by Sāyaṇa. Hymn (V.56) is an invocation to *maruts* to come down to earth from above. Effortlessly, *maruts* bring down the rocks of the mountains. In (V.57) they are called *vāśimantah,* as in (I.87.6). As per Yāska this refers to weapons made of stones or to voice. Clearly, this epithet refers to stony meteorites making rumbling sound as they approached earth at high speed. *Marut*s are in the form of large drops *(purudrapsāḥ)* and carry the name *amṛtam.* Hymn (V.58) contains verses in which *marut*s are associated with water. But in (*v*.5) *maruts* are described to be of equal measure like spokes (in wheels) and (length of) days. Traditionalists take the first verse of hymn (V.59) to describe rainfall, by stretching the word *arṇava* to mean clouds. However, direct reading of the verse only indicates a shower of bright materials getting into the seas. The next verse (V.59.2) does not

refer to rainfall, but to the trembling earth compared to a shaking boat. Hymn (V.60) is similar to others in highlighting the power of *marut*s to disturb the mountains.

parvatścinmahi vṛddho bibhāya divaścitsānu rejate svane vaḥ | yatkrīḷatha maruta ṛṣṭimanta ***āpa iva*** *sadhryañco dhavadhve ||* (V.60.3)

Hey maruts! When you start playing, even the ancient big mountain fears your sound. The lofty regions of the sky tremble. Carrying spears you rush together like a stream of water.

The comparison *āpa iva* in the above verse, should put to rest doubts about *marut*s being agents of rainfall. Their stormy shower was only *like* a water stream.

In the sixth book of RV, hymn (VI.66) describes *maruts* as *samānam* in the first verse. Sāyaṇa explains, *marut*s are always of the same form (*marutaḥ sadā samānarūpāḥ)* and quotes RV (V.60.5) to emphasize that there are no elders and youngsters among them (*ajyeṣṭhāso akaniṣṭhāsa ete).* The next verse (VI.66.2) mentions that *maruts* shine like fires and increase by two and three. They are dustless and created with gold, wealth and power. The MPRV meaning for the word *girayaḥ* in (VI.66.11) as clouds unnecessarily negates the above realistic description of *maruts* as visible transient objects.

The lauds to *maruts* in the seventh book by Vasiṣṭha are similar to the hymns by other seers. *May your weapons be far from us,* is the constant prayer (VII.57.4). The birth of *marut*s was with great commotion. They were fast, fierce and wrathful. The whole world was afraid to look at them during their brightened travel (VII.58.2).

In the eighth book there is some further interesting information about *marut*s. The seventh hymn describes *marut*s in the same way as in other books, but is emphatic on the hills and peaks getting physically affected. Like hills control themselves (bend) at the arrival of *marut*s, even rivers control their flows (VIII.7.5). This meaning is acceptable to Sāyaṇa also. The last three verses of this hymn show that *marut*s should have been extra terrestrial objects hitting hill peaks. These were thought to be connected with a celestial object, referred by the generic name *agni.*

girayścinni jihate parśānāso manyamānā | parvatāścinni yemire ||

ākṣṇayāvāno vahantyantarikṣeṇa patataḥ | dhātāraḥ stuvate vayaḥ ||

agnirhi jāni pūrvyaścchando na sūro arciṣā | te bhānubhirvitasthire || (VIII.7.34-36)

(As the maruts arrive) hills get hit and disturbed from their position. Even mountains are controlled. Speedy carriers bear the flying maruts through space. They are givers of riches to the worshipper. Agni was born previously (among gods) bright like the sun. Then the maruts stood surrounding him with their lights.

The above rendering closely follows Sāyaṇa, with the word *girayaḥ* here being taken as hills by him also. The word *ākṣṇayāvāno* is explained by Sāyaṇa as traveling faster than the eyes. There is one more hymn lauding *marut*s in the eighth book by Sobhari Kāṇva. In this we find a reference to *maruts* disturbing islands and deserts (VIII.20.4). In this hymn the 13th verse

informs that even though *maruts* are many and extend widely like a sea, they are known by only one name as per ancestral tradition. In (VIII.20.17), *maruts* are qualified as sons of Rudra (*rudrasya sūnavaḥ*) and as *asurasya vedhasaḥ*. The word *asuraḥ* is explained by Sāyaṇa at many places as *one who throws,* derived from the root *asu kṣepaṇe* (to throw). However in the present verse he interprets *asuraḥ* as *creator of clouds*, which hardly fits the context. The direct meaning of *one who throws* (stones/missiles) is appropriate here also, since the falling objects would have been like stones.

In the tenth book hymns (X.77 & 78) are devoted to *maruts*. These appear to have been composed after the status and position of *maruts* in the sacrifices had been finalized. Oblation to *maruts* is mentioned in (X.77.7), which is not so conspicuous in the other books of RV. An interesting highly technical simile describes the motion of *maruts* as, *like the nave of a wheel with spokes* (*rathānām na ye arāḥ sanābhayaḥ* | X.78.4). Sāyaṇa explains this in detail as; *even though maruts are several, they move equally spaced like spokes connected at the center of a wheel*[9]. The descriptions of *maruts* in the various hymns are broadly similar, with minor differences which indicate repetition of the same natural event with variation in the details. Inducing rain was not the main function of RV *marut*s, as assumed by the tradition and later classical Sanskrit literature. Relation with water is a minor detail mentioned in the 5th book, but otherwise the majority of the hymns uniformly describe *marut*s as a collection of bright objects that moved in swarms, appearing even in day times. They made a characteristic sound inducing fear in men. They were known to bring stones hitting the hills and the ground. At least once they created a crater with water for Gotama. This poetic but nevertheless realistic description cannot possibly be valid for any event other than a cluster of meteorites or fragments of an asteroid hitting the earth.

Vibhāvasu

Our study of the word *dhūmaketu* shows that this *fire in the sky* was related with *maruts* and also with *vibhāvasu*. From a detailed study of RV text it is seen that *maruts,* beyond reasonable doubt, must have been showers of meteors and/or meteorites. Since comets and meteor showers can have causal connections, it appears that *vibhāvasu* in some places of RV refers to a comet. This word is interpreted in the tradition of Sāyaṇa as *fire* qualified as *wealth of the night*, which is the literal meaning obtained by breaking the word into its two components *vibhā* and *vasu.* Even in this sense it retains in its name a significant comet image. The word *vibhāvasu* occurs in the first (I.44.10), third (III.2.2) and the fifth (V.25.2, 7) books. Next it is used five times in the eighth book, twice in the 9th book and thrice in the 10th book.

In the second verse of the *agni-vaiśvānara nivid* (III.2) by Viśvāmitra, the birth of *agni* is described. As per the Bṛhaddevatā, *nivids* indicate the qualities of the deities addressed in such hymns. *Agni* is here described as brightening heaven and earth at his birth. He is qualified also as *viśām atithiḥ vibhāvasuḥ*. This is taken as *guest of men, affluent in radiance.*

[9] *rathānām na rathacakrāṇāmivārāḥ te yathā bahavo'pi sanābhayaḥ samānanābhayo bhavanti tadvadye sanābhayaḥ samānabandhanā ekasminnevāntarikṣe vartamānāḥ* || (Sāyana's commentary on RV X.78)

Since the word *viś* means *maruts* in several other places, here also the *agni* referred must be related with *maruts.* As per the Bṛhaddevatā *vaiśvānara* is fire in the sky, *jātavedas* fire in the mid-space and *agni* the fire on earth. In the 14th verse of (III.2) the prayer is to the fire seen *at daybreak, emblem of the sky, a big horse* (*uṣarbudham divaḥ ketum mūrdhānam vājinam brhat|).* The implied meaning of the hymn is that, *vibhāvasu* was a horse-like fire seen in the eastern sky early in the morning *(rochanasthām)*. This leads to the inference that the word here stands for a comet.

In RV (V.25.2) the reference is to the fire praised as *vibhāvasu* who was kindled in the past by gods and seers. Further in (*v*.7), this *agni* is addressed as *vibhāvaso*, because from him riches come out. Quite interestingly in the 8th verse this fire is lauded as self effulgent in the sky, making thundering sound and *is said to be like a huge rock* (*bṛhat grāveva ucyate*). It is generally observed that the word *Vibhāvasu* is used in RV with differing meanings, but it refers to a celestial figure, identifiable as a comet in a few places.

Many More Comet Images

The reference to *dhūmaketu* identifiable as Comet appears in the relatively late books of RV namely, the first, eighth and the tenth *maṇḍala*s. However, there are distinct references in the earlier books of RV to an ancient fire in the sky correlated with *agni, vaiśvānara, mātariśvan, arvan, ajaikapāt, ahirbudhnya, pūṣan* and other deities. Hence, in the earlier layers of RV transient celestial objects might have been described using nomenclature the original physical meanings of which might have been forgotten. The only way to address this issue is to see how likely such celestial fires match with known modern comet and/or meteor images. To keep the discussion brief, only three such instances are considered here.

The famous hymns (I.162 & I.163) on *Aśva* by Aucathya are traditionally taken to refer to the Horse-sacrifice (*Aśvamedha*). But these hymns primarily describe a bright horse-like moving object in the sky. This event in a slightly different form appears also in the Mahābhārata[10]. In hymn (I.162), the celestial horse, a replica of which is sacrificed in the *Aśvamedha* is described. This is the *medhyāśva* (sacrificial horse) born out of *tvaṣṭā* (I.162.19). This particular verse has two meanings referring to both the divine horse which was killed by gods and the terrestrial animal which is to be similarly sacrificed by men. MPRV quotes the Taittiriya Samhitā to clarify the close relationship between *tvaṣṭā* and *arvan*[11]. The deity called *arvan* was the first born in the sky, making sound, with wings of falcon and ankles of deer (I.163.1). This horse given by *Yama* was harnessed by *Trita* for *Indra* to ride. Here the word *Yama* is interpreted in the Nirukta as *agni*, which as per Sāyaṇa would indicate the simultaneous birth of *agni* and *Indra.* In (*v*.3) this *arvan* is said to be threefold with three bonds in the sky *(trīṇi divi bandhanāni*). Sāyaṇa interprets these three bonds to be similar to the three ropes with which an earthly horse is held[12]. Further, the seer describes the sequence

[10] *tvāṣṭrī tu saviturbhāryā vaḍavārūpadhārinī | asūyata mahābhāgā sā'ntarikṣe aśvināvubhau ||*
mahat hayaśiro bhūtvā yattad vedavido viduḥ | tamagnim udgiran vaktrāt pibatyāpo mahodadhau||
(MB. Ādi Parvan 66.36 & 180.22)

[11] *tvaṣṭā vīram devakāmam jajāna tvaṣṭurarvā jāyata āśuraśvaḥ||* TS (V.1.11)

[12] *āhuste trīṇi divi bandhanāni||* TS (IV.6.7):

in which he saw the horse. In (*v*.5) he says; *I saw your reins* (*te bhadrā raśanā apaśyam*). Next the poet saw the head of this horse. MPRV reports two types of arranging the words of (*v*.6), to yield meanings applicable to the earthly horse and the heavenly horse respectively. In the derived meaning, the horse is said to be going from the earth by way of heavens to the sun. The primary meaning is; the poet in first person says that *he saw the head of the horse in the sky flying down towards the earth* (*divā avaḥ patayantam patatri….. śiraḥ apaśyam* || I.163.6). This is continued in the next verse to inform: *I beheld your best form at the cow's foot (te rūpam uttamam apaśyam……ā pade goḥ*|). Sayaṇa takes the word *goḥ pade* to mean the sacrificial place on earth, which is the secondary meaning of the hymn suited to the sacrificial tradition. However, primarily for an object seen in the sky it should have been natural to mention its location with respect to the stars and hence one should take *cow's-foot* as the *nakṣatra* with that meaning which is *proṣṭhapada* (Pegasi). Reference to this location appears again in RV (III.39.5 & IX.71.5). The hymn which so far described a single object, refers in the next verse (*v*.10) to multiple celestial horses comparing their flight to that of a line of swans *(hamsā iva śreṇiśo yatante|).* This picture is a plain indication of transient celestial objects flying like birds in a line. This simile is again used in (III.8.9) to describe the arrival of *yūpāḥ,* the sacrificial columns of gods in the sky, which has an inbuilt comet image.

The 48th hymn in the 6th book is about *agni* and *maruts.* The sixth verse in this hymn describes the sight of *agni moving in the night sky along with smoke. He with attractive colours becomes visible pushing aside the darkness and stays through the night (dhūmena divi dhāvate…śyāvāsu ūrmyāsu tamaḥ tiraḥ ā dadṛśe|).* From (*v*.11) onwards *maruts* are praised to bring riches from above. In (*v*.21) the poet mentions that *maruts* cover the sky with their brightness like the sun and are the cause of killing *vṛtra*. The last verse mentions that the earth and the sky got created only once. Similarly the milk of *pṛśni,* namely *maruts,* showered only once. *Pṛśni* is the night sky dotted with stars, compared to a spotted cow. This hymn is inspired by a special sky event to sing a prayer to *agni* and *maruts.*

The hymn to *keśins* (X.136) has definite comet imagery. This hymn is about bright, long hairy objects in the sky. However, the hymn also reflects deeper mystical and philosophical thoughts. This hymn has the earliest reference to the concept of *vātaraśanāḥ*, which in later Indian astronomy became the invisible air-strings of force holding the planets in their position. This hymn perhaps indicates a cosmic view emerging out of traditional knowledge and new observations.

Veiled Sun

The above analysis of RV, even though limited in extent, makes a case for the ancient seers to have witnessed some unusual and spectacular events in the sky. But, the description of the purported effects of the transient sky objects on earth is intriguing. When the hymns describe distress it would appear that the community had to face some unexpected adverse climatic conditions due to a disturbed sky. This is not a farfetched inference when it is noted that in several hymns the physical sun is said to be covered by some type of dust, so much so there was no recognizable day break for considerable length of time. There are too many hymns and legends about this event for us to ignore the absence of sunlight as a poetic license to

describe the dark night of the human soul or as the prolonged winter of the northern latitudes. In RV (I.51.4) Indra is said to have established sun after destroying *vṛtra*. In RV (I.86) *maruts* are prayed to remove the darkness and create the light for which people were longing. Hymn (I.175) is about Indra stealing Sun's wheel, which is an euphemism for the absence of normally expected rise, movement and setting of the Sun. Hymns (I.183 and 184) refer to the ending of a period of darkness. In the second book hymn (II.15) is about Indra crushing the vehicle of *uṣas,* which is a metaphor for a continuous dawn like condition without a visible sun. Indra had to be supplicated by men who struggled to get sunlight (II.19). Indra found the sun dissolving in darkness near the cow's-foot (III.39.5, 6). In (4.16.9) Indra is implored in the battle for sunlight. Indra is said to have hurt *uṣas*, daughter of the sky which refers to absence of day break, near River Vipāśa (IV.30.9-11). This event is recounted in a slightly different form in the tenth book in hymn (X.138). In hymn (V.31.11) when the night was ending, sun's wheel is said to have gone backwards. This is again a reference to absence of day break and nonexistence of observable sun's movement across the sky. Even though the temporal ordering of the various events is left in doubt, the metaphoric texts lead one to perceive extreme climatic conditions preceded by uniquely spectacular celestial events. *Maruts* should have had an important role to play in these natural events, since they are said to reduce heat and conduct a sacrifice in the heavens (V.54.1). In (V.59.5) it is said that *marut*s are capable of blocking the sun by their showers (*sūryasya cakṣuḥ pra minanti vṛṣṭibhiḥ|).* This has been routinely taken, by many translators, to be a cloud cover on a rainy day. However, this interpretation does not match with the immediate next verse, which refers to a special event in the sky.

Like line of birds they flew in lengthened lines from heaven's ridges to the borders of the sky. Rudra's children are all similar with none younger or older. (V.59. 6, 7)

This must have been a wide meteoritic ring or trail of a comet obstructing the sun's orb being seen from the earth.

In (VI.7.5) *vaiśvānara* is praised to have freed and set the sun in the sky for all to see. A similar statement occurs in (X.156.4) mentioning that *agni* has made Sun mount the sky. Several hymns to Indra are prayers for sunlight or laudation after sunlight was restored. In (VI.17.5) Indra gives splendour to Sun, which had been lost. In RV (VI.39) the reference is to a light called *Indu* which brightened the worlds that were not shining. Reference to the widespread abnormal darkness appears in one form or other in several places of RV, with its all pervasive cosmological, philosophical, mystical and religious influence running through the later Vedic texts[13]. Some hymns of RV praise Indra for having given light to sun as in (VIII.3.6). A few others (VIII.12.30, VIII.89.7) laud Indra for having fixed sun in the sky. In the hymn (X.37) dedicated to Sun, the general prayer is; *May we never suffer from want of sun's presence,* which is very similar to the verse (II.33.1) from an earlier stratum of RV. One of the most cryptic descriptions of the sun being covered up is in the seventh book,

[13] *citrāvaso svasti te pāramśīyetyāha rātrirvai citrāvasuravyuṣṭyai vā etasyai purā brāhmaṇā abhāiṣurvyuṣṭimevāvarundhe* || Tai.Sam. (I.5-7) (In ancient times the sages feared that they may not see the dawn again. By the Citrāvasu hymn, it is said, they won the dawn.)

tānīdahāni bahulānyāsan yā prācīnamuditā sūryasya | yataḥ pari jāra ivācaranty uṣo dadṛkṣe napunar yatīva|| (VII.76.3)

Many days were over before the old sun rose again. In this period Uṣas was seen behaving like a maiden with her lover.

The above is a plain statement that once, there was a long gap between dawn and sun rise. It also implies that the Vedic seers considered this period to be *uṣas* or dawn only. Since nothing is said about the nights, it is conjectured that they could recognize the passage of time as implied in the key phrase *ahāni bahulāni* (many days). The immediate next verse (VII.76.4) mentions about the ancestors of the poet rejoicing after discovering the hidden light of sun. The above incident and the verse are perhaps the basis for all later legends associating *Prajāpati* (Creator) with *uṣas* (his own creation figuratively called daughter) as in the Vedic Brāhmaṇa literature[14].

Discussion

As is known *agni* and *Indra* are the most important deities in RV. This is true, not only in a statistical sense, but also in terms of the importance they have carried in the Vedic rituals and literature devoted to the elucidation of RV. Even though the original *agni* of RV was clearly celestial, the terrestrial sacrificial *agni* assumed greater significance in the traditional *(yājñika)* interpretation of RV by Sāyaṇa and others before him. The reason for this is not difficult to find. The Vedic religion of *yajña* on earth is a replica of what the gods did once upon a time. This *yajña* of the gods was of celestial origin with its effects reaching the earth. Hence this was of profound spiritual significance to the originators of Vedic religion and philosophy to raise questions about the place of man in the universe culminating in the *Vedānta* or the *Upaniṣads*. There are several instances in the Vedas where this point is stated either metaphorically or even directly. In the second book (II.21.5), Uśijs (Aṅgiras) are said to have found the path by means of *yajña.* The allegorical reference is to the overthrow of *vala* to get the waters released. RV hymn (VIII.89) by Nṛmedha and Purumedha (Aṅgiras) is about Indra supported by *marut*s as a group. In this hymn the principle of *yajña* is said to have originated when Indra spread between the earth and the sky for killing *vṛtra*. This *yajña* of gods had a corresponding sacrifice on earth also, which in modern parlance could be called a natural disaster. Maitrāyaṇī Samhitā mentions that gods did a sacrifice at Kurukṣetra[15]. This is confirmed with further elaborations in the Taittirīya Āraṇyaka[16]. Taittirīya Brāhmaṇa categorically states, *marut*s killed Prajāpati's creatures because they (*marut*s) were not initially worshipped by the people. Prajāpati (Progenitor of people) had to behold a particular offering and present it to *maruts* in order to save his creation[17]. A similar statement occurs in

[14] *prajāpatirha svām duhitaramabhidadhyau| divam voṣasam vā mithunyena yāsyāmiti tām sambabhūva||* ŚB.(I.7.4.1-4)

[15] *devā vai sattramāsata kurukṣetre||* Mai. Sam. (IV.5.9)

[16] *devā vai satramāsata…teṣām kurukṣetram vedirāsīt| tasyai khāṇḍavo dakṣiṇārdhamāsīt| tūrghnamuttarārdhaḥ| pariṇajjaghanārdhaḥ| marava utkaraḥ ||* Tai. Āra. (5.1.1)

[17] *saṃvatsaro vai prajāpatiḥ| saṃvatsareaivāsmai prajāḥ prājanayat| tāḥ prajā jātā maruto'ghnan asmān api na prāyukṣateti| sa etam prajāpatirmārutam saptakapālam apaśyat| yāḥ pūrvāḥ prajāḥ asṛkṣī| marutastā avadhiṣuḥ ||* Tai. Brā. (I.6.2.2-3-4)

the same text about *marut*s disturbing the work of Prajāpati[18]. Since RV is the earliest among the Vedas, other texts derive inspiration from RV for their contents and practices. Thus Vedic literature has evidences to infer, the sacrifice by the gods through the agency of meteoritic storms called *marut*s in RV might have depleted population in the northern parts of ancient India.

The present study started by tracing the word *dhūmaketu*. In the sequel *maruts* and *vibhāvasu* were found to be intimately connected with the fiery *dhūmaketu*. *Vibhāvasu* could be the name of one or more comets but the evidence is equivocal. It is possible this word was used in some hymns as a qualification for *agni,* which depending on its location was called by different names. In one place significantly, *vibhāvasu* is said to be like a big rock (V.25.8) making one surmise that the ancients had guessed the basic nature of these near earth objects, sometimes called deities but at other instances as demons, correctly. It is *maruts* that get more space than the other two objects considered here, almost competing with Indra and *agni* with whom they are any way closely related. The minimal commonality in the physical feature of *marut*s, is their countable membership to a group (*gaṇa*), unlike undifferentiated masses of clouds or sheets of water. The Brāhmaṇa texts explain that *marut*s are *viś;* the groups (or clans) and this means their abundance in the skies[19,20]. The perception of the RV composers (I.27.12) was that as in their community traders and agricultural people (*viś*) were in abundance, so were *marut*s abundant in the sky. The Taittirīya Brāhmaṇa declares this explicitly; *maruts are the most numerous among the gods*[21].

Three broad phases can be discerned in the description of *marut*s. The first, probably the earliest in time, are hymns which express awe at the approach of *marut*s. These also express a sense of fear that *marut*s are prone to kill people on earth. In the second group are prayers so that the shower of stones may avoid the worshippers of *marut*s. The third layer contains hymns wherein *marut*s are invoked to come to prayer or worship. It may not be wrong to conjecture that this trend should have been directly matching with the frequency of the storms of *maruts*. We also find hymns in which *marut*s are prayed to bring medicines and precious materials (*sanāddhi vo ratnadheyāni santi* | X.88.8). This should be a later view of *marut*s after physical examination of the falling objects and a feel for their contents. A point to be reconciled is the meaning of *maruts* as wind deities in later literature. We guess, with the status of Indra getting downgraded in time to a mere rain god, *marut*s always linked with Indra, were also brought down as wind deities. This has happened notwithstanding the fact *parjanya* and *vāyu* are the independent rain and wind deities in RV.

The later Vedic texts corroborate the above points, since they essentially describe invocations and offerings to *maruts*. The Taittirīya Āraṇyaka which, states that *marut*s were in abundance and killed people, also states that there is only one Rudra and the innumerable thousands

[18] *maruto yajñamajighānsan prajāpateḥ* || Tai. Brā. (I.3.4.4)

[19] *viśo vai maruto bhūmo vai viṭ* || ŚB. (III. 9.1.17)
[20] *maruto hi vai devaviśaḥ antarikṣa bhājanāḥ* || Kauṣītaki Brā. (7.9.16):
[21] *maruto hi devānām bhūyiṣṭāḥ* || Tai. Brā. (2.7.10.1)

(Rudra's children) are not seen any more but only remembered[22]. It also associates a season with *maruts,* namely the *hemanta ṛtu* the dewy season which is the two month period ending with the winter solstice[23]. It is most likely; *maruts* were thought to originate from a particular object in the sky, called *Rudra*. In many hymns of RV *maruts* are the children of *Rudra,* and their downward gliding motion is described by the unique word *skandanti* from which the proper name *Skanda* has originated. It is noted here that not in all Vedic literature *marut*s are denoted as Rudra's children. The Taittirīya Āraṇyaka differentiates *rudragaṇa* from *marut-gaṇa* and mentions that the first appear in the *grīśmaṛtu,* the two month season ending with the summer solstice before the rainy season starts. The latter appear in the *hemantaṛtu*, as in the Taittirīya Brāhmaṇa. The commentators mention that both are sky deities appearing in their respective seasons. *Rudragaṇa* is described as being white robed and recurring with the summer season[24]. The second group appears red with anger as though ready for battle in the dewy season[25]. It is easily recognized that both are meteor groups separated by six months. This again makes a case for ancient sky observations and earthly rituals going hand in hand. It also hints at the development of observational astronomy starting with the identification of seasons, connected with the observable meteor showers, which once should have caused destruction on land. This raises the question whether *marut* was a generic word for all types of meteoritic activity or it referred to particular types. This cannot be answered definitively at present. *Ulkā* the popular word for meteorite in classical Sanskrit is already in use in RV. This word in plural occurs in (IV.4.2) where *agni* is asked to cast his firebrands (meteors) around. Again *ulkā* appears in the singular in (X.68.4) where a meteor is said to be cast down from Sun. The group nature that is special to *maruts* is absent in the occasional meteor called *ulkā*. It is not the case that the composers of the 4th and the 10th books were not aware of *marut*s. But they deliberately brought in a new word to discriminate *maruts* from other transient falling objects. The Ṣaḍvimśa Brāhmaṇa further brings in new terminologies and events *tārāvarṣa* or star showers, and *dig-dāha* meaning blaze of the cardinal directions or zodiacal light in addition to *ulkā* and *ketu.*

Modern Concepts

Only a small sample of RV hymns is investigated in the present study. But, if the events described in these were descriptions of real events, either by direct experience or based on family tradition, the situation would indicate the occurrence of an ancient natural disaster attributable to meteoritic showers, comets, dust veils and climate alteration for an extended length of time. Evidence for such a severe natural disaster to have occurred in ancient India is available also in the Mahābhārata and the Skānda Purāṇa[26].

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[22] *ya eko rudra ucyate| asankyātāḥ sahasrāṇi smaryate na ca dṛśyate||* Tai. Āra, (I.12.1)

[23] *hemantaṛtunā devāḥ marutastriṇave stutam* || Tai. Brā. (II.6.19.2)

[24] *viśeṣaṇam tu vakṣyāmaḥ| ṛtūnām tannibodhata| suklavāsā rudragaṇāḥ | grīṣmeṇāvartate saha | nijahan prthivīm sarvām* || Tai. Āra. (1-3-3).

[25] *abhidhūnvanto abhighnanta iva| vātavanto marudgaṇāḥ| amuto jetumiṣumukhamiva| sannaddhāḥ saha dadṛśe ha| apadhvastairvastivarṇairiva| viśikhāsaḥ kapardinaḥ| akruddhasya yotsyamānasya| kruddhsyeva lohinī| hematah cakṣuṣī vidyāt| akṣṇayoḥ kṣipaṇoriva* || Tai. Āra. (I.4.2)

[26] *Profile of a natural disaster in ancient Sanskrit literature*. By R.N.Iyengar; Ind. J Hist. Sci., 2004; 39.1. pp. 11-49.

In recent years scientific evidence for near earth objects to have impacted earth in the past has been growing. The path of the Taurid group of extra terrestrial objects consisting of meteors, meteoroids, asteroids and Comet Encke intersect the orbit of the earth making earth vulnerable for impacts from these objects. Some of these objects instead of reaching the ground may vaporize in the atmosphere leading to air blasts and fires as it happened in Tungska, Siberia in 1908. It is held by astronomers that in the last 10,000 years Comet Encke split and further disintegrated to leave a trail of debris which caused dust veils that would have temporarily blocked sunlight reaching earth[27,28]. Thus, the Ṛgvedic descriptions of *marut*s killing people on earth, birth of *agni* and the Horse in the sky, *vṛtra* covering the sun, Indra restoring sunlight, breaking down of *viśvarūpā* son of *tvaṣṭā* and celestial deities coming down to earth (India) to become important in cultural and religious practices, are to be taken as natural events of low probability but not impossible to have happened in the fourth millennium BCE or earlier.

Chronological Footprint

The relatively late usage of the word *dhūmaketu* in RV has chronological significance for understanding the development of astronomy in ancient India. The word *dhūmaketu* for a transient celestial object in the RV and in the AV is in harmony with the use of the word to indicate a comet in later literature. This acquires significance since, names of some of the Vedic deities (*devatā*) coincide with the names of comets and other non-planetary objects described by Parāśara, Vṛddha-Garga, Nārada and Devala who have left records of what may be called scientific literature prior to the development of mathematical astronomy in India[29]. Parāśara knew twenty six comets (*ketu*) long before Varāha-mihira (6th Cent. CE) stated them in the wrong order in his Bṛhatsamhitā. The last comet of this list was called the *dhūmaketu.*

The most conservative dates for RV agree that the canons were closed, including the late 8th and the 10th books, by 1500 BCE. This, situation not only supports the deciphering of some RV deities as transient celestial objects, but also indicates the existence of a parallel tradition of sky observations contemporaneous with what is mentioned poetically in RV. Parāśara and subsequently Vṛddha-Garga had more things to say about comets. These conspicuously included their specific names, year number, and position in the sky, movement, color, visibility, duration, and effect on earth. They also classified meteors *(ulkā)* into five types. Parāśara and Vṛddhagarga mention that a *graha* (grasper) called *Tvaṣṭā* can darken Sun and Moon at odd times. Varāha-mihira, a votary of mathematics for predicting eclipses severely criticizes Parāśara for his eclipse divination methods, but retains the above legend in his writings. We conjecture that strong belief in the historical reality of such a rare event should have been in the collective memory of the community since the start of the Ṛgveda, for Varāha to accept its possibility and retain this event in the Bṛhatsamhitā.

Interestingly, *marut*s and correlated sky objects do not refer to the moon directly. References to the moon, months, intercalation, eclipses probably belong to another strata of RV coming

[27] *The Cosmic Winter*. By Clube and Napier; Basil Blackwell; U.K. 1990.
[28] *Rogue Asteroids and Doomsday Comets.* By D. Steel J. Wiley & Sons New York. 1995.
[29] Iyengar R.N., *Archaic Astronomy of Parāśara and Vṛddhagarga*, IJHS 43.1, pp.1-27, 2008.

after the havoc caused by *maruts* and the consequent climate alteration effects subsided. It is as if the original group of people left their memories of a divine (celestial) catastrophe in poetic language upon which their successors added further observation of the sky leading to lunar and solar rituals. An algorithmic calendar attributed to Lagadha became a necessity for timing the rituals. The Ṛgveda is well aware of eclipses and their recurrent nature. This is in contrast to sun getting veiled due to atmospheric dust or trail of comet debris. While the observation of a solar eclipse by Atri is easily recognized, lunar eclipses are metaphorical invoking *agni* to a *yajña* when moon appears red in colour. The number 3339 mentioned twice in RV is explained by the Brahmāṇḍa Purāṇa unambiguously as a lunar number. This symbolic connection between the above Ṛgvedic number and the eighteen year eclipse period is discussed in the next chapter.

2. Eclipse Cycle Number 3339 in the Ṛgveda

Introduction

The composers of the Ṛgveda and their immediate followers were not just casual onlookers of the night sky but were inspired and clearly fascinated with what they observed. They not only named an object as *dhūmaketu* the smoke-bannered fire, they also noted that *maruts* appeared always in a group consisting of individually differentiated members, all looking similar, but moving together as if they had a central axis. The spectacle should have been so attractive the observers liked to count the numbers in the group or *gaṇa*, out of which *gaṇita* (Mathematics) evolved. It need not concern us here whether this counting was out of fear or for adoration or out of just curiosity. We need not also wonder whether these numbers were correct or not, beyond recognizing that counts of 7, 63, 108 are possible to be counted in naked eye observations of a meteor burst or shower. From the evidences presented in the previous article one can infer that when a transient celestial object such as a comet apparition intervened between sun and earth, the concept of *ketu-graha* as an object that could mask sun and perhaps even the moon arose.

Eclipses of sun and moon must have been experienced by the Vedic people as they became consciously sensitive to the visible sky. The codified *darśa-pūrṇamāsa* rite, observed to this day by some *āhitāgni*s, indicates a fairly sophisticated stage when time reckoning and the calendar had become important. Between such practices and the ancient worship of *marut*s with invocations to celestial fires, what can we infer about possible eclipse observations described in RV? This question is not simple to answer, since the word *rāhu* so common in later literature does not appear in RV, in stark contrast to the word *ketu* that appears eighty times. The first reference to *rāhu* by name is in the Atharvaveda where the moon, planets, meteors, *rāhu* and the *dhūmaketu* are mentioned together[30]. Thus, at least by the time of compilation of the Atharvaveda the Vedic community had differentiated the actions of *rāhu*

[30] ś*am no bhūmirvepyamānaḥ śamulkāhatanca yat*| *....śam no grahāhcāndramasāḥ śamādityaśca rāhuṇā*| *śamno mṛtyurdhūmaketuḥ śam rudrāḥ tigmatejasaḥ* | Atharva Veda Samhitā (XIX.9.7-10).

and *ketu*, as agents capable of masking the celestials. In the later texts of Parāśara, Garga, the two Epics and classical Sanskrit literature, *rāhu* modeled as a large dark planet is taken as the cause of both solar and lunar eclipse. In the RV the well recognized solar eclipse is attributed to *svarbhānu* but description of lunar eclipse is not easily recognizable in the text. In hindsight this is only natural, since in contrast to the darkening of sun, moon appears red in a total eclipse. Thus for the earliest Vedic observers it was natural to postulate two different obstructing agents for the day time and night time events.

The covering of the sun by *marut*s, stopping of the chariot of the sun and the many prayers for restoration of sun's light cannot be taken as references to solar eclipses. The predominant action of *vṛtra* was prolonged masking of sunlight, whereas any solar eclipse could have been for comparatively very short durations. However, the word *vṛtra* can be interpreted as *one who covers* and since it is said that he was won over by *Indra*, the same imagery might have been used in the early periods to describe solar eclipses also. Usage of the same word to denote two distinct objects can be reconciled when one can attribute the same type of action to the two objects. As is known *vṛtra* is the archetype *asura* or demon in later *purāṇa* legends. We infer that a negative meaning for the word *asura* had gradually gained acceptance during the RV period itself, as someone who could obstruct celestial objects. This is reflected in the legends about *marut*s that they once killed the children of *prajāpati* because they were not respected. Conversely those venerated by people were known as *asura*, who could discharge stony weapons towards earth. The homonyms *asurā… pūrvadevā suradviṣaḥ* listed in the Amarakośa support this conclusion[31]. The word *sura* in the sense of *deva* or a deity is not found in RV. The popular interpretation of *asura* as the opponent of *sura* is a later development in the Brāhmaṇa texts. However, in some places in RV, *asura* are in conflict with *deva* the celestial luminaries of the *adhidaiva* meaning. Thus it should not be surprising to see *asura* being described as personified dark objects in the sky. In fact we find the word *asura,* that is used to refer to *marut*s in RV, is also used directly or in a derivative form while describing eclipses. We see that in such cases the composers might have referred to the past actions of *asura* covering the sun or some other luminary. This situation no doubt brings in some ambiguity in locating references to eclipses in Vedic literature, except when the statements are explicit and hence cannot be taken otherwise.

[31] *asurā daityadaiteyadanujendrāridānavāḥ| śukraśiṣyā ditisutāḥ pūrvadevāḥ suradviṣaḥ||*
(Amarakośa I.1.12)

Solar Eclipse

Indian tradition takes the RV *sūkta* (V.40) to be the description of a solar eclipse. Modern authors also agree with this explanation. It will be interesting to briefly review the contents of this hymn to appreciate the epithets and terminologies used.

Oh Sun! When svarbhānu the āsura struck you with darkness the worlds became like a person not knowing where he stood. (5)

Indra! While you were removing the illusions of svarbhānu that spread below the sun, Atri by his fourth prayer rescued Sun concealed by darkness. (6)

Let not the violator devour me with darkness. You are Mitra whose wealth is truth. Let you and King Varuṇa protect me. (7)

Then, Atri bringing the stones together, offering prayers to deities dispelled the darkness and placed the eye of Sun in the sky. (8)

Only the Atris and none others, could subsequently find Sun whom āsura svarbhānu struck with darkness. (9)

Several interesting information can be gathered from the above hymn. The above verses (5-9) are part of a larger hymn that addresses Indra. Even though the event is popularly known as Atri's eclipse, it is Indra who is said to have removed *svarbhānu*. Sun prays to Atri along with Mitra and Varuṇa seeking protection. After this, it is said that Atri placed Sun in the sky. The 9th verse is somewhat unconnected with the previous verses since it refers to the family members of Atri and not to any specific Atri. The eclipse shadow called *svarbhānu* has the epithet *āsura*, which is popularly rendered as *demon*. But from what we found in the previous chapter *maruts* were the original *asuras* who could throw stones at earth. They had also covered up Sun once. However, in RV this word has other positive connotations as being powerful and at times even as divine. Here in the hymn RV (V.40) we see the evolution of the concept of an obstruction being called *āsura* a derivative of *asura* who had to be removed by Indra. This clear link between *āsura* and eclipse shadow indicates that wherever the word *asura/āsura* appears one has to investigate whether or not any metaphorical picture of an eclipse is embedded in the hymn. The above event is also the traceable textual source for the legend of *rāhu* equated with *svarbhānu* being known as an *asura* in later literature. The word *asura* in the *purāṇas* is more in the sense of an enemy of *sura* who in turn are equated with gods or regent deities. As already noted *rāhu* the eclipse causer appears in Vedic literature

first in the Atharvaveda. Since *svarbhānu* is *āsura,* with tenuous connection to *maruts,* the word *rāhu* is likely to be a short form of the epithet *varāhu* used for *maruts* in RV (I.88). After a few more hymns in the same book we read in (V.49.2)[32]

Knowing the asura's time of returning, worship the deity savitar with hymns and praises.

This verse uses the technical word, *prati-prayāṇam*, which means return journey or travel. Reference to the return journey of *asura* and worship of Sun leaves one wondering whether this pertains to an expected solar eclipse. This hymn has *viśvedevāḥ* as its deities, in common with several other hymns yet to be considered that carry some type of eclipse imagery.

Viśvedevāḥ (VD)

The group of deities known as *viśvedevāḥ* is of considerable importance in Vedic literature and also in Hindu religious observances. It has been the practice to translate this word as *All-gods*, which hardly conveys the role of these deities in the Vedas. A brief review of the traditional stand on these deities is important for our further analysis, since *viśvedevāḥ* (VD) were also countable like *maruts.*

In RV apart from many isolated verses there are fifty-eight independent hymns devoted to VD. What was the role of VD in the Vedic world view? On this point, there is difference of opinion among the later texts and commentators. In one place in the ŚB it is said VD created the directions[33]. However, in another place they are described as the seasons[34]. The attributes and actions of VD are varied, but are almost always connected with time and space and hence important in our study. Bṛhaddevatā (BD) of Śaunaka an explanatory text describing the legends, organization, numbers, and actions of the RV deities, is indispensable in the study of RV. As per BD the eleven hymns starting with (V.41) in the 5th book of RV are devoted to VD[35]. According to BD (1.136) all the Vedic deities structured into three sub-groups taken together are known as *viśvedevāḥ.* The hymns about VD are also classified into three groups (BD 3.42). A list comprising of both individual deities and several sub-groups is given in BD,

[32] *pratiprayāṇam asurasya vidvān sūktairdevam savitāram duvasya |*
upa bruvīta namasā vijānan jyeṣṭham ca ratnam vibhajantamāyoḥ || RV (V.49.2)
[33] *viśvedevāḥ vaiśvanarā diśaḥ kṛtvā tāsvetām āśiṣamāśāsata* || ŚB. (6.5.2.6)
[34] *ṛtavo vai viśvedevāḥ tadenām viśvairdevaiḥ ṛtubhiḥ samvidānaḥ* || ŚB. (7.1.1.43)
[35] *ko nu vām vaiśvadevāni ekādaśa parāṇyataḥ*|| (B.D.5.36).

as making up the full VD group[36]. BD also provides names of some forty RV seers who had understood or realized the nature of *viśvedevāḥ*[37]. But, the hymns assigned to many of these seers are found to be about *agni*. The explanation of the Vedic tradition for this apparent anomaly is; when *agni's* cosmic actions are described, such a hymn refers to VD[38]. What was this special cosmic action of *agni* which took the Vedic seers beyond meteors, comets, lightning and the sun that further necessitated a set of countable deities? The answer to this question is also available in the Bṛhaddevatā[39]

The seers of Atri family, for removing the ill effect of Sun who was seen (covered) by svarbhānu, woke up ***agni*** *with twenty-seven hymns*. (BD 5.12)

Thus as per the orthodox tradition all the twenty-seven hymns of the fifth book devoted to *agni* have some connection with eclipses. One can easily suspect that this relation between a solar eclipse and *agni,* other than indirectly indicating that Sun was recognized as a form of fire, should have been through a connection between VD and *agni.*

About the total number of deities recognized by RV there is difference of opinion among the commentators. As per the Nirukta even though there are only three natural deities localized to earth, atmosphere and sky, due to their separate activities the deities are counted as thirty

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[36] s*aptarṣayo vasavaścāpi devā atharvāṇo bhṛgavaḥ somasūryāḥ*|
pathyā svastī rodasī coktamantre kuhūrgungūraditirdhenuraghnyā||
asunītirilā cāptyā vidhātānurmatirha yā |
angirobhiḥ sahaitāḥ syuruktamantrāśca devatāḥ ||
vaiśvānaro hi suparṇo vivasvān prajāpatirdyauḥ sudhanvā nagohyaḥ|
apāmnapādaryamā vātajūtirilaspatiścāpi rathaspatiśca||
ṛbhavaḥ parjanyaḥ parvatā gnāśca dakṣo bhago devapatnīrdiśaśca|
ādityā rudrāḥ pitaro'tha sādhyā nipātino vaiśvadeveṣu sarve || BD (8.125-128)

[37] *medhātithiragastyastu bṛhaduktho manurgayaḥ*|
ṛjiśvā vasukarṇaśca śāryāto gotamo luśaḥ|
svastyātreyaḥ parucchepaḥ kakṣīvān gāthinaurvaśau |
nābhākaścaiva nirdiṣṭo dyuvasyurmamamatā sutaḥ||
vihavyaḥ kaśyaparṣiravatsārāśca nāma yaḥ|
vāmadevo madhucchandāḥ pārtho dakṣasutāditiḥ|| BD (3.55-60)

[38] *āgneyam sūktamaibhiryadvaiśvadevam ihocyate* |
tadviśvalingam gāyatram vaiśvadeveṣu śasyate || (BD 3.33).

[39] *svarbhānudṛṣṭam sūryasya apahatya tato'trayaḥ*|
saptavimśatibhiḥ sūktaiḥ abodhītyagnimastuvan || (B.D. 5.12)

three[40]. According to this logic still larger numbers can be recognized depending on the multiplicity of actions assigned to the thirty-three deities. In RV (I.34.11) the two *aśvins* are invoked to arrive along with the *Thirty-three* deities[41]. This evidently implies that the *Thirty-three* meant some sub-group excluding *aśvins* whose importance is obvious in RV. Notwithstanding such differences, quite surprisingly, there is unanimity among all the authorities that the total number of VD is 3339.

In the RV we come across many small numbers and also a few fairly large numbers. The small ones such as 3, 7, 12, 27, 49, 360 can be explained as having some physical significance and are also easily countable. A notionally large number appearing in a sacred text due to chance is more apt to be in hundreds and thousands in round figures. Curiously enough 3339 is a large number but is too precise and specific to be taken as an arbitrary count of VD due to chance. It is deliberately connected with *agni* which in turn has had a link with VD, and this number is repeated twice in the RV in the third and the tenth books.

The hymn RV (III.9) is by Gāthina Viśvāmitra, a legendary figure of immortal fame in the cultural history of India. This hymn has *agni* as its deity. The main purport of the hymn is to invoke *agni* who has to come from a distance, being hidden as the child of celestial waters. In brief, the legend alluded here is that *agni* was hiding in a cave, like a lion, till *viśvedevāḥ* searched him and found him out (RV III.9.4). The next verse mentions that *mātariśvan* has brought by force this *agni* who was playing at a distance[42]. Sāyaṇa interprets *mātariśvan* as atmospheric wind which can bring fire by force. The phrase *sasṛvāmsamiva* is explained as *like bringing a son by force who was playing somewhere at will*[43]. This simile is quite unusual, since it indicates something that was long awaited, to have happened suddenly. Beyond this the cosmic action of this *agni* is not made explicit in this hymn. The last verse of the hymn is about the above *agni* being worshipped by 3339 deities. This verse occurs again in the tenth book. The text with the translation by Aurobindo of this verse is[44]

trīṇi śatā trī sahasrāṇyagnim trimśacca devā nava cāsarpayan|

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[40] *tisra eva devatā iti nairuktāḥ | agniḥ pṛthvīsthānaḥ| vāyurvendro vāntarikṣasthānaḥ| sūryo dyusthānaḥ| tāsām mahābhāgyādekaikasyāpi bahūni nāmadheyāni bhavanti| api vā karma pṛthaktvāt||* Nirukta (7.5)

[41] *ā nāsatyā tribhir ekādaśair iha devebhir yātam madhupeyam aśvinā|* RV (I.34.11)

[42] *sasrvāmsamiva tmanāgnim ittha tirohitam|*
ainam nayan mātariśvā parāvato devebhyo mahitam pari|| RV (III.9.5)

[43] *sasṛvāmsamiva | yathā svācchandyena sasṛvāmsam sarantam gacchantam putram pitā balādānayati| tadvat||* (Sāyaṇa Bhāṣya on RV III.9.5)

[44] *Hymns to the Mystic Fire*, by Sri Aurobindo, S.A.Ashram, Pondicherry, 1998

aukṣan ghṛtairastṛṇan barhirasmā ādiddhotāram nyasādayanta|| (RV III.9.9; X.52.6)

Gods three thousand and three hundred and thirty and nine waited upon the Fire. They anointed him with many streams of the clarity; they spread for him the seat of sacrifice, and seated him within as Priest of the call.

This verse is the famous *nivid* that specifies the number of *viśvedevāḥ* to be 3339. Why this verse and the characteristic number find mention twice in RV is not explained in the Vedic literature. However the use of this special number in RV appears to be by design since the context of the hymns (III.9) and (X.51-X.55) are fairly similar.

Saucīka Hymns

Hymn (X.52), where the number 3339 occurs for the second time in RV, is about *viśvedevāḥ* attributed to the authorship of Saucīka Agni. It is possible this name of the composer is notional and not meant to denote any real person. If *viśvedevāḥ* can be rendered as *all-gods*, the name *saucikāgni* can be translated as *indicator-fire*. This again makes one wonder what could have been the connection between *viśvedevāḥ* and *agni*. Quite interestingly hymns (X.51) and (X.53) are also by Saucīka Agni and these also contain cryptic metaphorical references to *devāḥ* and *agni*.

Hymn (X.51) is in the form of a conversation between *devāḥ* and *agni,* where in (*v*.2), *agni* wonders *'how many gods have clearly beheld my form'*. There is also an allusion, like in RV (III.9) considered previously, to *agni* hiding in secret places. The legend outlined in the hymn is briefly as follows. *Agni* had three elder brothers who were doing the work of carrying sacrificial offerings to gods. All the three died due to the harsh *vaṣaṭ* sounds uttered during the sacrifices. Hence the youngest fire known as *saucīka* fearing the same treatment will befall him, was hiding in (celestial) waters, till *viśvedevāḥ* found him and requested him to come out and help in carrying sacrificial offerings to gods. *Saucīka* agrees to their request under the condition that he should have prominent role in the *yajña* and that he should get the *prayāja* and *anuyāja* offerings. BD explains this legend at great length to conclude with the total number of VD as the sum of three different numbers, namely 3000; 309 and 30[45]. This establishes that bringing *saucīkāgni* was the prime role of the VD deities adding up to 3339. The next hymn RV (X.52) starts with *agni* asking VD to instruct him as to how he should pass on the sacrificial offerings to them. In (*v*.2) *agni* mentions *aśvin*s as the *adhvaryu*s and

[45] *tavāgne yajña ityetat pratyārdhi sviṣṭakṛcca saḥ|yasya trīṇi sahasrāṇi nava trīṇi śatānica || trimśaccaivatu devānām sarvāneva varāndaduḥ| tato'gniḥ sumanāprīto viśverdevaiḥ puraskṛtaḥ ||* (BD 7.75,76)

samidh or Moon as the Brahman in the *yajña*. Quite cryptically this *samidh* is offered as oblation to *aśvins*. The Vedic tradition does not identify *aśvin*s with any specific celestial object but is quite clear that *samidh* should be equated with *soma* and the moon[46]. The next verse (*v*.3) alludes to counting of days or nights, where the reference is to one *who springs to life month by month and by each day (aharahaṛ jāyate māsi māsi).* The conclusion that this should be a reference to moon is unavoidable. *Agni* being honoured by 3339 gods is the theme of the last verse (*v*.6) of this hymn.

Hymn (X.53) contains nine verses attributed to VD and two to *saucīkāgni*. In the first two verses (*v*.1, 2) VD laud *agni* who is sitting as the leader of the sacrifice. Significantly (*v*.2) is the mantra *arādhi hotā* prescribed to be meditated upon at the start of the Vedic *darśapūrṇamāsa* (DP) rituals observed at New Moon and Full Moon. In (*v*.3) it is declared;

Agni has arrived with the life (time) given to him by the gods and has made our offerings to the gods auspicious. We have obtained (understood) the secret of the sacrifice.

Tradition attributes this statement to VD. However, as a matter of fact, the poet is here most probably eulogizing a lunar eclipse, since moon as per the previous verse was the sacrificial offering. Moon was also the *Brahman,* who in Vedic parlance is the presiding officer during a sacrifice. This word also can mean *one who had grown big* indicating a full moon. The life given to *agni* by the gods has to be a *time period* and is to be connected with the number 3339. This secret of *agni,* who was the tongue of gods for drinking *soma,* was known to the composer.

The next verse (*v*.4) is by *agni* declaring the best advice by which gods can overcome *asura*s, where this word is used obviously in a negative sense. This verse, like the second verse above, is prescribed for use in the *DP* rituals[47]. Linked with the moon and the Full Moon rites the word *asura* might be an oblique reference to an eclipse. The next verse is also said by *agni*, but the second-half of (*v*.5) is more appropriately by the human poet requesting earth and sky for protection from earthly and heavenly pollution *(aṁhasaḥ).* Tradition takes the word *aṁhasaḥ* as *pāpa*, which in turn is usually translated as *sin*, which does not fit into the

[46] *kaḥ samit samiddḥ candramāḥ| candramā brahmā bhavatu| ...sa ca samit samiddhaḥ candramāh vām yuvayorhomārtham……āhutirbhavatvityarthaḥ|| somātmako hi candramā hūyate||* (Sāyaṇa Bhāṣya, MPRV Edition)

[47] *tadadya vācaḥ prathamam masīyeti samāpya||* Āśvalāyana Gṛhya Sūtra (1.2*)*

context. However, if we recognize that the sky picture of moon being offered in sacrifice by *agni,* as an eclipse, the word *aṁhasaḥ* refers quite appropriately to the cosmic pollution caused due to the covering of sun or moon during an eclipse; a religious belief widely prevalent in cultures influenced by the Hindu world view. In (*v*.6) *agni* is asked by VD to follow the sun protecting the luminous path, which is a poetic but plausible reference to the ecliptic. This statement makes it clear, that in this context *agni* is not the Sun, but some other agent which had actually approached *Moon*. In (*v*.7) the deities eligible to take *soma* are asked to arrive in a chariot that is eight cornered or is bound eight fold.

Hymn (X.54) is about Indra the supreme force of RV. It was observed previously in RV (V.40.6) that the covering of the sun by *svarbhānu* was removed by Indra. Here in (X.54.6) also Indra is said to establish the light in the celestials.

Hymn (X.55) in the first two verses refers to Indra addressed as Maghavan with secret celestial forms. In (v.3) he is said to envelop heaven and earth with the same type of light. He oversees in various roles the five deities (*pañcadevān*), the Seven-times-seven (*saptasapta* or forty-nine) entities season by season, along with the Thirty-four *(catustriṁśatā).* The above three numbers should naturally refer to three sets of countable objects in the sky. Sāyaṇa's gloss takes the five deities to be the five tribes that include humans, which meaning is unlikely as humans are not referred as *devāḥ* in RV. In verse (*v*.5) the reference is to *vidhu* that is Moon, whom Sāyaṇa interprets as *Indra in the form of Time.* The gist of this verse can be rendered as[48]

He is woken up from his slumber running his course with many around him…. He who died yesterday is living today.

The next verse (*v*.6) is even more cryptic in mentioning the arrival of the ancient red bird which has had no nest to dwell in (*aruṇaḥ suparṇaḥ anīḍaḥ*|). Again Sāyaṇa takes this *red bird* to be Indra, equated by him previously with *vidhu,* normally interpreted as Moon. If the poetic language is disentangled, the context can be understood to be a celestial event in which Full Moon is seen and an apparition of red colour also appears. Mention of the arrival of a red coloured bird with no permanent nest to reside, is easily recognized as a transient event

[48] *vidhum dadrāṇam samane bahūnām yuvānam santam palito jagāra*|
devasya paśya kāvyam mahitvādya mamāra sa hyaḥ sam āna|| RV (X.55.5)

associated with the total eclipse of the moon. The summary of the archaeo-astronomical information contained in the above five hymns is: *in the night sky, moon's colour turned red due to the arrival of saucīkāgni brought in by viśvedevāḥ numbering 3339.*

Marriage of Sūryā with Soma

Hymn RV (X.85) is one of the most beautiful poetry in the whole of Vedic literature. This is popularly known as the marriage hymn describing the bridal procession of *sūryā* for her union with *soma* the Moon. The implied imagery of a lunar eclipse, hidden beneath the ancient enchanting poetry of the meeting of two celestial persons, is quite apparent from the beginning of the hymn. This hymn also presents a window to one of the esoteric cosmic thought that forms the basis of Hindu mysticism. There are forty-seven verses in this long hymn. We consider here only those connected with *soma* which in the *adhidaiva* sense is the moon as per the orthodox tradition of Yāska[49]. The gist of the astronomical information available is as follows.

Earth is held by truth and the heaven is upheld by Sun. Ādityas depend on the cosmic order, while Moon is stationed in the sky. *(1)*

Soma the moon is stationed near the nakṣatras. *(2)*

He who crushes and drinks the juice thinks that the herb is Soma. But only the seers know the real nature of the regent deity of Soma (the moon). *(3)*

Soma! You are protected by seven layers of covers. Humans cannot take part in drinking you. *(4)*

Soma! Whereas the gods drink you, you become bright again. The wind protects the Soma, while moon is the creator of the years. *(5)*

The above five verses introduce moon as the object of the hymn. The next seven verses (*v.*6-12) describe the travel of Sun's daughter *sūryā* in the sky towards her husband the Moon, in abstract terms. Her friends were *Lauds* and *Hymns*; her dress was made of *Sāma* music; her chariot was the Mind and her cover was the Sky. Two bright objects (*śukrau*) were the bullocks drawing her cart. In other words she was really invisible, till the poet was able to see her dress in colour much later in verse (*v.*35). In this picture the two *aśvins* appear as visible,

[49] *samānām samvatsarāṇām māsa ākṛtiḥ | somo rūpaviśeṣairoṣadhiścandramā vā||* Nirukta (11.4-5)

hinting them to be twin stars witnessing the act. Verse (*v.*13) provides the locus of the celestial marriage through a metaphor.

sūryāyā vahatuḥ prāgāt savitā yam avāsṛjat|
aghāsu hanyante gāvo'rjunyoḥ paryuhyate || (X.85.13)

Traditionally this is rendered to mean:

The bullocks of the cart with the wedding gifts were whipped in the Maghā asterisms. Sūryā was carried to her husband's place in the Arjunī asterisms.

This is the literal meaning given by Sāyaṇa also. But in view of the context of the night sky being pictured, the word *gāvaḥ* in the *adhidaiva* sense should mean *rays* or *light,* which is an accepted meaning of the word as per the Nirukta[50]. This leads to the direct meaning:

The light rays (of moon) are hit in passing through the Maghā stars, while sūryā is carried over by moon in the Arjunī stars.

This in plain language means the shadow on the moon started near group of six stars called *Maghā* the brightest among them being the ecliptic star Regulus. The eclipsed moon progressed in time towards *Arjunī* which refers to the two stars of the *Pūrva-phalguni nakṣatra*. In summary the eclipse was in the constellation Leonis. The next verse (*v.*14) mentions that when *aśvins* arrived asking for *sūryā,* their request was supported by *viśvedevāḥ*. We are not sure of the role of *aśvins* in the sky picture, other than inferring they should have been two closely spaced stars, but mention of *viśvedevāḥ* probably indicates a connection with their characteristic number 3339. Verses (18 & 19) are about the playful nature of sun and moon, where the property of being reborn is associated with the moon. The hymn from (*v.*20) onwards digresses on to the marriage of humans except in a few places where *sūryā* is referred. For example (*v.*35) is about the visible form of the three-fold dress of *sūryā* the pollution due to which only a seer can relieve. Similarly the upper cloth of a human bride is said to be afflicted by a deity, *dark coppery red in colour*. This reference to coppery red in relation to *sūryā* can be inferred to be the colour of the moon's orb as seen from earth during a total eclipse. We have seen previously that *viśvedevāḥ* are the deities who bring *agni.* In verses (38-41) *sūryā* is said to have been given to *agni* by the *gandharva* who in turn got her from *soma.* The hymn presents a picture of the night sky, with moon being visible. Circumstances describing the journey of Sun's daughter, named *suryā* to marry moon and the

[50] *svedayaḥ| kiraṇāḥ|gāvaḥ|raśmayaḥ|…….suparṇā iti pañcadaśa raśmināmāni||* Nirukta (1.5)

coppery red colour of the apparition indicate a total lunar eclipse. Mystically, this event highlights the cosmic *agni-soma* union.

Vedic Long Count 3339

From the above analysis a physical connection between the 3339 *viśvedevāḥ* and an *agni* who can cause eclipses is seen to exist. Even if the hymns were to be taken as mystical poetry the reference to the waxing and waning of moon and further eclipse imagery is too conspicuous to be overlooked. Most probably in the early stages of theorization, *svarbhānu* and *sūryā,* both literally indicating a connection with the sun, were taken to be the active external partners in solar and lunar eclipses caused by *agni* brought in by *viśvedevāḥ*. The intriguing aspect of this ancient theory of eclipses is the number 3339 and its intended meaning. The extant Vedic texts are essentially silent on this. Sāyaṇa's gloss on the Taittirīya Brāhmaṇa (II.7.12.2) where this number 3339 occurs, declares that over and above the thirty-three RV deities others are supernumeraries. Some modern day scholars have also speculated on the nature of this number. Shama Shastry takes 3339 to be the number of year-gods and looks for a link with a 33 year cycle[51]. Sarma interprets this as a period of thirty years consisting of 371 lunar months[52]. Kak thinks that 3339 is the total number of gods in a year personified as *agni*[53]. He breaks the number into its factors 9 and 371 to identify the first as the *bhāmśā*s in a *tithi* and the latter as the number of *tithi*s in a solar year. While these authors have at least guessed this number to be associated with a time measure, majority of indologists and historians have presumed this to be just a part of variable Vedic mythology, wherein the number of gods increased from thirty-three to higher figures (even 33 Crores) with time. This type of speculative generalization has happened due to literalistic interpretation of Vedic texts following the sacrificial tradition ignoring the celestial nature of the deities and their actions. On the other hand, Purāṇas by tradition are supposed to be of help in understanding the Vedas. In fact the *adhidaiva* tradition is preserved in bits and pieces in some of the Purāṇas. Fortunately, the physical meaning of the above number 3339 and related legends are well preserved in the Brahmāṇḍa Purāṇa.

Purāṇic Harmony

[51] *Drapsa the Vedic Cycle of Eclipses* by R. Shama Shastry, Mysore 1938.
[52] Sarma K.V. *A Survey of Source Materials*; IJHS, 20.1-4, 1985 pp.1-20.
[53] *Astronomical Code of the Ṛgveda* by S.Kak, Munshiram Manoharlal Publn. N,Delhi 2000.

The eighteen major and eighteen minor *purāṇās* make up an enormous body of Sanskrit literature, not easy to read, much less to synthesize to see the common cultural threads linking them to the Ṛgveda. Here, the *Brahmāṇḍa Purāṇa* (BP) will be considered briefly to bring out the rationale behind the 3339 *viśvedevāḥ* of the Ṛgveda. All the important *purāṇas* describe the night sky and present ancient astronomical models based on Meru and the Pole Star. In a few of the available texts the nucleus of this sky model can be traced back to the Vedas. The BP one of the earliest among the eighteen *purāṇa* explains the waxing and waning of moon as part of its astronomy. A few verses are given below with a working translation to appreciate the legend of *somapāna* (drinking of the moon), by the gods

āpūrayan suṣumṇena bhāgam bhāgamahaḥ kramāt |
suṣumṇā āpyāyamānasya śuklā vardhanti vai kalāḥ || BP. I. (23.61)

The bright parts (of moon) increase in the śukla pakṣa, with sun filling them up in daily sequence through his suṣumṇā ray.

Bhakṣārtham amṛtam somaḥ pourṇamāsyām upāsate |
ekām rātrīm suraiḥ sarvaiḥ pitṛbhiḥ sarṣibhiḥ saha ||
somasya kṛṣṇapakṣādau bhāskarābhimukhasya tu |
prakṣīyante pitṛdevaiḥ pīyamānāḥ kalākramāt ||
trayaśca trimśataścaiva trayaḥtrimśat tathaiva ca |
trayaśca trisahasrāśca devāḥ somam pibanti vai ||
ityetaiḥ pīyamānasya kṛṣṇā vardhanti vai kalāḥ |
kṣayanti tasmāt śuklāśca kṛṣṇā āpyāyayanti ca || BP.I. (23.66-69)

Moon is approached by all the deities, manes and Ṛṣis for a night on Full Moon, for partaking nectar. From the beginning of the dark fortnight, parts of moon facing sun, decrease being drunk by the manes digit by digit. Three hundred and three, then thirty-three and again three thousand and three gods drink soma. Being drunk this way, the dark digits increase with corresponding decrease in the bright digits.

This is a clear enunciation of the scientific naturalism behind the 3339 gods and what their role must have been in the Ṛgveda. The nomenclature of the deities might have changed, but these were special and their count was sequential, in the order of the decreasing phases of moon adding to 3339. The above description is in tune with the Ṛgveda and the Vedic ritualistic picture of moon and drinking of *soma* by the gods. The tripartite Vedic division of *viśvedevāḥ* is also maintained in the *purāṇa* as the sum of three numbers 33, 303 and 3003.

Eclipse Cycle of 18 Years

The symbolism of gods drinking the digits of moon, which obviously refers to the dark fortnight, and their total number being 3339, has its origin in the Ṛgveda. For this characteristic number the above *purāṇic* model has to be accepted as the proper explanation. The count started on *pūrṇimā* to proceed till *amāvāsya* and stopped till the next Full Moon, to repeat again in the same fashion with gaps in the bright fortnights. In other words, this number is the count of *tithi*s only in the dark fortnights summed up as 3339 sequentially for a special purpose. If both the fortnights were to be included, the real time elapsed by this count would be 6678 *tithi*s. At the rate of thirty *tithi*s per lunation, this long count is equal to 222.6 lunations, which in round figures is the eclipse cycle of 223 synodic months. It is known that for the Vedic people months were lunar but the year was solar. It is also known from Lagadha's Vedāṅga Jyotiṣa that one solar year was taken to have 371 *tithi*s. Hence the Vedic number 3339, which is half of 6678, is a proxy for 18 solar years. *Agni, viśvedevāḥ*, *yajña* and *somapāna* described in various places of RV are symbols or metaphors for technically modeling the celestial phenomenon of similar lunar eclipses. The context of the number in the RV and evidence from the BP leads to the conclusion that the number 3339 was the Vedic long count of *nights or tithi* linked with lunar eclipses occurring near the same *nakṣatra*.

Other Vedic Texts

Later texts such as the Taittirīya Samhitā (TS), the Śatapatha Brāhmaṇa (ŚB) and the Tāṇḍya Brāhmaṇa know the solar eclipse of RV but describe the same in different ways. The Taittirīya Samhitā has a sacrificial interpretation mentioning that the eclipse shadow, as it receded, was taken to be a barren divine animal (*devapaśu*). It is said that the gods discussed as to whom that animal should be offered[54]. There is no mention of Atri or Indra in this hymn. ŚB (V.3.2.2) also knows *svarbhānu* and the solar eclipse. This text attributes the release of Sun from darkness to *Soma* and *Rudra. Soma* is moon and solar eclipses occur only on *amāvāsya* day when moon enters sun as per the Aitareya Brāhmaṇa. Rudra is the progenitor of the *marut* group, which had covered Sun's eye once in the past. This might be the reason for ŚB to link the release of Sun to Soma and Rudra. Kauṣītaki Brāhmaṇa (XXIV. 3-4) describes the eclipse quoting RV (V.40.9) and linking the event with the *svarasāman*, the *saptadaśastoma* and the *viṣuvant* day. Tāṇḍya Brāhmaṇa (IV.5.2; IV.6.13) refers to *svarbhānu* and a solar eclipse. Most probably this is also a reference to the solar eclipse of RV. However, Sengupta has treated the two events as independent and also dated them under

[54] *svarbhānurāsuraḥ sūryam tamasā'vidhyat tasmai devāḥ prāyaścittamaicchan .....te devā abruvan devapaśurvā ayam samabhūt kasmā iyamālapsyāmaha iti* || TS (II.1.2.2)

assumptions that are not independently verifiable[55]. According to him The RV solar eclipse is dateable to the summer solstice day corresponding to 26th July 3928 BCE. Since the Tāṇḍya Brāhmaṇa refers to the *svarasāman* days along with the solar eclipse he has argued that this eclipse should have happened on the equinoctial day corresponding to 14th September 2451 BCE. Stockwell based on the interpretation of some German scholars that the RV solar eclipse occurred three days before the autumnal equinox, dated the RV eclipse to 20th October 3784 BCE[56]. From several considerations it appears that all the Vedic texts refer only to the original total solar eclipse of RV experienced in the 4th millennium BCE.

The Vājasaneya Samhitā (33.7), the Kāṇva Samhitā (32.7) of the Śukla Yajurveda and the *khilasūkta* of RV repeat the *viśvedeva-nivid* of RV (III.9.9). The Taittirīya Brāhmaṇa (TB) records the same hymn at (II.7.12.2). Thus, the use of the number 3339 was wide spread in ritualistic observances. TB (I.3.10) describes the legend of Indra returning on an *amāvāsya* after having defeated *asuras.* It further refers to the arrival of *pitṛ*s at that time and they being given a boon to drink *soma* on *amāvāsya*. Their number is said to be six as being related to the six seasons. This most probably refers to a solar eclipse the details of which are not available now.

Ṛgvedic hymns describe or at least allude to eclipses in poetic fashion relating the events with *agni, soma, viśvedevāḥ, yajña, Indra, svarbhānu, sūryā* and the coppery red colour. But the significance of number 3339 that appears in association with *VD* is no where stated in the Vedas. The *purāṇa* text presents the meaning of the number clearly but stops short of relating it to eclipses. However, by combining the Vedic and *purāṇic* information we can safely conclude that the Vedic people knew the so called *saros* of 223 lunations, nearly equal to eighteen years, in a more fundamental and hence original form as 6678 *tithi.* Discovery of this number and its use in describing a natural astronomical event represents the earliest development of scientific thinking in India. This knowledge probably was treated as secret and hence its origin has so far remained shrouded in mystery. Such a special number surely would have left its foot prints on the sands of time and hence gets revealed once the archaeo-astronomical metaphors are uncovered as demonstrated above.

Discussion

[55] *Ancient Indian Chronology* by P.C.Sengupta, Univ. of Calcutta, 1947
[56] Stockwell J.N., The Astronomical Journal, XV, 10, 1895 Boston.

Evidence available so far, points out that the long count number was discovered with the help of lunar eclipses. This is implied by the counting of the 3339 *tithi*s starting from a Full Moon and carrying this count only during the dark fortnights, to end on an *amāvāsyā*. The expectation would have been that the subsequent Full Moon would be an eclipse night. Duncan Steel in his famous monograph on eclipses discusses how ancient civilizations could have arrived at the 18-year cycle by observing the moon rather than marking solar eclipses[57].

Vedas are broadly divided into Samhitā, Brāhmaṇa, Āraṇyaka and Upaniṣad. The Ṛgveda Samhitā is the most ancient with parts of the text belonging to as ancient as the 4th millennium BCE. RV as available now is organized as *sūkta*, made up of *mantra* or metrical verses endowed with knowledge said to have been revealed to a *Ṛṣi* (seer). What is interesting is that the text contains special numbers, at least one of which, namely, 3339 is a long count connected with the 18-year lunar eclipse cycle. Brāhmaṇā texts are taken to be explanatory guides for the Samhitās. However, in their available format, the explanations are too convoluted with ritualistic jargon and hence not easily amenable for establishing a one-to-one relation with the original hymns. In the present case the Brahmāṇḍa Purāṇa preserves a simple explanation for the above number. This leads us to the conclusion that 3339 represents the *tithis,* in the dark fortnights, separating two lunar eclipses of the same type. *Tithi* is a time unit well known to Vedānga Jyotiṣa, Purāṇas, *siddhāntic* astronomy and continues to be used in India to this day. The present study indicates that this concept has come down to us from RV times, even though how it was originally measured is not yet completely understood. But it may be noted, the word *tithi* in the sense of *date in a year* is explicitly used in the Śatapatha Brāhmaṇa. Unfortunately those who read only the English translation of this important Vedic text miss this word since Eggeling in his translation left out this word[58]. Since there are some historians who hold on to the opinion that the word *tithi* is not of Vedic origin, it is necessary to quote the original text. This appears in the legend of Manu's Flood (ŚB I.8.1)

*sa ya**tithim** tatsamām paridideśa ta**tithim** samām nāvamupakalpyopāsām cakre||*

[57] *Eclipse- The celestial phenomenon that changed the course of history*, by D.Steel; National Academy of Sciences, USA, 2003.(*http://books.nap.edu/catalog/10123.html*)

[58] *The Śatapatha Brāhamaṇa (English Translation in 3 vols. SBE series)* by J.Eggeling. Motilal Banarsidas, N.Delhi, 1963. Extracts from the translation of J. Eggeling: *"...Thereupon it said, in such and such a year that flood will come……when the flood has risen thou shalt enter into the ship…..And in the same year which the fish had indicated to him, he attended to (the advice of the fish) by preparing a ship; and when the flood had risen, he entered into the ship….hence that (slope) of the northern mountain is called Manu's descent. The flood then swept away all these creatures, and Manu alone remained here."* (ŚB I.8.1)

This alludes to the promise of the Fish to come on a specified *tithi* in a specified year and that Manu awaited the arrival of the Fish on that *tithi* in that year with a boat ready for travel. Although no specific year or day is mentioned the word *tithi* has been used in this early Vedic text in the sense of *date*.

Now, turning our attention to Purāṇas, there is a view that in the remote past these were fewer in number. Since the present day versions contain same or similar texts in too many places, it is logical to postulate the origin of these books from a single source, which is not traceable in its original form now. Existence of *itihāsa* and *purāṇa* are known at least from the Vedic Brāhmaṇa and Upaniṣad times as evidenced in T.B (III.12.8.2) and the Chāndogya Upaniṣad (3.4.1). It is possible, like the Brāhmaṇas explaining the ritualistic and the Upaniṣad the philosophical aspects (Bṛhadāraṇyaka Upaniṣad III.9) the Purāṇa once explained the physical worldly meaning of the Vedas.

The legend of gods and manes drinking nectar of moon appears in several Purāṇas. Since, at present, the texts are inflated and have many errors due to transmission and copying problems, it is difficult to discuss the numbers mentioned differently in some of these texts. For example, in the vulgate Viṣṇu and the Liṅga Purāṇa texts we read,

trayastrimśatsahasrāṇi trayastrimśat śatāni ca|
trayastrimśat tathādevāḥ pibanti kṣaṇadākaram|| (VP. II.12.7)

trayastrimśatśatāścaiva trayastrimśat tathaiva ca|
trayastrimśatsahasrāṇi devāḥ somam pibanti vai ||
evam dinakramāt pīte vibudhaistu niśākare |
pītvārdhamāsam gacchanti amāvāsyam surottamāḥ || (LP. 56.11-12)

The numbers of deities mentioned above add to 36333; whereas the remaining statements are as in the Brahmāṇḍa Purāṇa. There is no reason to believe that VP and LP propose astronomical models different from the one that appears in BP. It is found that BP is more reliable for matter-of-fact astronomy than VP. Hence we can take the number 3339 as the valid Vedic long count restated in the Purāṇas also. How was this number observed, marked and counted? What could have been the influence of this number on the *darśapūrṇamāsa* sacrifice which draws inspiration from the *saucīka* hymns of the 10th book of RV? These questions are studied in the next chapter.

3. Darśapūrṇamāsa Rite, Moon's Abode and Calendar

Introduction

In the previous chapter we have seen that RV associates the occult number 3339 with the Moon in the *Saucīka* hymns of the 10th book. The mantras of these hymns are prescribed for use in the *darśa-pūrṇamāsa* sacrifice (Newmoon-Fullmoon rite or DP rite), thus hinting at a possible connection between the DP rites and the above number. As the name itself indicates, DP rite in the earliest period of its institution must have been based on directly observing the Moon, till a practical calendar was developed. The Vedāṅga Jyotiṣa (VJ) of Lagadha spells out its objective as providing a way to know the correct times for observing Vedic rites. Hence, we can safely say that the algorithmic VJ calendar is later than the Vedic rituals such as the DP rite. A question of seminal importance is how the characteristic lunar number 3339 was traced and counted over a long period of time of at least 18 years, before the evolution of a formal calendar? What connections could exist among the long count, lunar eclipses, the DP rite and the VJ? In this chapter these questions are addressed, to the extent possible, by analyzing some of the Vedic texts for available clues.

Darśa-pūrṇamāsa-iṣṭi

Ancient Vedic practices prescribe offerings in fire to be carried out on various occasions. Among these the *darśapūrṇamāsa-iṣṭi* (DP rite) is an astronomy related religious practice, as the name directly indicates. The ritual is also known as DP-*yāga* and sometimes as DP-*yajña*. As per Āpastamba an ancient authority on Vedic rituals, DP rite is prescribed by both the Ṛgveda and the Yajurveda[59]. There are no explicit statements about the performance of this rite in the RV other than the *Saucīka* hymns which are prescribed for use in the DP rite by all the authorities. Hence, this can be taken as a clue provided by the tradition that the *viśvedeva* number 3339 is connected with the DP rite and the moon. The ritual is described to varying

[59] *yajñam vyākhyāsyāmaḥ||.....ṛgvedayajurvedābhyām darśapūrṇamāsau* || Āpastamba-paribhāṣā-sūtra (1-4). (Ed.) A.M.Śāstri; Mysore,1893.

levels of detail in the texts belonging to the Yajurveda. The construction of the altars in which sacrificial oblations are offered is described in the Śulba Sūtra texts which are formulaic and hence cryptic but preserve the scientific developments of the Vedic period in some detail. The mathematics and geometry behind the construction of the different shaped altars have been investigated in the past notably by Datta[60], Sarasvati[61], Sen and Bag[62], and Seidenberg[63]. A variety of geometric shapes are prescribed in the texts. But the symbolism behind them is explicitly made known only in a few cases. While the square, circle and semicircle are relatively simple the geometrical design of the *śyena-citi* (Falcon altar) is complex. However as the name indicates the required shape of this altar is of a bird. We may conjecture that based on some type of physical observation, experience or principle the shapes first came into vogue, the details of which are not available now. Another important formalism of the Vedic altars is in their specified area. The *gārhapatya, āhavanīya* and *dakṣiṇa* altars that are respectively circular, square and semicircular have to be equal in area. This principle demands squaring a circle and circling a square which eventually leads to estimating the irrational quantities π, $\sqrt{2}$ and $\sqrt{3}$ in terms of rational fractions.

The DP rite is among the *śrauta* sacrifices requiring a group of priests to assist the *yajamāna* (sacrificer) and his wife to complete the prescribed ritual. The details of the canonical hymns selected from different texts and the complete procedure of carrying out the ritual are available in print[64]. The DP rite needs four altars namely the *gārhapatya, āhavanīya*, *dakṣiṇa* and the *darśa-pūrṇamāsa-vedi* (DP altar). The last one is also known as *dārśikivedi* and sometimes as *antarvedi*. We have already seen the first three of these are of different shapes but of equal area. These three altars are built with bricks in five layers to carry fire in them to make prescribed offerings. The most intriguing altar is the DP altar which is not built in five layers, has no fire lit on it and for all practical purposes is just a sacred platform, nonetheless indispensably central to the esoteric principles behind the ritual. The symbolism behind the DP altar is not described in any of the texts except for intriguing and cryptic hints. But the geometrical construction of this altar, which is like an enclosed platform, is carefully detailed so that the altar acquires a special curved shape. Since the DP rite is connected with the

[60] Datta B.B., "The Science of Śulba, a study in early Hindu Geometry", Calcutta Univ., Kolkata, 1932
[61] Sarasvati T.A., "Geometry in Ancient and Medieval India", MLBD Publ., Delhi 1979.
[62] Sen S.N. and Bag A.K., "The Śulba Sūtras with Text, Translation and Commentary", INSA, N.Delhi, 1983.
[63] Siedenberg A., "The geometry of the Vedic rituals,", in ***Agni,*** Frits Staal ***(ed.),*** Vol.2, 95-12, 1983.
[64] Paranjape V.R., (Ed.) *Śrauta Sanjīvini-1;Darśapūrṇamāsa Prayogaḥ*. Bhāratī Prabodha Śodha Samsthā; Sonda, 2007

moon it is natural to suspect that the DP altar should have some archaeo-astronomical significance linked with the moon.

Design of the DP Altar

The design and marking of the DP altar is described in several Śulba Sūtra texts[65]. The details are nearly same in all the texts with some minor differences. All texts mention that the altar should be constructed symmetrically about the base line *(pṛṣṭhyā)* in the East-West direction. Here an interesting question would be how the E-W line was drawn. The Kātyāyana Śulba text prescribes the use of gnomon for following the shadow of sun to mark the E-W direction. The Mānava Śulba text proposes observing two visible stars to mark the E-W line. The text followed by the translation of Sen and Bag is;

antareṇa citrāsvātī śravaṇapratiśravaṇau kṛttikāpratikttike tiṣyapunarvasū ca prāgdeśo'yam yugamātroditayoḥ pāśañca || Mānava Śulba Sūtra (1.3)

By the middle of a pair (of nakshatras) Citrā and Svātī, Śravaṇa and Pratiśravaṇa, Kṛttikā and Pratikṛttikā, Tiṣya and Punarvasū, having risen 86 aṅgulas (above the horizon), is (fixed) is the eastern (cardinal) point, and it is (brought into a line) with the ties (of the chord).

This indicates that the line was drawn early morning, aligning it with the centre of specified pair of stars, when these stars were above the horizon by a *yuga* which is mentioned in other places to be equal to 86 *aṅgula*. How this altitude which is really an angular distance was measured is a matter of conjecture. We guess that *aṅgula* as a known linear measure was used to fix the angular position of the stars above the horizon with the help of a vertical staff. Four star pairs are mentioned for this purpose most probably corresponding to the four quarters of the year. These are: *citrā-svātī; śravaṇa-pratiśravaṇa; kṛttikā-pratikṛttikā;* and *tiṣyā-punarvasū.* The method suggested seems to be to identify a pair of visible stars early in the morning in the eastern sky and mark a line on the ground as if the line passes in between the two stars. The statement that *kṛttikā* (Alcyone) once arose precisely due east as per the Śatapatha Brāhmaṇa gives credibility to the E-W alignment of the central axis of the DP altar for some esoteric astronomical purpose. The stars *citrā* and *svāti* (Spica-Arcturus) are on either side of the celestial equator. The two appear nearer to each other and hence these two

[65]Sen S.N., and Bag A.K., *ibid.*

when visible a few degrees above the eastern horizon can indicate the eastern direction. The details of fixing the staffs to make the E-W marking are not available in the texts. But from the Taittirīya Brāhmaṇa (I.5.2) it is known that Vedic people observed a desired *nakṣatra* before sun rise and made marks on ground to estimate the time remaining for the star to be visible in the eastern sky[66].

Once the E-W line is taken as drawn, further construction is symmetric about this line. First an isosceles trapezium ABCD is drawn as shown in Figure 1. The eastern and the western sides AC and BD are respectively 48 and 64 *aṅgula* in length. The height of the trapezium is 96 *aṅgula*. With points C and D fixed, a rope of length 2CD is stretched in the southern direction till point F. With F as the centre and FC as the radius, an arc of a circle is made to pass through points C and D. This is repeated symmetrically on the northern side AB. Similar arcs are drawn on the eastern and western sides. This altar is not a *citi* wherein offerings are made in the fire; hence there are no prescriptions about the shapes of the bricks to be used on this altar. Nevertheless this altar is as important as the other three altars in the DP rite. Principally *darbha* grass is spread on the DP altar for seating special deities and water ablutions are offered on this altar to *Ekata, Dvita* and *Trita* the three elder brothers of Saucīkāgni of the hymns of RV (X.51-55).

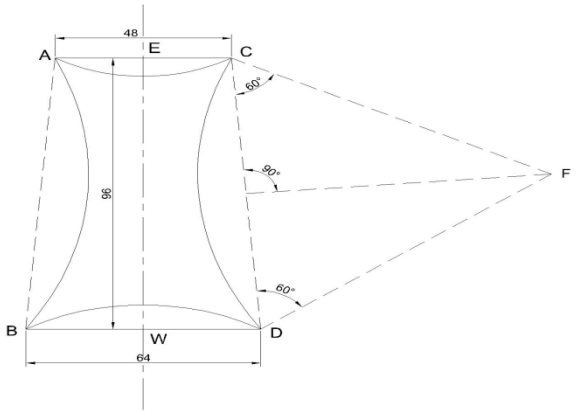

Figure 1. Geometry of the DP altar

Area of the DP Altar

[66] *yatpuṇyaṁ nakṣatraṁ | tadbaṭ kurvītopavyuṣaṁ | yadā vai sūrya udeti | atha nakṣatraṁ naiti| yāvati tatra sūryo gacchet | yatra jaghanyaṁ paśyet| tāvati kurvīta tatkārī syāt | puṇyāha eva kurute* || TB (I.5.2)

An important concept associated with a Vedic altar is its shape and area. As per the Śatapatha Brāhamaṇa the circular *gārhapatya* is supposed to represent the earth, whereas the square *āhavanīya* stands for the sky. Both these altars along with the semicircular southern altar are of same area equal to one *vyāma*. The DP altar is situated within the space enclosed by the above three as shown in Fig.2. The positioning of the DP altar between the circular earth and the square sky naturally implies that its special shape hides a cosmic symbolism. The ritual manuals discriminate the DP altar from the other three altars for some special reason. What strikes the eye is the peculiar shape of the altar which is deliberate and painstakingly explained in the manuals. The principle of equivalence of the areas encourages us to find the area of the DP altar, the construction of which is available in the Baudhāyana Śulbasūtra among others. The area of the basic trapezium (Fig.1) is 5376 square units. Since by construction CDF is an equilateral triangle, the area of the curved region cut out from the trapezium is $(\pi/6 - \sqrt{3}/4)\ CD^2$. The exact length of the side CD is 96⅓ units, which is slightly more than the height of the trapezium.


Figure 2.

From these considerations the area cut out on the four sides of the trapezium can be found to be 2261 units. This gives the exact area of the DP altar to be 3115 units. It is to be noted here the above value is based on the presently known accurate values of the irrational numbers π and $\sqrt{3}$ and the exact expression for the area of the arc of a circle. Here we may pause and ask; what could have been the area the ancients desired to have for the finished altar? Since no text mentions this area but only gives the construction, we attempt to estimate the desired

area to the level of approximation of the Śulba Sūtras. If the Samhitā and Brāhmaṇa texts represent earliest observations of the sky, the Śulba Sūtras are records of early Indian mathematics and geometry. The area of a circle was estimated by dividing the figure into large number of squares. In the present case for the arc of the circle in Fig.1, our ancients must have used a similar approximation which is not available in the texts. However we can take errors in such approximations to be represented effectively by errors in the values used for the irrational numbers π and √3. The Śulba Sūtra texts provide considerable information on how the above irrational numbers were handled by the Vedic people eventually arriving at approximate values. The best of the ancient approximations were π = 3.0885 (as a fraction) and √3 = 26/15 as explained in detail by Sen and Bag[67]. Hence the area implied to be removed from the basic trapezium was most probably equal to 2032 square units making the desired area of the final altar to be 3345 units. If the Vedic priests took the length of AB = CD as 96 instead of the correct 96⅓, the area of the DP altar would have been 3334 units. The above two numbers can be taken as fair estimates of the area desired for the altar when it was conceived for the first time in the remote past. This result is remarkable as the two values happen to be too close to 3339 the Ṛgvedic count of the deities *viśvedevāḥ* correlated with lunar eclipses as demonstrated in Chapter 2. Hence, we can infer beyond reasonable doubt that the desired area of the original DP altar was equal to 3339 units. This choice was not due to chance but was a deliberate selection to provide equivalence for the number of *viśvedevāḥ* to be seated on the DP altar in the Vedic rite. In turn, this number should have been the count of *tithi* in the dark fortnights between two similar lunar eclipses occurring near the same *nakṣatra.*

The above analysis helps us to unearth the symbolism behind the shape of the DP altar and the possible method adopted for counting the Ṛgvedic large number 3339. The Vedic and the Purāṇa texts mention that gods consume moon digit by digit in the dark fortnights. In matter of fact language this means the waning moon was observed each night and a count was kept. This is astronomically meaningful since in the dark fortnight moon would be visible all through the night after its rise. Starting from a Full Moon rising at sun set, moon rise is delayed by about an hour on each subsequent night but remains visible till sun rise. It is in this context the Vedic concept of deities drinking Moon only in the dark fortnight has to be appreciated as a naturalism which is at the root of Vedic philosophy and religion. From modern astronomy it is known that moon's orbit is inclined to the ecliptic by about ±5°.

[67]Sen S.N., and Bag A.K., *ibid.*

Since the ecliptic and the equator are inclined at about 24^{o} with each other an observer on earth will see Moon wandering, sinuously on either side of the local E-W direction. If at a fixed time, every night the observer were to follow the location of the Moon, starting from its maximum deviation the figure over a long period of time will appear symmetric about the E-W line and curved on the N-S sides like the DP-altar. Actually this will be a bounded region in the visible sky apparently flat and aptly denoted as the *candra-maṇḍala* (Moon's Abode) in the Purāṇas. The extreme southern and northern positions of the moon are similar to the solstices of the sun. Vedānga Jyotisha in fact mentions *ayana* (N-S-N movement) for both sun and moon. But we have not come across unambiguous lunar standstill statements in the ancient texts. Nevertheless, the possible recognition of a standstill provides a clue to how the Vedic people might have kept track of the waning moon. Suppose the Vedic astronomer (*nakṣatradarśa*) started with a lunar eclipse near a major standstill and marked moon's declination approximately by placing a pebble or piece of stone on the ground, about a nearly E-W line for 3339 nights, the resulting figure would be very similar to the DP altar. The counting method automatically correlates with the phase of the moon and eventually leads to the formal DP altar for purposes of calendar and religion based on cosmic concepts. A modern verification of this claim is demonstrated in Figure 3. This figure is a plot of the declination of moon for 3339 nights, starting at the bottom from 7th September 2006 with a lunar eclipse to end on the New Moon of 24th September 2024. It can be verified an eclipse will take place on the subsequent Full Moon. The resultant shape of the diagram that transfers the position of the moon on to the ground will be very robust as can be expected from Figure 3. Even with many misses and mistakes the symbolic shape of moon's abode in the sky gets captured fairly well by the DP altar. The enveloping boundaries are not circular, but the Śulba Sūtra prescriptions are good approximations. This figure also helps us to understand how in ancient times moon might have been observed for keeping count of *tithi.* Even though *tithi* is widely prevalent in India even now, the present way of fixing the *tithi* was not the method followed in Vedic times. In the previous chapter we have seen that the word *tithi* was used in Vedic times to denote a date within a year. We do not know precisely how this was done, but it certainly depended on the phases of the moon. The DP rite as described in the Sūtra texts and the still later manuals is strictly codified with precise instructions and minute details of Vedic hermeneutics. However, for the ritual to get fixed so accurately, considerable time should have elapsed during which period variable interpretations and observations must have been prevalent. We get some inkling to this in the texts to arrive at a plausible conjecture that

the DP rite should have helped in the evolution of the Vedic Calendar or Vedāṇga Jyotiṣa (VJ) of Lagadha.

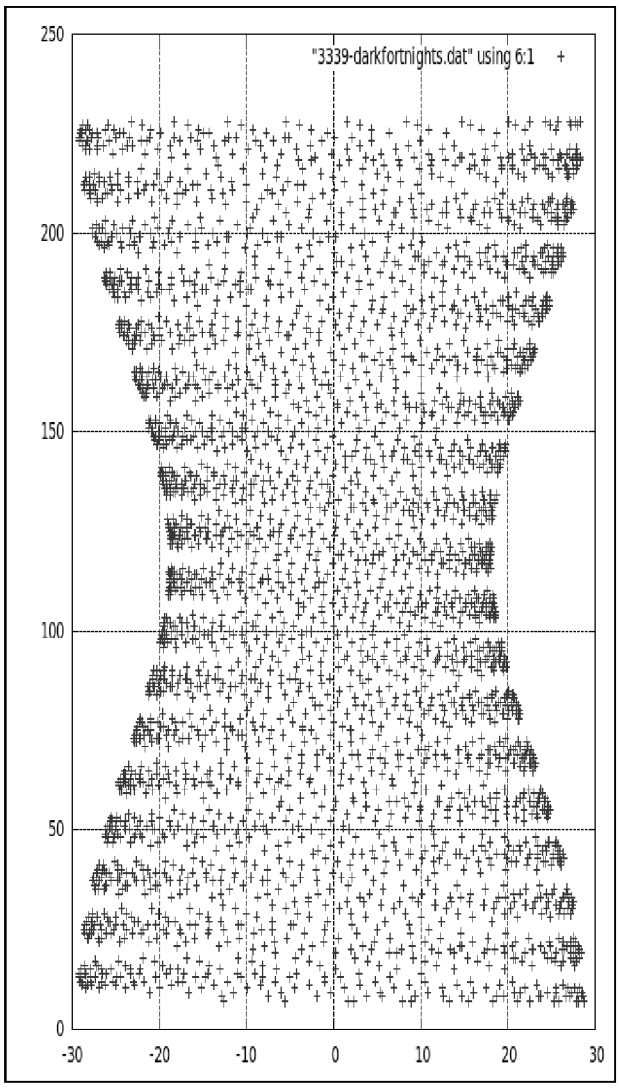

Figure 3. Position of moon on 3339 consecutive nights of the dark fortnights starting from 7th September 2006

DP rites are enjoined to be carried out for 15 years or 30 years or lifelong. The Śatapatha Brāhamaṇa (XI.1.2.10) instructs[68]

"One ought to perform DP-yāga for 15 years. In these there are 360 Full Moons and New Moons. There are 360 nights in a year. He gains these nights (in 15 years). If he performs the DP-yāga for another 15 years, he gains the year itself."

The rationale here is that the lunar year has 360 *tithi*, where as the solar is 372 *tithi* long. This difference of 12 *tithi* can be made up in 30 years since, 12x 30= 360 to bring the two rhythms together. This, of course, does not make the solar and lunar years to correctly synchronize,

[68] Shamasastry, R., *Drapsa: The Vedic Cycle of Eclipses*, Panchacharya Electric Press, Mysore, 1938.

due to the wrong length of the solar year. But it is only through such efforts the VJ with better intercalation could have evolved.

VJ Calendar and the Vedic Long Count

VJ is a text critically edited and studied in the past by several scholars[69,70,71]. Hence, here we limit our attention to investigate how the Vedic long count could have influenced VJ. It is known that the Vedic people had a luni-solar calendar where the year was solar but the months were lunar. Intercalation was practiced to bring the solar and lunar year into harmony by various methods. The central theme of VJ is to provide an algorithm to find in advance the *tithi, parvan, nakṣatra* in the formalized Vedic five year cyclic calendar. Thus its focus is not observational but essentially computational. VJ has come down to us in two branches, namely the *ārca-jyotiṣa* and the *yājuṣa-jyotṣa.* The basic elements are common to both and hence the two are generally considered together as a single tradition of ancient Vedic astronomy. The basis of VJ is the five year *yuga* period equated to 62 synodic lunar months of 1830 days, taken equal to 67 sidereal months. There are 1768 moon rises and 1835 risings of the ecliptic star *Śraviṣṭhā* (*Dhaniṣṭhā, Vāsava*, β-Delphini), with which sun and moon came together at winter solstice *c* 1400 BCE. The length of a solar year according to VJ is 371 *tithi* or 366 days. Any three independent elements among the above parameters lead to the complete luni-solar calendar of VJ. There are several publications discussing the strength and weakness of VJ as a calendar. The glaring inaccuracy is with the length of the solar year which is too long. Hence if the formulae are used blindly, the results would perceptibly miss reality within a few years. However it has been pointed out in the past[72] corrections were done in the form of intercalary months and dropping of *tithi* to keep the calendar in tune with the sun. There have been efforts to interpret VJ, claiming that the 19-year Metonic cycle is implied by the Ṛgvedic VJ text which would have lead to a near perfect synchronization between the lunar and solar movements[73]. This does not explain why Lagadha went in for a five year cycle with excess length of the solar year. Thus, the Metonic 19-year knowledge or equivalent long count could not have been the basis of VJ. It may be noted here that the five year cyclic calendar with 366 days per year was adopted also by the astronomical text Sūryaprajñapti-Candraprajñapti, (*c* 500 BC) belonging to the Jaina tradition[74].

The Vedic year

Vedic people had recognized several types of years such as the *nākṣatra*, the lunar, the *sāvana*, the solar and the intercalary year. The Nidāna Sūtra (V.11-12) belonging to the school of the Sāmaveda states this as,

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[69] Sastry T.S.K (Ed.) *Vedāṅga Jyotiṣa of Lagadha,* IJHS, 19.4. Supplement, pp l-74. INSA N.Delhi, 1984
[70] Shamasastry, R. *Vedāṅga Jyoutiṣa, Text, Translation and Commentary,* Mysore. 1936.
[71] Kouṇḍinyāyana S.A., *Lagadhamuniproktam Vedāṅgajyotiṣam* (with commentaries of Somākara and Kauṇḍinyāyan) Chaukāmba Vidyābhavan. Vārāṇasī, 2005.
[72] Abhyankar, K.D., *Pre-siddhiintic Indian Astronomy*, ISERVE, Hyderabad. 2002
[73] Holay, P.V., *Vedic Astronomy*, Apte Smarak Samiti. Nagpur. 1989.
[74] Kanhaiyalal (Ed.) *Sūryaprajñapti-Candraprajñapti*, Jināgama Granthamālā, 29 Beawar. 1989.

ṣaṭtrimśono navonaśca ṣaḍahono'tha sāvano'ṣṭādaśabhiḥ jyāyān ahobhiḥ sāvanāt paro nākṣatram iti|| māsaśca tasya caiva trayodaśa cāndramasaḥ sāvanaśca ubhāvathāṣṭādaśyuttano aṣṭā-saptatrimśate pourṇamāsyām prasādhayet ||

The year that is less (than the sāvana year) by 36, the year that is less by 9, that which is less by 6, then the sāvana year, then the year greater by 18 days. The sidereal year (less by 9) has thirteen months (of 27 each). The two kinds of years are the lunar and the sāvana. The year greater than 18 days has to be observed in (between) 37-38 Full Moon.

This was understood by taking a *sāvana* year of 360 *tithi* as the reference. The first one deficient by 36 was the *nākṣatra* year of twelve sidereal months making 324 *tithi*. Then the one less by 9 was a lunar year consisting of 13 months of 27 *tithi* each. The *sāvanā* lunar year of 360 *tithi* was made up of 12 synodic months. The solar year of 366 days and intercalary years of longer duration were also recognized. For our purpose the points to note are that the month was always reckoned with the help of moon's position and the VJ solar year with 371 t*ithi* was an approximate effort at making the *sāvana* year match with the position of the sun. The rich variety of years clearly indicates an effort at synchronization of two or three different observable celestial rhythms. Since it is the moon that was observed, the ancients must have first noted the synchronization between the sidereal and the synodic months. It is the near equivalence of 12 synodic months with 13 sidereal months, counted in terms of sunrises, would have lead to the concept of year as a longer measure of time than the month. This harmonizes with the earliest Ṛgvedic word denoting year as *samā*, used in the sense of being same, coincident, equivalent. With the recognition of seasons as dependent on the sun, synchronization of three rhythms seems to have become important. The Nidāna Sūtra refers to this equivalence more accurately in the form of a verse which was already known to the Vedic community it was addressing,

yasmin vai parivatsare sauryo māso'tha cāndramaso |
nākṣatro na vilupyate kasvittam veda kasvit ||
aṣṭāsaptatrimśate tasmin samvatsare mite |
sauryo māso'tha cāndramaso nākṣatro na vilupyate ||

Who knows that year in which the solar, the lunar, and the sidereal months are not lost, who knows that? In the year measured by 37 or 38 (full-moons), the solar, lunar and the sidereal months are not lost.

This points to the approximation of 37 synodic months with 40 sidereal months, even though the latter number is not mentioned. Similarly, for the solar cycle also to have matched, 37 synodic months should have been taken equal to three (solar) years. The number word *aṣṭā-sapta-trimśate* gives the meaning of being *between 37 and 38,* not of *37 or 38*, as in the above translation of Shamasastry[75]. Taking 30 *tithi* per month, one gets 1110 *tithi* in three (solar) years giving 370 *tithi* per year, which is nearly the value used in VJ. The above also hints at the presence of a three year cycle that should have existed before the improved five year cycle of VJ came into vogue. The text of the Nidāna Sūtra cited above is openly available on

[75] Shamasastry R., *Drapsa: The Vedic Cycle of Eclipses*, Panchacharya Electric Press, Mysore, 1938.

the internet[76]. However, it is to be noted that on page 72 of this web edition the words *atha sāvanaḥ* appear wrongly as *atha sādhanam,* which is not meaningful in the context.

In the available core Vedic literature there are no direct references to occurrence of eclipses during a ritual. But, a close reading of the hymns prescribed for the rites, shows several interesting statements pointing to a relation between eclipses and the ritualistic numbers. For example, the Nidāna Sūtra mentions a special sidereal year that falls short by nine (*navona*) in relation to the *sāvana* year of 360 *tithi*. This year had 13 months of 27 *tithi* making the length of the year to be 351 *tithi*. This corresponds to a year of 346-347 (solar) days. What was being achieved by this, unless this had some hidden connection with the eclipse year? In modern parlance, eclipse year is the time taken for the lunar nodes to be in line with the sun and the moon, when an eclipse is possible. The well known eclipse period of 223 lunation is equal to 18.03 solar years or 6585.32 days. This consists of 19 eclipse years of 346.6 days. The unknown element here is the ancient way of measuring *tithi*. We can however be reasonably certain that it was associated with the phases of the moon. Nevertheless *tithi* was known to be less than the mean solar day with its value stated to be equal to (61/62) in VJ. Desire to avoid fractions in the remote period of Vedic astronomy must have given place to approximations in terms of integers with an error of one unit. Thus, the eclipse year length might have been approximated to 351 *tithi*, while its actual length was nearer to 351½ *tithi*. Nineteen such years lead to 6669-6678½ *tithi* which is twice the special number 3339 already stated in the Ṛgveda twice.

VJ Parameters

With the above long count of 3339 *tithi*, we can understand how the basic VJ parameters might have been arrived at. The eclipse period must have been taken equal to 18 nominal solar years. This was a consequence of the older concept of 37-38 synodic months being equal to three solar years, consisting of 1110 *tithi* discussed above. If the solar year were to be taken equal to 370 *tithi*, one would directly get 18.04 years as the eclipse period. On the other hand to get a round figure; 18-year was taken as a special, perhaps occult number leading to 371 *tithi* per year, which is an important VJ parameter. Since we know that the correct solar day count would be 6585.32, dividing this by 18 gives the length of the nominal solar year to be 365.851 days rounded off to 366 by VJ. If one takes 223 synodic months as equal to 18 years, the first four convergent of the fraction 223/18 are 12/1, 25/2, 37/3, 62/5. The last one namely (62/5) is the VJ approximation. This was an improvement over a previous approximation of (37/3) which was known to the Vedic people as stated above in the Nidāna Sūtra. Similarly, since 223 synodic months are equal to 241 sidereal months, we can approximate the fraction (241/223) as 13/12, 27/25, 40/37, 67/62. VJ uses the last approximation of 67 sidereal months as equal to 62 synodic months, which is better than the previous one of 40/37 corresponding to three years, as mentioned in the Nidāna Sūtra.

Yajurvedic Texts

[76] http://is1.mum.edu/vedicreserve/kalpa/shrauta/nidana_shrauta_sutra.pdf.

There are several instances of numbers adding to 17, 18 or 19 as special length of years embedded in the Yajurveda texts. In the Vājasaneya Samhitā (XVIII.24-28) the number sequences 1 to 33 of odd integers and 4 to 48 of even integers increasing in steps of four, are given followed by a list of symbolic animals with their ages. The ages mentioned are 1½, 2, 2½, 3, 4 and 6 adding to 19 years. This is followed by offerings to seasons and months showing the context to be part of Time worship. The same Samhitā at (XXI 12-17) repeats year numbers adding to 19 associating them, respectively with meters *gāyatri, uṣṇik, anuṣṭup, bṛhatī, pankti*, and *triṣṭup.* Similar statements occur in the Kāṇva Samhitā (30.24-28), and in the Taittirīya Samhitā (TS IV.7.10), where the animal-ages add to either 17½ or 18 years. The difference is due to the interpretation of the word *paṣṭavāham,* taken to be 4½ or 5 or 6. The number of syllables in each of the above named meters increases by four and the total adds to 204 corresponding to the other total namely 17 years of 12 months each. Even in the ritualistic context the hymn appears to embed some type of number equivalence between the animal-ages and the meters. If the length of the year is taken as 360 *tithi*, we have 17x 360 = 204 x 30. On the other hand if it is taken as 354 days, we get the length of the synodic month to be (17x354)/204 = 29½ days, which is exactly the value adopted by VJ. As already noted the *nākṣatra* year of 324 nights/days with 27 units per month was also in vogue in ancient times. It is observed that 17 x 324 = 204 x 27. Such interesting properties of the number 17 based on observation of the moon could have lead to the early adoption of this as *Prajāpati's* number in the Vedas. The immediate next hymn of the Taittirīya Samhitā (IV.7.11-12) supports this inference. This is the famous sequence of seventeen odd integers 1 to 33, increasing in steps of 2, adding to 289 and equal to square of 17. This is followed by a sequence of even integers 4 to 48 increasing in steps of 4 adding to 312. The implied time-wise equivalence of two numbers in the previous hymn makes us wonder whether the number pair (289, 312) also has some useful astronomical property. Quite interestingly 289 synodic months are nearly equal to 312 sidereal months.

Even though there is a case for the VJ parameters to have come out of the observed 18 years, lunar eclipses are not mentioned in VJ. This situation may appear anomalous. However, there is mention of moon's lateral movement across the ecliptic, denoted as *ayana* similar to the seasons associated with the north-south movement of the sun. This has been ignored in the past as being of no astronomical significance[77]. But as demonstrated above the Vedic DP altar is correlated with the lateral wandering of the moon in the sky. VJ mentions that there are 134 *ayana* or north-south-north movements of moon in 67 *nakṣatra* months. Each *ayana* consists of three *Ṛtu*. Even though this has nothing to do with the felt (weather) seasons associated with the Sun, the lateral lunar movement is real to an observer on earth. The Vedic word *Ṛtu* is usually translated as *Season* as though indicating the felt weather. But in the earliest periods of scientific development, Vedic people had already noted that the "felt seasons" can be five or six or even seven in a year. This got formalized more accurately based on observation of sun's position with the *nakṣatra* as in the Maitrāyaṇīya Āraṇyaka and later in the VJ, Parāśaratantra and the Vṛddhagarga Samhitā, the details of which require a

[77] Sastry T.S.K (Ed.) *Vedāṅga Jyotiṣa of Lagadha,* IJHS, 19.4. Supplement, pp l-74. INSA N.Delhi, 1984.

separate chapter. Here it suffices to point out that a *Ṛtu* was defined as the time interval for sun or moon to cover a span of four-and-half *nakṣatra* space in the sky.

Moon stationed with a known *nakṣatra* say *Maghā* (Regulus) will come back to the same star after nearly 28 *tithi*, but not with the same phase. Thus starting with *māgha-pūrṇimā*, a sidereal month later, the *nakṣatra* will be *Maghā* but the *tithi* will not be *pūrṇimā*. During the course of this month, every night moon can be observed to occupy different *nakṣatra* position in a sinuous fashion. This happens all through the (solar) year with nearly 27 *ayana* for moon. VJ recognizes the similarity between sun and moon in the sense of what happens to sun in one year happens to moon in one month. Further as the year evolves, moon continuously wanders on either side of the 27 *nakṣatra* band closely representing the ecliptic. During this serpentine movement whenever a Full Moon occurs on the ecliptic, a lunar eclipse is possible. We have already seen how the symbolism of the 3339 *viśvedevāḥ* is connected with lunar eclipses. Number symbolism of meters, measures, areas appear in Vedic texts almost everywhere. The Taittirīya Samhitā starts with the DP rite hymns, elaborated in 14 *anuvāka* (sections). The total number of syllables in these hymns adds to between 3339 and 3349. The 9th *anuvāka* is about the preparation of the *vedi* or the DP altar with interesting etiology. The legend of an *asura* named Araru and his shadow falling on earth is cited. The altar is enjoined to be dug for only four *aṅgula*, because a deeper altar belonged to the ancestors. This appears in the Taittirīya Brāhmaṇa (III.2.9)

"(If the vedi should be) excessively (i.e. too deeply) excavated, it would belong to the Fathers (i.e. the deceased ancestors) (and it would not be fit for the sacrifice to the gods). He (the Adhvaryu) excavates it to such an extent that it is equal to Prajapati, the mouth of the sacrifice. (Formerly) the vedi hid itself from the gods. They found it four angulas deep (in the earth). That is the reason why it should be excavated four angulas deep."[78]

One wonders whether there is a hint here that such altars were in use for a long time before the DP ritual got fixed. Even more interesting is the further laudation of the altar[79]:

"...you are the self-law....you the glorious one, take the earth.... by means of its self-law and place it on the moon."

This is the extract of the translation of the hymn by Kashyap[80]. As per Sāyaṇa's interpretation also the altar was used by the ancestors of the current practitioners to establish earth on the moon as per natural self-law (*svadhā*)[81]. Even though we cannot claim that the shadow of the earth falling on moon was known to be the natural reason for the eclipse, the legends related to the DP altar, its shape and area point towards the pervasive influence of the Ṛgvedic

[78] Dumont P.E., *The Full-Moon and New-Moon Sacrifices in the Taittirīya Brāhamaṇa* (I Part, Text with Translation) Proc. Am. Phil. Soc., 101, 2, 1957, pp,216-243.

[79] *purā krūrasya visṛpo virapśinnudādāya pṛthivīm jīradānuryām airayan candramasi svadhābhiḥ tām dhīrāso anudṛśya yajante*|| TS (I.1.9).

[80] Kashyap R.L., *Taittirīya Samhitā* (Text with Translation), Vol., 1SAKSIVC, Bangalore. 2002.

[81] *pūrve yajamānā vedirūpam yām pṛthivīm kṛtsnabhūmerāsuryāḥ sakāśadūrdhvamādaya candramsyamṛtakiraṇaiḥ sārdham sthāpitavantaḥ idānīmtanāstu dhīmantaḥ tāmimām vedim manasānucintya tasyām yajante*|| Sāyaṇa Bhāṣya (TS I.1.9)

number 3339 and its hidden meaning connected with eclipses, in the proceedings of the DP rite.

It is not surprising eclipses, their periodicity and predictability have engaged the Hindu mind since the remotest past as evidenced by the RV and other Vedic texts. While legends, folklores and beliefs were plenty; observation, explanations and physical models were not lagging behind. The various Purāṇas allude to the mythical eclipse demon Rāhu but unequivocally equate this with the shadow of the earth, as in the Brahmāṇḍa Purāṇa[82]. The Mahābhārata, lauded as the Fifth-veda, occupies the position of a text in transition between the Vedas and the Purāṇas. Although in the first book legendary explanations about eclipses are stated, in the sixth book a physical model in which Rāhu the dark planet moving below sun and moon but larger in size than the two celestial objects is cited as the cause of eclipses[83]. Between such speculative efforts and the well reasoned mathematical astronomy starting with the Common Era, there was growth of matter-of-fact observational astronomy parts of which are still preserved in the Parāśaratantra and the Vṛddhagārgīya Jyotiṣa.

Summary and Conclusion

There are many numbers in the Ṛgveda and other texts, in the form of some types of time measures. These range from the short *muhūrta* (RV III.33.5) to longer days, fortnights, months, years and even longer periods. Vedāṅga Jyotiṣa (VJ) of Lagadha recognizes formally several other measures necessary for calendar calculations. The long count number 3339 is also a time measured in *tithi* linked only with the waning moon. Since as per VJ there are 371 *tithi* in a solar year, the long count is a proxy for 223 lunation or 18 years. This is the so called Saros eclipse cycle knowhow, supposedly inherited by the Chaldeans from their Babylonian predecessors[84]. But 223 is only a derived number based on the more fundamental count 3339 and the time measure *tithi,* which number and word appear respectively for the first time in the Ṛgveda and the Śatapatha Brāhmaṇa. Hence the statement of Pingree that *tithi* and the VJ owe their inspiration to outside sources is unfounded[85]. The direction of transmission of this knowledge could as well have been from India to Chaldea. The shape and the area of the DP altar in synchrony with the Vedic long count lead us to argue that the number should have been counted by placing a pebble on ground marking the relative position of moon on successive nights. Quite interestingly in RV (V.40.8) during the solar eclipse, Atri is said to have placed the eye of the sun in the sky by *bringing together the stones.*

The DP rite is special in several ways. From the astronomical point of view, the DP altar holds an esoteric central role. The hymns used in the liturgy refer to the sky and there is always more than what meets the eye in Vedic rituals. In one place, the altar is said to be in the sky and protected in the north by Mitra and Varuṇa, with the invariable law[86]. Naturally

[82] *tulyastayostu svarbhānuḥ bhutvādhastāt pravartate| uddhṛtya pṛthvīcchāyām nirmito maṇḍalākṛtiḥ* || Brahmāṇḍa Purāṇa (I Pt.23.101)
[83] Bhīṣma Parvan; Chapter 40; verses 40-47. The Mahābhārata, Crtical Edition, BORI, Poona.
[84] Neugebauer O., "A History of Ancient Mathematical Astronomy" Springer-Verlag. Germany 1975
[85] Pingree, D "Indian Astronomy", Proc. American Philosophical Society, 122,6, pp.361-364. 1978.
[86] *mitrāvaruṇau tvottarataḥ pari dhattām dhruveṇa dharmaṇā* || TS (I.1.11.12)

this makes one wonder whether Mitra and Varuṇa, two of the most important Vedic deities could have been visible stars in the northern sky, with some special properties. Such cryptic statements add an extra dimension to the astronomy of the Vedic times, since the practitioners did not limit themselves to physical observations but wished to attain a position in the sky. This mystical naturalism gets highlighted by the role of the Brahman, the presiding priest of the DP rite, who blesses the sacrificer silently

may the yajamāna attain a place at the base of the heaven, near the constellation Saptarṣi[87].

The northern sky region around the *Saptaṛṣi-maṇḍala* (U. Major) has always held prominent position in ancient texts as the base of the heaven and the centre of the universe. This region was the seat of another constellation known as *Śiśumāra*, identifiable with the modern constellation Draco. The first star at the head of this figure was called *Dharma*. Two among the fourteen stars making up the figure of this constellation were known as Mitra and Varuṇa in the ancient texts, to which the above TS hymn (I.1.11) refers. The fourteenth star at the tail end of this aquatic animal figure was called *Abhaya,* the original *Dhruva* or the fixed Pole Star.

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[87] *.....nākasya pṛṣṭhe yajamāno astu| saptaṛṣīṇām sukṛtām yatra lokastatremam yajñam yajamānam ca dhehi||* (See Ref.6)

4. Śiśumāra the forgotten Northern Constellation with Dhruva the Vedic Hindu Pole Star

Introduction

Alberuni (973-1048 CE) in his book on India mentions that devout Hindus held that the Pole Star was in the constellation that looks like a four-footed aquatic animal called, *Śākvarā* and also as *Śiśumāra*[88]. He further says that this name sounds similar to the Persian *Susumar*, which is the constellation of the Great Lizard, same as the modern Draco. He further adds that "the Hindus tell ludicrous tales about this figure." By this, he alludes to the Purāṇas that praise people with correct knowledge of the 14 stars making up the constellation to be blessed with an extra 14 years of life. Alberuni, as is well known, was interested in the philosophical and intellectual traditions of India. He translated into Arabic, apart from astronomical texts, the Yogasūtra of Patañjali. While explaining the aphorism; *dhruve tadgati jñānam* (YS 3.29) Alberuni again discusses the constellation *Śiśumāra* and *Dhruva* the Pole Star, as per the ancient Hindu tradition prevalent during his time[89]. Alberuni had admiration for Indian astronomers for their scientific approach to the subject. But, none of the *siddhānta* texts of the period described any constellation by the name Śiśumāra. Curiously enough, they were much more interested in establishing the first visibility conditions for the southern star Agastya (Canopus). This should not be surprising, since there was no visible star at the North Celestial Pole (NCP) during the first millennium of the Common Era (CE) which was the prime period of mathematical astronomy in India. This situation perhaps prompted Alberuni not to take the Purāṇas seriously as having preserved more ancient observations, in the form of legends and cultural beliefs. However, common people carried in their collective memory the story of a child prince by name Dhruva who was established as the fixed Pole Star and the Purāṇas had already built up a cosmological sky model around Dhruva. The orthodox Vedic tradition of the *vedāntin*s, cultivated in parallel also held that Dhruva the Pole Star was located in the constellation Śiśumāra. From modern astronomy it is known that such a situation was possible in the remote past *c* 3000 BCE, when α-Draconis (Thuban) was the Pole star. Recognition of this fact has far reaching consequences for understanding the history of ancient India and of Hindu astronomy going back to Vedic times.

[88]Sachau E.C. *Alberuni's India: An Account……of India About A.D.1030.* (Vols. I & II) London. 1910.
[89] Pines S. and Gelblum T. *Alberuni's Arabic Version of Patanjali's Yogasutra: A Translation of the third chapter and comparison with Related Texts*. Bull. School of Oriental and African Studies, Univ. of London, 2, pp.258-304, 1983.

In this article Vedic literature is considered first, followed by the Purāṇas and a few later texts. The information thus collected brings out some aspects of *dhruva-centric* or pole-centric astronomy that must have existed in India before the Common Era.

Taittirīya Āraṇyaka

The word *dhruva* occurs in many places starting from the Ṛgveda. The accepted meaning of this word is *fixed, true, stationary, unchanging* with shades of meaning very similar to these. For example in the Ṛgveda hymns (I.73, IV.5, VI.52, VII.88, X.173) the word is used as an adjective to indicate the *firmness* of objects such as the earth, the mountain, and the sky. In the 10th book the hymn (X.173) extols Varuṇa the King, as being true and steadfast. From the context of the hymn, this appears to be a prayer to a universal force, with the sky and most likely a star in the background. In the Yajurveda and the Atharvaṇaveda, eight and sometimes ten directions are named. In this nomenclature invariably *udīci* stands for north, *ūrdhva* for *above* and *dhruvā dik* refers to the lower direction in the sense of *fixed* earth. However, in the *Taittirīya Āraṇyaka* (TA) a change in this notation is seen. The phrase *adharāyai diśe* (TA II.20.1) instead of the more common *dhruvāyai diśe,* is used to denote the lower direction.

TA is an accented Vedic text, belonging to the Kṛṣṇa-Yajurveda branch. This text contains several interesting astronomical information that should be of interest to historians of science. The first *praśna* (section) of the text is about the six seasons and how they have to be recognized taking note of social behavior and some natural changes. Time is explained as flowing out of Sun and that *Time* flows like a river continuously (TA I.2). The text declares, the knowledge of Sun's station to be available to everyone using the four tools; memory, direct observation, history and inference [90]. As pointed out previously in the first Article in this series, two meteoritic showers spaced at six months interval find place (TA I.3; I.4) in recognizing the *grīṣma* (summer) and the *hemanta* (dewy) seasons. The concept of *mahāmeru* the imaginary mountain-like axis connecting earth with the heavens appears for the first time in Vedic literature in TA. The text alludes to seven suns and one more, the eighth called Kaśyapa, who does not leave *meru* but goes round the *mahāmeru*[91]. This

[90] *smṛtiḥ pratyakṣamaitihyam anumānaścatuṣṭayam| etairādityamaṇḍalam sarvaireva vidhāsyate||* TA (I.2.1)
[91] *kaśyapo'ṣṭamaḥ sa mahāmerum na jahāti|.....na hi śekumiva mahāmerum gantum | apaśyam aham etat sūryamaṇḍalam parivartamānam | gārgyaḥ prāṇatrātaḥ |gacchanta mahāmerum||* TA (I.7.1-3)

concept of a celestial body going round *meru* evolved into a physical astronomical model in the Brahmāṇḍa Purāṇa as will be explained later.

We have seen in the previously that the performer of the *darśapūrṇamāsa* sacrifice wishes to be stationed near *Saptarṣi* at the base of the heavens. This esoteric concept finds unambiguous mention in TA where it is mentioned that *the Seven Sages and Agastya are living with the stars*[92]. This tradition of naming stars, we may presume, must have started after the earthly sojourn of the eponymous human *ṛṣis*. Hence, it would be of interest to identify such stars by their modern names. Through unbroken tradition, and copious textual citations, *Agastya* can be equated with Canopus. But the same cannot be done with the other seven stars, since the names of the sages are not mentioned in TA except for Atri. The commentators of TA have taken the *Seven Sages* and *Agastya* to be the originators of the *gotra* system, as mentioned in the later *Sūtra* literature[93]. Hence it is not necessary to identify the *Seven Sages* alluded to in TA only with the stars of U. Major, even though such equivalence appears natural. The *Saptarṣi-maṇḍala* is unequivocally identified with U.Major, but the tradition of *ṛṣi*-names of the stars has changed over time[94]. The name of sage *Atri* once again appears in TA as a star in the description of the celestial *Śiśumāra,* a constellation in the form of an aquatic animal (alligator, or whale or dolphin), with a star named *Abhaya* at its tail end, which over time acquired the legendary name *Dhruva*, due to its property of being fixed in position as seen from earth.

The Celestial Śiśumāra

The second book (*prapāṭhaka*) of TA known also as the *Svādhyāya Brāhmaṇa*, gives the hymns used in the daily prayers of those initiated into the Vedic rites. The nineteenth hymn of this book known as the *Brahmopasthānamantra* is used at the conclusion of the evening meditation, which in the most ancient times was carried out outdoors most probably near a water body. The astronomical part of the text with a free translation follows:

*....dharmo mūrdhānam brahmottarāhanuḥ yajño'dharā viṣṇurhṛdayam samvathsaraḥ prajananam aśvinau pūrvapādāvatrirmadhyam mitrāvaruṇavaparapadau agniḥ pucchasya prathamam kāṇḍam tata indrastatḥ prajāpatirabhayam caturtham| sa vā eṣa divyaśśākvaraś**śiśumāraḥ…**| …….dhruvastvamasi dhruvasya kṣitamasi tvam*

[92] *ṛṣayassaptātriśca yat| sarve' trayo agastyaśca| nakṣatraiśśamkṛto'vasan||*
[93] *viśvāmitro jamadagnirbhāradvājo'tha gautamaḥ|atrirvasiṣṭaḥ kaśyapa ityete saptarṣayaḥ | saptānām ṛṣīṇām agastyāṣṭamānām yadapatyam tadgotramityācakṣate||* (Āśvalāyana Śrauta Sūtra Pariśiṣṭa)
[94] Mitchiner J.E., *Traditions of the Seven Ṛṣis*, MLBD N.Delhi, 2000.

bhūtānāmadhipatirasi tvam bhūtānām śreṣṭho'si tvām bhūtānyupaparyāvartante namaste namaḥ……śiśukumārāya namaḥ|| (TA. II.19.1)

….Dharma is the forehead, Brahma is the upper jaw, Yajña is the lower jaw, Viṣṇu is the heart, Samvatsara is the genital, Aśvins are the forelegs, Atri is the center, Mitra and Varuṇa are the hind legs. Agni is the first stem of the tail, then Indra, then Prajāpati and then ***Abhayam*** *is the fourth. This is the shining celestial* ***Śiśumāra****…….You are fixed (dhruva), you are the place of* ***Dhruva****……You are the Lord of Beings; you are the best among them. (All) Beings go around you. Namaste!…… salutations to you the boy-child.*

The commentary of Sāyaṇa clearly mentions that this hymn is to be used in the evening, turning towards the north and looking at the *dhruva-maṇḍala,* for meditating on the Cosmic Brahman[95].

The above hymn lists fourteen stars, *Dharma, Brahma, Yajña, Viṣṇu, Samvatsara, (Twin) Aśvins, Atri, Mitra, Varuṇa, Agni, Indra, Prajāpati, Abhaya,* along the body of the figure of the *Śiśumāra,* starting from its head to the end of its tail, unequivocally said to be in the sky. Both Bhatta-bhāskara (10th Cent.) and Sāyaṇa (14th Cent.) describe the esoteric import of the hymn, along with the parts and form of the animal figure in the sky. The former commentator takes *Prajāpati* to be *Kaśyapa* the eighth sun, mentioned previously in TA as not leaving the *meru*[96]. This hints at the circumpolar nature of at least some of the stars of this constellation, which finds prominent mention in the later Purāṇas. The hymn is more about the constellation figure as a group of stars, but the equivalence of *Abhaya* with the Pole Star later known as *Dhruva* is evident from the context. The text of TA is among the so called forest books supposed to be learnt in the seclusion of a forest, as it contains secret mystical and naturalistic meanings at the same time. The play on the word *Śiśumāra* finally concluded as *śiśukumāra* (boy-child) should have been the inspiration for the legend of the fear less child prince Dhruva, placed in the sky as the Pole Star near Viṣṇu, who is the regent deity at the heart of the ***Śiśumāra***.

In the accented text *Ekāgni-kāṇḍa,* also belonging to the Kṛṣṇa-yajurveda, hymns to be used in Vedic marriage rites are given. The hymn for observing and addressing the Pole Star Dhruva is;

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[95] *anena mantreṇa udaṅmukho bhūtvā dhruvamaṇḍalam paśyan śiśumārarūpeṇa tamupatiṣṭhet* || Sāyaṇa's Commentary on TA (Edited by H.N.Apte, Anandashrama Press, Pune, 1898).

[96] *Taittirīya Āraṇyaka with the Commentary of Bhaṭṭabhāskara Miśra* (Edited by A.M.Shastri and K.Rangacharya. Mysore 1900).

dhruvakṣitiḥ dhruvayoniḥ dhruvamasi dhruvatasthitam | tvam nakṣatrāṇām methyasi sa mām pāhi pṛtanyataḥ || Ekāgni (I.9)

Here the quality of *Dhruva* as a star is said to be fixed. *Dhruva* is praised as the *methī* or the fixed column to which the *nakṣatra*s are bound. The commentator Haradatta explains the word *methī* as *khalevālī*, a thick wooden peg fixed in the ground, to which animals are tied so that they do not stray away[97]. This *methī* became the *meḍhī* a pole or column in the Purāṇas, highlighting the fixity of the star *Dhruva* and the importance of *Meru* in the development of early astronomical models. As we go back in time naturally uncertainties increase, but beyond reasonable doubt the composers of the above Yajurveda texts knew *Abhaya alias Dhruva* as the Pole Star*;* that is a central star farthest in the sky, to which other celestial bodies were tied and kept in their path.

The ***Śiśumāra,*** which we meet again in the Purāṇas, based on the vivid description of the position of the 14 stars and the importance attached to its form, can be identified with the constellation Draco. It follows; *Dhruva* in its earliest nomenclature as *Abhaya* has to be equated with Thuban or α-Draconis. By back computations it is known that α-Draconis was the Pole Star during 3200-2400 BCE. In this long period, the declination of this star varied from 87^0 56' to $87^0$36', reaching nearest to NCP with $89^0$53' in 2830 BCE. The naming of the Vedic star *Abhaya* (No-fear) as *Dhruva* (Fixed, Certain) in the *Śiśumāra* should have happened during the above period, which provides an important chronological footprint not only for the Vedic culture but also for the roots of Hindu astronomy. By 1900 BCE the separation of *Dhruva* from NCP increased to 5^0 and the circumpolar nature of the star would have been evident to observers of the night sky. The declination changed to nearly 82^0 by 1500 BCE and the drift of the star away from the NCP should have been glaringly evident for observers in India. In the Maitrāyaṇī Āraṇyaka Upaniṣat (*aka* Maitrī Upaniṣat, MAU) one of the important question posed by King Bṛhadratha to Sage Śākāyanya was, *why Dhruva drifts, why the air strings holding the celestial bodies dip*[98]. Implicit in this question is the statement: *the North Star understood by us as fixed has changed its position;* an unmistakable reference to the effect of precession as noticed by King Bṛhadratha. This Yajurvedic text also contains astronomical statements to the effect that the northern course of sun started at the

[97] *Ekāgnikāṇḍa with the Commentary of Haradatta* (Edited by L.Srinivasacharya). G.O.L.Mysore 1902
[98] *kimetairvārnyānām śosanam mahārnavānām śikharinām prapatanam dhruvasya pracalanam vraścanam vātarajjunām nimajjanam prthivyāh sthānādapasaranam…||* MAU (I.4)

middle of the *dhaniṣṭhā* star division[99]. This corresponds to a few centuries before the Vedāṅga Jyotiṣa of Lagadha which states that the winter solstice coincided with sun at the beginning of star *dhaniṣṭhā.* This is a well discussed topic with the said observation dateable to *c* 1400 BCE[100]. The amount of precession between the two observations would be six to seven degrees. Thus, the drift of the Pole Star mentioned by King Bṛhadratha above is broadly consistent with 1900-1800 BCE.

The knowledge of *Śiśumāra* as a constellation, in contrast to the word meaning an aquatic animal, is wide spread in Vedic literature. In the first book of the Ṛgveda (I.116.18) we come across Aśvins bringing riches to Divodāsa in a cart to which were yoked a *śimśumāra* and a *vṛṣabha*. Griffith famous as the translator of RV, overlooking the astronomical culture of the Vedas, has translated this literally to mean a *cart drawn by a porpoise and a bull yoked together*[101]. In the commentary of Sāyaṇa, the word *śimśumāra* is identified as a variant of the word *śiśumāra.* Sāyaṇa also recognizes the impossibility of an aquatic animal and a land animal yoked to drag a cart pn earth and explains this as the special act of the *divine twins* the Aśvins exhibiting their extraordinary powers[102], which obviously makes the location to be the visible sky. Even if Divodāsa were to be a human king, favouring whom the above is mentioned, it should not be difficult to recognize that the verse alludes to an event in the sky in which the constellations Draco and a group of stars resembling the head of a bull, most likely the Taurus, were meant by the poet.

The Pañcavimśa Brāhmaṇa of the Sāmaveda has an interesting story about the cosmography behind the name *Śiśumāra*. It is said that originally this was a *Ṛṣi* or seer of the same name in the earthly ocean. He did not praise Indra fully and hence got stranded on the sands. After having praised Indra fully by the *śarkara sāman* song he could get into the water again. Later he attained the sky as the constellation with the same name. The word *śarkara* means constellation which is a variant of the word *śākvara* as in TA. The text further says that the

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[99] *sūryo yonirvai kālasya|tasyaitadrūpam yannimeṣādikālāt sambhṛtam dvādaśātmakam vatsarasya āgneyamardhamardham vāruṇam maghādyam śravisthārdhamāgneyam| krameṇotkramena sārpādyam śraviṣṭhārdhāntam saumyam||* MAU (VI.14)

[100] *Vedāṅga Jyoutiṣa of Lagadha* (Ed. by T.S.K.Sastry) IJHS, 19.4. Supplement, 1-74. N.Delhi. 1984.

[101] *When to his house ye came, to Divodāsa, hasting to Bharadvāja, O ye Aśvins,*
The car that came with you brought splendid riches: a porpoise and a bull were yoked together. (RV I.116.18; Translation by Griffith R.T.)

[102] *tasmai divodāsāya prāpayāmāsa| apica tasmin rathe vṛṣabhaḥ anaḍvān śimśumāraḥ grāha ca paraspara viruddhāvapi svasāmarthya prakaṭanāya yuktā vāhanatayā samyuktāvāstām ||* (Commentary of Sāyaṇa, RV I.116)

śarkara sāman chant is meant for crossing the oceans[103]. This has to be taken as a reference to the circumpolar nature of the bright stars of the *Śiśumāra* constellation which must have helped ancient mariners in navigating the seas. The Jaiminīya Brāhmaṇa text also has a similar legend about the constellation *Śiśumāra.* The Gṛhya Sūtra texts which were fixed much later than the accented core Vedic texts are prescriptive in nature about religious rites and customs to be followed by the orthodox. The religious practices of different Vedic clans which must have been prevalent since the most ancient times are codified in the formulaic *Sūtra* literature, not only canonizing the hymns to be used in the rites, but also fixing the actions to be followed by the main performers, participants and the priests. There are several different Sūtra texts attached to the four Vedas demonstrating not only their lateness, but also their spatial spread in accounting for the variation in the practices. However, the common feature of all these texts, in the historical context, is their memory of *Dhruva* as a fixed star to be invoked, seen and shown to the bride in the marriage rite. In all cases, the hymn for addressing *Dhruva* is same as or very similar to the one in the *Ekāgni-kāṇḍa* (I.9) mentioned above. The Hiraṇyakeśi Gṛhya Sūtra, in particular, prescribes worship of stars *Arundhatī, Saptaṛṣi*, and *Dhruva* even during the first kindling of the fire used in Vedic sacrifices. This text extols the Pole Star as, Brahman, fixed, non-slipping, non-shaking and as the centre of the universe.

It is noted that the Vedic people had direct knowledge of the constellation with fourteen stars, resembling in its outline an aquatic animal known as *Śiśumāra*, the 14th star counted from the head and placed on its tail being the fixed *Dhruva* or the Pole Star. The effect of precession on the sky picture was also felt as recorded in the Maitrāyaṇīya text, where *Dhruva* was observed to be drifting away from its original position. Notwithstanding such natural effects, the formality of showing the star Dhruva has continued in Hindu marriages over centuries coming down in the same form to this day as a ritual, even though everyone may not know which star was originally invoked by the prescribed hymns. But the orthodox successors to the Vedic tradition have preserved this information quite correctly as will be seen later.

It has to be pointed out here that the not so well known Indian scholar Aiyangar[104], in his writings on Indo-Aryan mythology discussed the TA hymn on *Śiśumāra* as representing a

[103] Caland W. English Translation of the *Pañcavimśa-Brāhmaṇa,* Bibliotheca Indica Series, 255, Calcutta, 1932.
[104] Aiyangār M.N. *Essays on Indo-Āryan Mythology*, Bangalore 1898. Available at: (https://archive.org/details/MN40106ucmf_3)

constellation in the sky and hesitatingly proposed that the *Dhruva* of this hymn was perhaps the Pole Star. He was more interested in gathering and deriving philosophical information from the Vedic and Purāṇa stories. He did not recognize the constellation *Śiśumāra* in astronomical terms but drifted widely to other astral myths in an effort to match the Vedic and the Purāṇic stories without appreciating the effect of precession as recorded in the astral legends.

Brahmāṇḍa Purāṇa (BP)

This tradition of observing *Śiśumara* and *Dhruva* was not restricted to the closed Vedic groups but was available to everyone as depicted in the Purāṇas, which have preserved such observational knowledge in the form of cultural astronomy. The story of the young boy Dhruva, who by his penance got the boon of being fixed in the north as the Pole Star, is a popular legend widely known all over India. The origin of this story can be traced to the Viṣṇu Purāṇa (VP) and repeated in several other texts. However, the related background astronomy is preserved in the Brahmāṇḍa Purāṇa without mythological embellishments. Since the word Dhruva means *fixed, certain, unchanging*, it is implicit that the boy Dhruva was identified with the eponymous Pole Star. This fact becomes interesting since BP, VP and several other texts not only provide cogent information on its location in the sky but also mention the observable self-rotation of Dhruva as the driving force for other celestial bodies to move around the NCP. This theory of Dhruva, takes us to the most ancient form of Indian astronomy which was *dhruva-centric*, or *meru-centric*. It is known that no absolute dates can be put forth for any of the eighteen Purāṇa texts, which have grown over time with bulky additions. But, all or most of them retain the story of *Dhruva* as the Pole Star with variant readings. This is a clear indication of the branching of the Purāṇas from a nucleus which lies in the Vedic texts such as the TA and the *ekāgni-kāṇḍa* which knew the prominent constellation *Śiśumara* with 14 stars, the fixed *Dhruva* and the *Meru* connecting the earth with the NCP. Among the Purāṇas it is in BP we find matter of fact statements about *Dhruva*. As far as ancient astronomy and cosmology are concerned, BP preserves the original concepts, out of which the Viṣṇu, Vāyu, Liṅga and Matsya Purāṇa have bifurcated with further variations. This chronological perspective finds support in the works of a few indologists also[105].

[105] Clarke W.E., *A note on Pargiter's Ancient Indian Historical Tradition*, J Am. Ori. Soc, 43, pp. 130-131, 1923.

The *dhruva-centric* model of the sky can be best appreciated in the BP as an outcome of direct observation. We consider here BP first and later look at variant information from a few other texts. In the first chapter of BP a list of the contents to be covered is provided. This promises astronomy related to Dhruva as,

sūryādīnām syandanānām dhruvādeva pravartanam|
kīrtyate śiśumāraśca yasya pucche dhruvaḥ stithaḥ || BP. I (1.84)

The movement of sun and other moving celestial bodies is explained as induced by Dhruva only. The constellation Śiśumāra, at the tail of which Dhruva stays, is also described.

This theory is further elaborated in chapters 21-24, totaling 520 verses, with many ancient concepts about Sun, Moon, eclipses and planets. Here, we restrict our attention only to a few important statements concerning *Śiśumāra* and *Dhruva*.

tatomandataram nābhyām cakram bhramati vai tathā|
mrtpiṇḍa iva madhyastho dhruvo bhramati vai tathā ||
trimśanmuhūrtānevāhuḥ ahorātram dhruvo bhraman|
ubhayorkāssṭhayormadhye bhramte maṇḍalāni tu ||
kulāla cakranābhiśca yathā tatraiva vartate|
dhruvastathāhi vijñeyastatraiva parivartate|| BP. I (21. 94, 95, 96)

Like the lump of clay at the middle of the potter's wheel moves slowly sitting at the navel, Dhruva rotates. Dhruva moves in circles day and night consisting of 30 muhūrtas, at the middle of the two directions (north and south). Like the nave of the potter's wheel stays in the same place, so also Dhruva should be known to be rotating there itself.

Chapter 21 containing 176 verses gives an account of sun's motion, with definitions of seasons, equinox and solstice. It introduces the cosmography of *Mt. Meru* connecting the earth and the heavens like a vertical pole in the north, around which all celestial bodies are modeled to move in circular paths. The star Dhruva is said to be at the tip of the *Meru*. The starry space in the sky between the nakṣatras of *ajaveethi* and star Agastya (Canopus) is said to be the *pitṛloka* (abode of manes), where as the corresponding region in the north between nakṣatras of *nāgaveethi* and *Saptaṛṣi* (U.Major) is the *devaloka* (abode of gods)[106]. The chapter ends by declaring the famous third step of Viṣṇu to be in the north above the *Saptaṛṣi* wherein *Dhruva, Dharma* and others are located[107].

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[106] *uttaram yadagastyasya hyajaveethyāśca dakṣiṇam|pitṛyānaḥ savai panthāḥ vaiśvanarapathādbahiḥ||*
nāgavītyuttaroyaśca saptaṛṣigaṇadakṣiṇaḥ|uttaraḥ savituḥ panthā devayānaśca sa smṛtaḥ ||
BP (21.156) and BP (21.168)

[107] *ūrdhvottaram ṛṣibhyastu dhruvo yatra savai smṛtaḥ | etadviṣṇupadam divyam tṛtīyam vyomni bhāsvaram ||*
yatra gatvā na śocanti tadviṣṇoḥ paramam padam | Dharmadhruvādyāḥ tiṣṭanthi yatra te lokasādhakāḥ ||
BP (21.175, 176)

Chapter 22 starts with a description of the position of *Dhruva* as

bhūtasammohanam hyetad vadato me nibodhata |
pratykṣamapi dṛśyam ca sammohayati yat prajāḥ||
yo'yam caturdaśarkṣeṣu śaiśumāre vyavasthitaḥ |
uttānapādaputro'sau meḍhībhūto dhruvo divi||
sa vai bhrāmayate nityam candrādityau grahaiḥ saha |
bhramantamanugacchanti nakṣatrāṇi ca cakravat|| BP. I (22. 5, 6, 7)

Listen to this explanation of mine which is real and observable but mystifying people. He, who is at the tail of the 14 stars looking like a śiśumāra; Dhruva the son of Uttānapāda, has become the main pivot of the pole in the sky. Verily, he rotates the sun, the moon and the planets continuously. The stars follow him who is himself circling like a wheel.

In the above the narrator (Sūta) is appealing to people to observe the sky and understand the ancient theory of *Dhruva* as the controller of the motion of the celestial bodies. Since *Dhruva* as a north star is said to be in a figure looking like a *śiśumāra,* this group of stars should be same as the constellation meant by the Vedic texts discussed already. BP further elaborates the self-circling motion of *Dhruva* and that of the stars (*tārāḥ*) and the *nakṣatras* around him. The point to be noted is the differentiation between the general stars and the *nakṣatras*. The latter are the 27 ecliptic asterisms and *Dhruva* was never one among them. There are 84 verses in this chapter, arguing for a physical model for the motion of sun seen in the day but, linked to *Dhruva* seen only in the night. The northern and southern sojourn of the sun also had to be explained within this model. Without going into the details, we note that Sun's chariot is said to have only one wheel the axle of which is connected to *Dhruva* by two strings of light which take care of the change in the orbit of sun around the earth. We speculate that the older analogy of the potter's wheel was unable to mimic the observed apparent motion of the sun and hence the two axle model and connection to Dhruva with two unseen strings was proposed to simulate action at a distance. This change is also seen in the example of the animal driven oil mill proposed as a physical model for understanding the motion of the stars around *Dhruva*.

yāvatyaścaiva tārāśca tāvanto vātaraśmayaḥ|
sarvā dhruve nibaddhāśca bhramantyo bhrāmayanti tāḥ||
tailapīḍā yathā cakram bhramanto bhrāmayanti ha|
tathā bhramanti jyotīṁṣi vātabaddhāni sarvaśaḥ|| BP.I (23.96,97)

There are so many wind-reins as there are stars. All (reins) are bound to Dhruva; themselves rotating; they make the stars to go round. As in an oil press, the wheel goes round and makes the other (the pole) rotate; so do the luminaries held in grip by the wind-strings, revolve.

In the oil mill, the central pole is rotated by the motive force provided by an animal moving in a circular path. In the Purāṇic sky model, the roles are reversed, such that the locally spinning Dhruva can make the celestial bodies at a distance to move around in their circular path, the connection being through strings (or rays) of wind (or light).

Chapter 23 of BP is indispensable to anyone interested in the history of Indian astronomy as it explains the astronomical symbolism behind the lunar number 3339, first appearing in the Ṛgveda[108]. Towards the end of this chapter the text describes the location of *Dhruva* along with other companion stars making up the animal figure *Śiśumara*.

evam dhruva nibaddho'sau sarpate jyotiṣāṅgaṇaḥ |
saiṣa tārāmayaḥ proktaḥ śiśumāro dhruvo divi ||
yadahnā kurute pāpam dṛṣṭvā tanniśi muñcate|
yāvatyaścaiva tārāstāḥ śiśumārāśritā divi ||
tāvantyaiva tu varṣāṇi jīvitābhyadhikāni tu |
sākāraḥ śiśumāraśca vijñeyaḥ pravibhāgaśaḥ || BP. I (23. 99, 101b)

Thus, centered in Dhruva, the circle of luminaries revolves. And this Śiśumara, fixed in the sky, is to be understood as made of stars. Whatever sin one commits during day, one is divested of it upon seeing Śiśumara in the night. As many stars as there are associated with Śiśumara in the sky, so many years more, does one live on. (For this) the form of the Śiśumara should be known in terms of its parts.

The chapter ends with a good description of the *Śiśumāra* constellation enumerating the constituent stars numbering fourteen. This is perhaps the earliest example of a star group being represented and named by an animal figure.

[108] See previous articles 2 and 3 of this series.

uttānapādastasyātha vijñeyaḥ sottarā hanuḥ |
yajño'dharastu vijñeyo dharmo mūrdhānamāśritaḥ ||
hṛdi nārāyaṇaḥ sādhyo aśvinou pūrvapādayoḥ |
varuṇaścaryamācaiva paścime tasya sakthinī ||
śiśnam samvatsarastasya mitraścapānamāsritaḥ |
pucche agniścamahendraśca mārīcaḥ kaśyapo dhruvaḥ ||
tārakāḥ śisumārasya nāstam yāti catuṣṭayam ||
agnīndra kaśyapānam to caramo'sau dhruvaḥ smṛtaḥ || BP. I (23. 102-104, 105b, 107b)

His (Śiśumāra's) upper jaw should be understood as Uttānapāda. Yajña (Kratu) is known as the lower jaw and Dharma as the head. At the heart is Nārāyaṇa (Sādhya). The twin Aśvins occupy the forelegs while Varuna and Aryamā are at the hind legs. Samvatsara is the genital and Mitra occupies the seat. In the tail are Agni, Mahendra, Mārīca-Kaśyapa and Dhruva. The (previous) four stars of the Śiśumāra never set. It is remembered that Dhruva is the last star after Agni, Indra and Kaśyapa.

This listing of stars on the body of the *Śiśumāra* is almost same as in TA with minor variations in the names, but the geometrical picture of the animal figure is same as in TA. The "addition of 14 years of life" which Alberuni found not rational, was a ploy of the narrator when BP was still orally transmitted, for encouraging people to observe and preserve the names of the constituent stars and the form of the constellation accurately.

Viṣṇu Purāṇa (VP)

The Viṣṇu Purāṇa one of the important religious texts relates the earthly story of Dhruva with poetic embellishments and devotional fervour. In the BP the boon for Dhruva to be in the sky as the Pole Star is given by Brahma, where as in the VP, Viṣṇu is said to give the boon. Interesting astro-mythological information provided in the VP is that Dhruva's mother Sunīti stays near him in the sky as a companion star. This provides a constraint on the identification of Dhruva in the *Śiśumāra* constellation. In the description of the stars making up the constellation fourteen are mentioned as in BP. The only difference being the word *mārīcaḥ* qualifying Kaśyapa is missing in VP. The cosmological functions assigned to Dhruva in the VP are same as in BP. Both mention Dhruva as the fourth after Agni and that the last four stars ending with Dhruva do not set. The Matsya and the Vāyu Purāṇa repeat similar astral information with a few deletions, about Dhruva and *Śiśumāra.*

Bhāgavata and Devibhāgavata

This is again a highly respected text mainly extolling devotion to Viṣṇu and his incarnations. Many of the statements in this text about Dhruva that are in prose form (BookV.Ch 23) are

same as in VP but not all the fourteen stars of the *Śiśumāra* are named. Dhruva is initially associated with stars Agni, Indra, Prajāpati, Kaśyapa and Dharma and is compared to a fixed object or pillar around which heavenly bodies rotate driven by *Time*. Dhruva's rotation as the driving force is conspicuously absent in this text. Further the text quite categorically states that *some people* meditate on the figure of *Śiśumāra* as the body of Vāsudeva. These people are said to think of Dhruva at the end of the tail; Prajāpati, Indra, Agni and Dharma on the trunk of the tail, Dhāta at the root of the tail and Saptarṣi (U.Major) at the waist. The text further describes how the coiled figure has to be imagined with sun, moon, stars and all the planets at the various places of its universal body[109]. In the Devī Bhāgavata the description of Dhruva is an exact restatement of the Bhāgavata in verse form. Here also *some people* are said to imagine the *Śiśumāra* constellation in an extended form to cover the whole sky as the divine body of Viṣṇu (8.18; v. 11-26). Whatever may be the inspiration for this extension, it is easy to observe that these texts lack the care and detail with which BP describes its *dhruva-centric* astronomy. The texts that are liberal with religious concepts at the cost of astronomical pictures can be easily recognized as being chronologically later, when the original *Dhruva* was not at the NCP.

The Constellation

The constellation of *Śiśumāra* consisting of fourteen observable stars that make up a figure like a dolphin (or porpoise or alligator) is well preserved in the Vedic and the Purāṇa texts. The Pañcavimśa Brāhmaṇa of the Sāmaveda already discussed indicates that the circumpolar property of the bright stars of this constellation was of help in navigation. The celestial ocean in which the constellation is said to rise and move can be recognized as the Milky Way, which BP calls *viyadgaṅgā* or the heavenly Gaṅgā River. With all the above details, recognition of this constellation as the modern Draco should be obvious. However, Allen[110] in his classical book on star names gives two meanings to *Śisūmāra* namely, Draco and Delphinius, the latter meaning attested nowhere in the ancient literature. The reason for this can be traced to the faulty rendering of original Sanskrit texts in popular translations. For example the vulgate Matsya Purāṇa has a footnote that makes *Śiśumāra* to mean *the zodiac personified and no other than the child Viṣṇu*[111]. In his translation of the Viṣṇu Purāṇa,

[109] ***kecanaiḥ*** *tajjyotiḥ anīkam śiśumāra samsthānena bhagavato vāsudevasya yogadhāraṇāyām anuvarṇayanti||*
[110] Allen R.H. *Star Names and Their Meanings,* Dover Publications. Inc., USA.1963
[111] The Matsya Purāṇa (Text and Transl by H.H.Wilson) Arranged by N.S.Singh, Nag Publ. N. Delhi, 1997

Dutt[112] takes fancifully *Śiśumara* in one place as the stellar sphere. Even the modern translation of the Brahmāṇḍa Purāṇa by Tagare[113] adds an unnecessary footnote citing the Bhāgavata that *all the stars and constellations are located as different parts of the body of this heavenly porpoise.* However, as seen previously the Bhāgavata mentions that some people for meditation follow such a procedure and as far as the BP text is considered such an interpretation is impossible. As per the original texts in the BP and the VP there is no way to conceive the constellation other than placing the fourteen stars on the outline figure of a *Śiśumāra* for its visual picture. The statement that four of the stars on the tail, with *Dhruva* as the fourth do not set clearly makes these circumpolar, for the observer and narrator *Sūta* of BP. The one to one correspondence between the Vedic and the Purānic description leads us to the conclusion that the constellation meant should be the Draco in the northern sky. Referring to Figure 1, the ancient description stopped with α-Draconis (Thuban) without including stars κ- and λ- Draconis. The names of some of the Vedic stars can be tentatively identified with their modern equivalents. Behind α-Draconis (Thuban) are ι, θ, η stars that can be recognized as *Prajāpati, Indra* and *Agn*i. The name *Samvatsara* literally *Year*, for one of the stars (5th or 6th from Dhruva) is interesting. It is said to be the genital, meaning thereby in Vedic parlance, the producer of Years. It would be interesting to investigate this further to see whether a star of this constellation which exhibited visibility phenomena could have been used as a marker for recognizing the beginning of the New Year in the 3rd millennium BCE. The stars *Dharma* and *Brahma* of TA can be identified as γ- and β-Draconis (magnitude 2.24 and 2.79) respectively. The Purāṇas changed *Brahma* to *Uttānapāda* so that his son *Dhruva (Abhaya)* remains at the end of the same figure, along with his mother *Sunīti* identifiable as star 10-Dra of magnitude 4.5. The forelegs with the two *Aśvins* and hind legs with *Mitra* and *Varuṇa* are identifiable as the two bends in the figure.

[112] Dutt M.N. *English Translation* of the Viṣṇu Purāṇa, Chowkamba Publ.Varanasi. 1972.
[113] Tagare G.V. *English Translation* of the Brahmāṇḍa Purāṇa, Motilal Banarsidas Publ. N.Delhi, 2000.

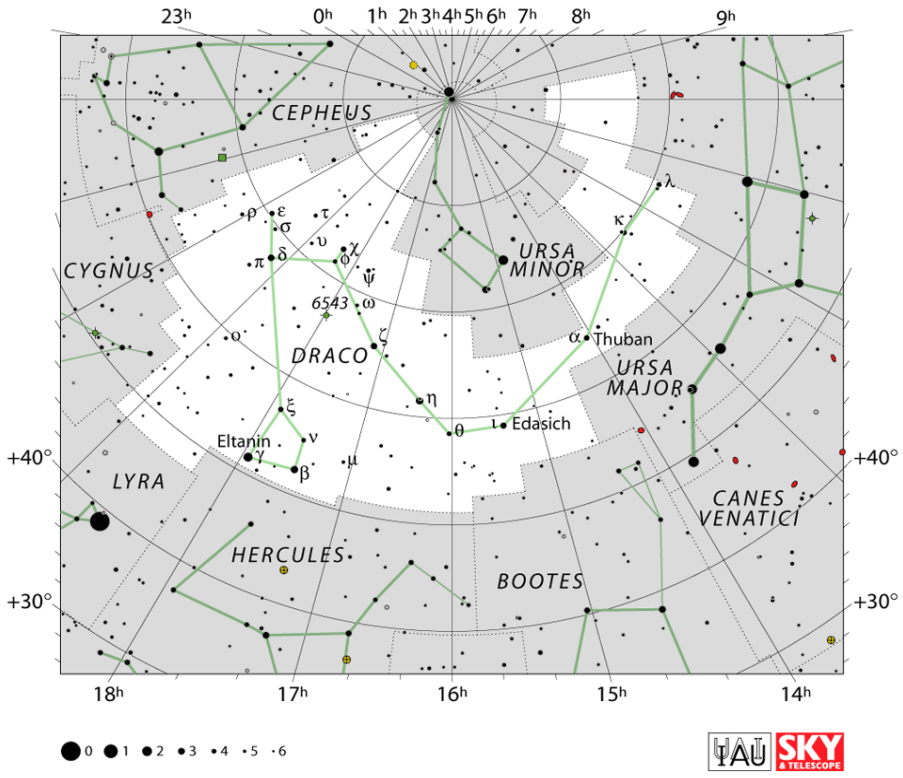

Figure 1. Constellation Draco with the Current (2000 AD) Pole Star at NCP
(http://www.iau.org/static/public/constellations/)

Precession

The constellation *Śiśumāra, Dhruva* and *Meru* have influenced the cultural practices of Indians for more than four thousand years. Nevertheless the inviolable effect of precession started taking its toll on the prime position *Śiśumāra* had as a constellation in the cardinal north direction during the 3rd millennium BCE. We have already seen mention of shifting and moving of *Dhruva* in the Maitrāyaṇīya Āraṇyaka in the 2nd millennium BCE. The Mahābhārata revered the constellation, when King Drupada announced the marriage of his daughter Draupadī. The place for holding the famous archery competition was named *Śiśumārapura* and this was located to the *northeast* of the capital city[114]. The name and the specific mention of direction is an unmistakeable reference to the shift of the constellation towards northeast in the sky also. As the figure shifted far away from its prime north position its shape altered to bring in new names such as Nahuṣa (serpent) and Ajagara (python) in the precession legends, in which the southern star Agastya (Canopus) also finds a role. The first recognition of the southern star and its identification with Sage Agastya in the Kurukṣetra

[114] *tataḥ purajanāssarve sāgaroddhūta nissvanāḥ| śiśumārapuram prāpya nyaviśan teca pārthivāḥ||*
prāguttareṇa nagarād bhūmibhāge same śubhe| samājavāṭaḥ śuśubhe bhavanaiḥ sarvato vṛtaḥ||
MB Ādi Parvan (Ch 176 v 15,16)

region seems to have taken place around 3100 BCE[115]. With passage of time the visibility interval of this star increased as also its altitude and importance of its first visibility in the Vedic annual cycle[116]. It is interesting to note here that many of the legends connected with Agastya are about balancing the earth and rectification of the North-South direction. A popular astral legend appearing in the Mahābhārata is about King Nahuṣa seated in a palanquin being carried in the heavens by the Seven Sages and Agastya, on their shoulders, when Agastya was kicked by Nahuṣa for being too slow[117]. Agastya in anger curses the heavenly King Nahuṣa to lose his exalted position to become an ordinary *ajagara* (python). This legend is easily recognized as an allegory for precession being felt in the form of the *Śiśumāra* constellation losing its prime northern celestial position, along with star *Agastya* coming into prominence as a new bright star in the south. An interesting study of the religious influences of the Nahuṣa-Agastya legend has been carried out by Hiltebeitel[118]. According to him, the identification of the heavenly Nahuṣa with the constellation Draco was first proposed by two German scholars, both Adof Holtzmann (uncle and nephew). The Mahābhārata also mentions the movement of *Dhruva* as a bad omen before the Great War[119]. This statement as also the most probable date of the war is in harmony with the middle of 2nd millennium BCE, when due to precession α-Draconis was no more at the NCP[120].

Among the three elements handed down by the Vedic TA, the visible entities were the star *Dhruva* and the constellation *Śiśumāra*. As these shifted position, the two receded from the day to day lives of common people, only to remain as legends. The third one namely the *meru* was always imaginary, but this withstood the passage of time best, providing the basis for the cosmological view of not only Hinduism, but also of Jainism and Buddhism and appears now all over India in temple architecture. The cosmology of the Brahmāṇḍa and other Purāṇas describing multiple ring shaped oceans, mountains and continental boundaries with distances stated in thousands of *yojanas* along with special numbers for sun, moon and

[115] Abhyankar K.D. *Folklore and Astronomy:Agastya a Sage and a Star*, Current Science, 89, pp.2174-2176. 2005.
[116] Iyengar R.N. *Parāśara's Six Season Solar Zodiac and Heliacal Visibility of Star Agastya in 1350-1130 BCE.* IJHS, 49.3, pp.223-238, 2014.
[117] Mahābhārata, Udyoga Parvan , Ch.17, v. 14-18. (BORI, Pune Critical Edition).
[118] Hiltebeitel A. *Nahuṣa in the Skies: A Human King of Heaven*. History of Religions. 16.4. pp.329-350. 1977.
[119] *dhruvaḥ prajvalito ghorah apasavyam pravartate* || (Bhīṣma Parvan Ch.3, v.17)
[120] Iyengar R.N. *Internal Consistency of Eclipses and planetary positions in the Mahābhārata* IJHS. 77-115, 2003.

planets sounds strange on first reading. However, recent studies by Kloetzli[121] on VP and by Thompson[122] on the Bhāgavata, show that Purāṇas present real three dimensional pictures projected on to a two dimensional plane, in layers, as in an astrolabe. A similar study on BP is desirable since, it is the source for all the ancient astral information that has been borrowed by the other texts either totally or with additions, deletions and distortions.

A difficulty one faces with BP is regarding its fixture in writing which must have happened in the early centuries of the Common Era. All Purāṇas basically claim to narrate ancient legends. Hence, one can object that BP text describing the *Śiśūmāra* need not refer to Thuban as the Pole Star, but another one lying very close to the Pole. Such a possibility cannot be denied, since BP can be interpreted to state 15 stars, by counting the stars *Mārīca* and *Kaśyapa* separately. The only eligible candidate for this possible alternate identification of *Dhruva* is κ-Draconis, which was nearest to the NCP *c* 1300 BCE at declination 85^0 13', violating the property of being seen to be fixed, even though it could still indicate the north direction. This possibility does not in any way affect the conclusions about *Abhaya-Dhruva* being known as a fixed star in the Vedic period. The other candidate suggested in the literature for being near the NCP is star Kochab (β-U.Minor). The nearest approach of this star to NCP was 83 degrees. This fact as well as the geometry of U.Minor, does not fit into the textual descriptions of *Dhruva* better than α- or κ-Draconis. Even though BP has a stray statement (21.144) about the equinox being located at the beginning of *meṣa (rāśi)* and the end of *tulā (rāśi)* matching with the Common Era, there are several other observations that synchronize clearly with 2^{nd} millennium BCE. In the identification of the equinox day, BP mentions that when Sun is in the first quarter of *kṛttikā* (Alcyone) and Moon in the fourth quarter of *viśākha* (α-Libra), the day and night are equal. Similarly when Sun is in the third quarter of *viśākha* and Moon is at the beginning of *kṛttikā* it is *viṣuvam* (equinox). This statement appears in several of the Purāṇas and hence cannot be ignored as spurious. This has been discussed in detail in relation to other ancient astronomical statements by Koch[123], to show that the record preserved in the Purāṇas holds valid for 1885-1645 BCE.

[121] Kloetzli W.R. *Maps of Time-Mythologies of Descent: Scientific Instruments and the Purāṇic Cosmograph.* History of Religions, 25,2. pp.116-147, 1985.
[122] Thompson R.L. *The Cosmology of the Bhāgavata Purāṇa* (First Indian Edition) MLBD Publn. Delhi. 2007.
[123] Koch D., *Astronomical Dating of the Mahābhārata War*. Erlenbach, Switzerland. 2014. (http://www.gilgamesh.ch/KochMahabharata6x9_V1.00.pdf)

First Millennium BCE

The very fact that BP first refers to Dhruva as a fixed peg to which the stars are tied, and next to a self-circling *Dhruva* driving the sun, moon and stars, is evidence of correction to previous hypotheses made necessary due to the effect of precession. The further cosmological extensions with large spatial measure numbers must have been inspired by the imaginary *Meru*, at the tip of which *Dhruva* was taken to reside. This may be a development of the first millennium BCE, when there was no visible Pole Star at NCP. Texts reliably dateable to the first millennium BCE are very few. We have already seen that the Gṛhya Sūtras dateable to *c* 500 BCE refer to the more ancient Vedic rites. These do not refer to Śiśumāra but by unbroken tradition the location of *Dhruva* must have been known to the faithful. The Atharavaveda Pariśiṣṭa (AVP) an unaccented text, considered to be an appendix to the Atharvaṇa Veda, is available in 76 Chapters[124]. The work contains very ancient as well as not so ancient material, added most probably after *c* 500 BCE. The text refers to Pāṇini (AVP 43.4.16) and also to *dināra* a gold currency (AVP 36.26.3) of foreign origin which was in circulation in the northwest part of India at the turn of the Common Era. AVP has long chapters on stars, planets and comets like a *jyotiṣa-samhitā.* For the present purpose it is sufficient to note that Chapter 52 titled *Grahasaṅgraha* preserves a collection of names of stars and constellations other than the well known *nakṣatra*s along the ecliptic. In this list the Seven Sages with names; *Gautama, Atri, Vasiṣṭha, Viśvāmitra, Kaśyapa, Ṛcīkaputra* and *Bharadvāja*, are said to be fixed in the north. This is followed by another star group fixed at the end of the middle sky, with unmistakable reference to *Dhruva* with *Śiśumāra* and a few others followed by *Viṣṇupada*[125]. Some of the stars are named differently from the Vedas and the Purāṇas, but the constellation figure of *Śiśumāra,* the famous ancient star *Dhruva* and the station of *Viṣṇu* are same as in the TA and BP texts. Some of the texts of the Jain tradition fixed within a few centuries after the advent of Mahāvira (599-527 BCE) contain information in the form of omens, anecdotes, and the calendar. The Bhadrabāhu Samhitā (*c* 300BCE) mentions a comet masking *śimśumāra* as a bad omen[126]. A more detailed statement about a comet by name *Calaketu* rising in the west and moving north touching Saptarṣi and Dhruva

[124] *Atharvaveda Pariśiṣṭa* (Ed.)G. M. Bolling and J. von Negelein, Leipzig,1910

[125] ***śiśumāreṇa*** *sahitā* ***dhruveṇa*** *ca mahātmanā | pulastyaḥ pulahaḥ somo bhṛgurāṅgirasā saha || hāhāhūhū ca vijñeyau* ***viṣṇoścapadam*** *uttamam| madhyāntasthāvarāṇāmtu niyatāviti buddhimān*||AVP(52.10.4,5)

[126] *Bhadrabāhu Samhitā* (Ed.) A.S.Gopāṇi, Sindhi Jaina Granthamālā. Bharatiya Vidhya Bhavan, Bombay, 1949.

before turning south, is available in the Parāśaratantra[127]. Such statements indicate that the constellation was variedly remembered, with or without Dhruva.

Common Era (CE)

As we enter the CE the nature of Indian astronomy, as is well known, changes its colour with emphasis on mathematics. The connection between the astronomical knowledge of the more ancient period and the Siddhānta texts of the CE is not well investigated. There was no recognized star at NCP during CE and we do not come across reference to *dhruva* unambiguously as the Pole Star till the 15th Century. But the terminology *dhruvaka* for polar longitude is derived from *dhruva*, interpreted as the Pole, an imaginary point on the sphere. *Meru* finds mention in the chapters on *Bhuvanakośa* but not *dhruva* as a visible star at NCP. Brahmagupta (598-670 CE) discussing the rotation of the celestial sphere uses the phrase *dhruvayoḥ nibaddham*, meaning the two geometrical north and south poles of the sphere. The group of stars near the Pole was named *dhruvamatsya* (Polar-fish) and not as *Śiśumāra*. Bhāskarācārya (1114-1185 CE) in his *Siddhānta-śiromaṇi*, under *Bhuvanakośa* refers to the mouth and tail of this polar-fish and its synchronization with sun rise and sun set. In the 15th Century the present Polaris or α-U.Minor had reached close to the Pole at about 86° and a line connecting it to star *markaṭi* (β-U.Mi or Kochab) was recognized to rotate like a hand in a clock. This fact was used by Padmanābha to develop his astronomical instrument *Dhruva-matsya-yantra* for finding time as in a clock[128].

Controversy among Indologists

European scholars started taking interest in Sanskrit language, grammar and the Vedic literature from the 18th Century onwards. A topic of interest to many of these scholars was the date of the Ṛgveda, the most ancient literature of India, variously assigned from 4th millennium BCE to 1500 BCE. Jacobi[129] a German scholar of repute was a proponent of astronomy as a means of dating the Vedic culture. He pointed out the importance given by all the Gṛhya Sūtras to show Dhruva as the Pole Star to the bride in the Vedic marriage rites. His argument was, since there was no Pole Star during the composition of the Sūtra literature, the composers of these texts should have known a star which was at the NCP in more ancient

[127] *Parāśaratantra (Reconstructed text with translation and notes)* by R.N.Iyengar. Jain University Press, Bangalore, 2013.
[128] Sarma S.R. *The Dhruvabhrama-Yantra of Padmanābha.* J. Rashtriya Samskrita Samsthan, Vol.6, pp.321-343, N.Delhi, 2012.
[129] Jacobi H.G. *On the date of the Ṛgveda, (Transl. from German)* The Indian Antiquary, 23, 154-159. 1894.

times, which can be none other than α-Draconis (Thuban). Jacobi somehow referred only to the late marriage codes for presenting his case. His opponents prejudiced as they were against dating the Ṛgveda to any period before 1500 BCE, treated *Dhruva* as an independent entity mentioned only in the Sūtras without any connection to the Vedic *Śiśumāra*. Typical was the dismissal by Whitney[130] an American academic, when he wrote "….any star not too distant from the pole would have satisfied both the newly wedded woman and the exhibitor; there is no need of assuming that the custom is one handed down from the remote period when α-Draconis was really very close to the pole, across an interval of two or three thousand years during which there is no mention of pole-star, either in Veda or in Brāhmaṇa." Keith working in India in the Colonial Office translated into English Taittirīya Samhitā and several other Vedic texts. Notwithstanding his knowledge of the country and its culture, he was derisive of the Hindu marriage ritual to comment[131] "…the argument from the pole star assumes an accuracy in the demands of the primitive Indian wedding ritual which is wholly unnatural." While criticizing the Śatapatha Brāhmaṇa text mentioning that the Pleiades do not slip from the east he wrote "a passage which consists of foolish reasons for preferring one or other of the Nakṣatras; we are in the same region of popular belief as when in the Sūtra literature the existence of Dhruva, a fixed polar star, is alleged." As if not satisfied with the above arguments he added a foot note on page 79 of his monograph; "The pole star, Dhruva, appears in the Gṛhya Sutras only." It appears Whitney and Keith had no understanding of the TA text, assuming that they had read it. Keith coauthored a Vedic Index with Macdonell[132], which is popular as a reference book even now. Under *Dhruva* there is reference to Jacobi and the controversy of this being the Pole Star. But under the entry *Śimśumāra/Śiśumāra* the word is taken just as an aquatic animal with no archaeo-astronomical recognition of a constellation. This is misleading, since even the Monier-Williams Dictionary of 1899 listed one of the meanings of *Śiśumāra* as: *a part of the heavens having stars of that shape*.

Conclusion

Any attempt to trace the history of Indian astronomy cannot overlook the vast Vedic literature starting from the Ṛgveda and the Purāṇas. These texts present the oldest description of a constellation named the *Śiśumāra* comprising of fourteen stars including the Pole Star. The identification and constraints for locating *Dhruva*, the ancient Pole Star, as vividly described

[130] Whitney W.D. *On a recent attempt by Jacobi and Tilak to determine on Astronomical Evidence the Date of the earliest Vedic Period as 4000 BC*. The Indian Antiquary, 24, 361-369. 1895.
[131] B.Keith (1925) *The Religion and Philosophy of the Veda and Upanishads* Harvard Univ. Press, USA
[132] Macdonell, A. A., & Keith, A. B. *Vedic Index of Names and Subjects.* J. Murray. London,1912.

in the Taittirīya Āraṇyaka of the Yajurveda and the Brahmāṇḍa Purāṇa are presented in this article from a chronological perspective. It is seen that the legendary *Dhruva* has left his imprint permanently on the sands of time, starting from 3200-2800 BCE to the present day. The ancient Indian cultural practice of maintaining a spiritual dialogue between the visible sky and the earth (*Dyāvā-pṛthvī*) has passed through the Vedic Samhitā, Brāhmaṇa, Āraṇyaka to the Purāṇas with many twists and turns and still later into the period of mathematical astronomy, preserving reference to two Pole Stars, a rarity for any culture. Scientific astronomers of the early siddhānta period scrupulously avoided the *Śiśumāra* of the Veda and the Purāṇa but retained the term *dhruva* to mean a fixed reference point, which terminology they needed for the coordinate *dhruvaka*[133]. But with passage of time, as star Polaris approached the NCP, the nearby group of stars was named *Dhruvamatsya* (Polar Fish) and the new Pole Star was kept at the *mouth* of the animal, in contrast to the ancient *Dhruva* placed at the tail of the aquatic animal *Śiśumāra* (Figure 2). This ambivalence must have confused an outsider like Alberuni since the orthodox Hindus whom he knew, must have held on to their belief that the Pole Star was at the tip of the tail of the constellation *Śiśumāra*, looking more like an alligator and not a fish. This amply demonstrates the long memory of the devout Hindus of their ancestral astral religion carried through centuries, attempting synchronization of their faith with the universal law as perceived in the Vedas.

The best example of how the Vedic facts are remembered is available in the commentaries on the *Viṣṇusahasranāma,* (Thousand names of Viṣṇu) which is a part of the Mahābhārata. All the three schools of *vedānta*, following Śankara, Rāmānuja and Madhwa recognize this text as important for their tradition. All the three commentaries specific to the three schools interpret the 441st name *nakṣatranemi,* as a homonym for Viṣṇu, the controller of the nakṣatras, stationed at the heart-region of the (constellation) *śiṁśumāra,* quoting the Vedic and Purāṇic texts in differing details. Śankarācārya explains that *Dhruva* sitting on the tail of this figure rotates the stellar circle. He quotes cryptically, the Vedic authority for his explanation as *viṣṇuṛhṛdayam,* which is the Taittirīya Āraṇyaka hymn (II.19)[134]. This commentary has a gloss by Tāraka Brahmānanda Sarasvati a monk of the Śankara tradition. His date is not exactly known, but he was after Sāyaṇa and hence can be assigned to 15-16 Century CE. We have already noted that Sāyaṇa commenting on the TA hymn says that one

[133] Abhyankar K.D. *Dhruvaka-vikshepa system of Astronomical Coordinates*, Ind. J. Hist. Sci. 41, 151-157. 2006

[134] *Viṣṇusahasranāmastotram with the commentary of Śankarācārya and the gloss of Tāraka Brahmānanda Sarasvati* (Edited by R.Rama Sastry) ORI Sanskrit Series, 106, Univ. of Mysore 1961.

has to see the *Dhruva-maṇḍala* in the evening (see *f.n.* 8). One may wonder, which part of the sky was meant by the *Dhruva-maṇḍala*, since Polaris was approaching the NCP and *dhruva-matsya* was perhaps known to the general populace. We can surmise that Sāyaṇa being a follower of Śankara would have known correctly the sky part of *Śiśumāra* with the last star being the Dhruva of the TA hymn. However, any semblance of doubt that may remain is set right by Tāraka Brahmānanda Sarasvati in his gloss. He not only elaborates on the original text and the commentary of his mentor but takes trouble to give the identification of the *Śiśumāra* in the sky. He first explains the meaning of this word as an animal figure looking like a Lizard or Iguana[135]. Next he says that *Dhruva* is residing at the tip of the uplifted tail of this figure, leaving the faithful with no doubt as to where to look for the *Dhruva*. In passing we note that Alberuni also refers to Draco as The Lizard.

We conclude that the Vedic people of the Yajurveda branch beheld the sky picture of a constellation named *Śiśumāra* (the modern Draco) with fourteen stars the last one being stationary without motion to be called Dhruva (α-Draconis) the Pole Star *c* 3000 BCE. They also preserved this information in their orally transmitted text Taittirīya Āraṇyaka which formed the basis for the *meru* centric astronomical models of the later Purāṇas and the still later cosmological speculations in the *siddhānta* astronomical texts.

[135] *śimśumāro jalajantuviśeṣaḥ saraṭagodhādyākāraḥ, tadākṛti jyotiścakram – śimśumaracakram tasya pradakṣiṇāvartakuṇḍalībhūtasya unnamitapucchāgre vyavasthito dhruvaḥ* ||

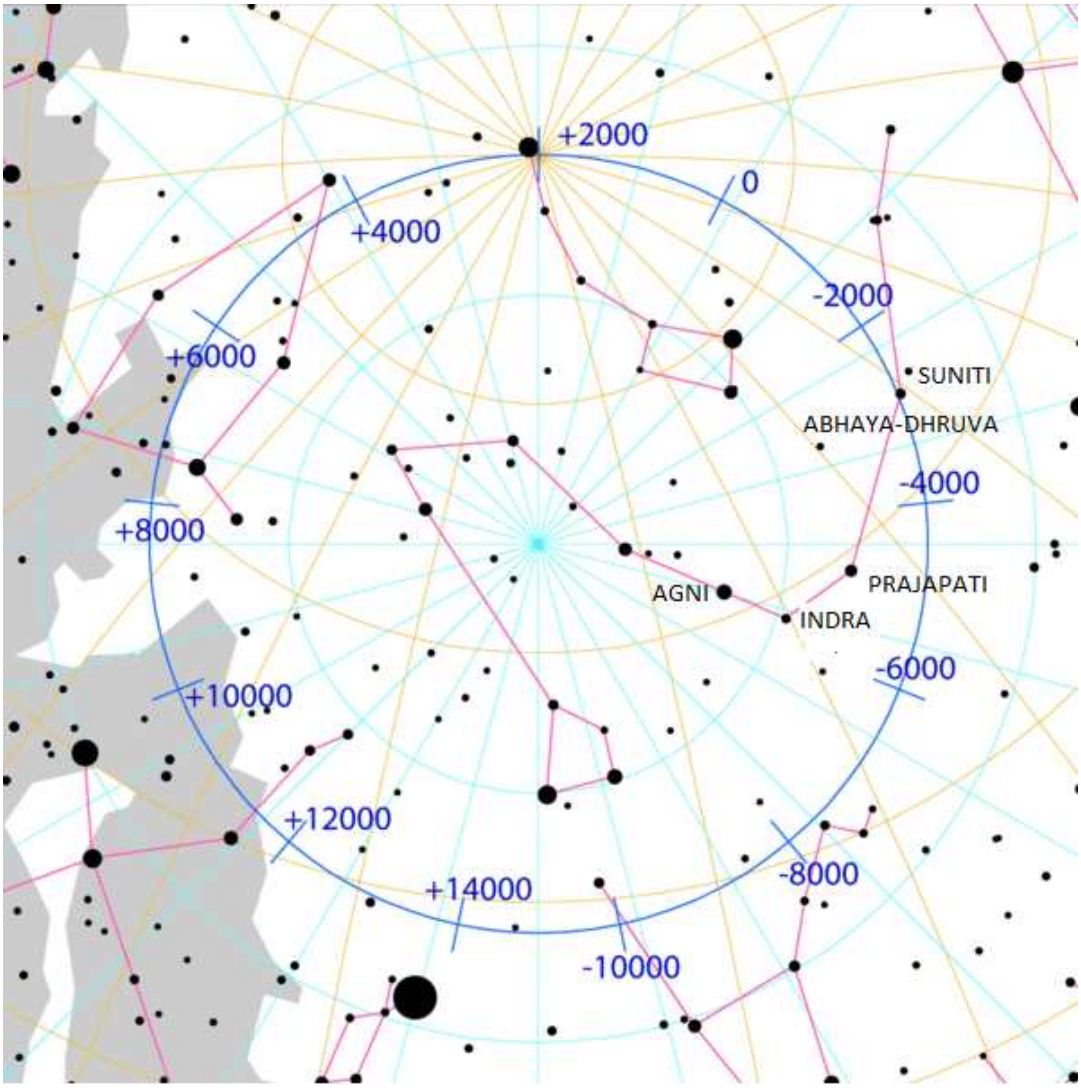

Figure 2. The Path of the North Celestial Pole among the Stars due to Precession

(Author: Tau'olunga June, 2006. https://commons.wikimedia.org/wiki/File:Precession_N.gif)

Figure adapted from the above link. The polar circle in blue colour shows the period in which visible Pole Stars are possible at the NCP. Negative years are BCE. Common Era starts from 0 year.