

ARCHAIC ASTRONOMY OF PARÂÚARA AND VR̥DDHA GARGA

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There were a class of compositions known as *Samhitās* before the Sanskrit *siddhāntic* astronomical texts. Parâúara, Vr̥ddha Garga, Asita, Devala and a few others are well known authors of these *samhitā* texts. None of these are now available in their original form. Even the manuscripts catalogued by the various libraries under the names of Parâúara and Garga are not critically edited and published for further study. However from what little that can be gleaned from the quotations by later authors, the prose text of Parâúara represents a unique ancient observational tradition of Hindu astronomy. Information about planets is brief, with emphasis on visibility of Venus and Mercury. But quite surprisingly Parâúara describes a sequence of twenty-six comets in detail. A year number, mentioned as the time interval between successive comet appearances is given. The total period covered adds to about 1300 years. The first comet is said to have appeared in the era of the Flood, which approximately gets dated to 2500-2700 BC. Vr̥ddha Garga appears to have followed Parâúara with some further improvements.

Key Words: Comets, Hindu Astronomy, *Parâúara Samhita*, Planets, *R̥g Veda*.

INTRODUCTION

S.B.Dikshit¹, the first person to write a definitive history of Indian astronomy, traces the subject in two distinct periods called pre-siddhāntic and siddhāntic. The word *siddhānta* in this context may be roughly translated as mathematical or computational astronomy. The content, outreach and limitations of the siddhāntic astronomy are better known, with large number

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of texts starting from the Common Era. A typical feature of these texts is their postulation of a long period of time called *Kalpa* in which planets execute integral number of revolutions. Another distinguishing feature of texts belonging to the siddhântic period is their total silence about comets, except for *Br̥hat-samhitâ* (abbr. *BS*)^{2,3} and *Nârada-samhitâ*⁴. Even here, Varâha-mihira the famous author of *BS* frankly declares that he is only presenting what ancient astronomers Parâûara, Garga, Asita and Devala have said about comets. Thus clearly there is nothing original in the *Ketucâra* of *BS* (Chapter XI), but is notable due to the bulk of information provided, which in parts appears realistic, even though there are inconsistencies. Even a casual reading of *BS* makes one wonder why Parâûara and others living several centuries before Varâha should have named, classified and left observational records about comets. For the pre-siddhântic period we have only a single published text namely, Lagadha's *Vedânga Jyotiṣa*⁵. But this text is solely devoted to the calendar and is silent about planets, eclipses and comets. However, several scholars have pointed out that a class of texts called *samhitâ*, containing astronomical information, authored by Parâûara, Garga and others should have existed in the pre-siddhântic period^{1,6}. Since Pânini, the famous grammarian, cites Parâûara and Garga, it is generally presumed that these astronomers lived before 700 BC^{7,8}. The texts of these authors are perhaps not any more available in their original form. Nevertheless there are two sources from which we can know the basic features of the ancient *samhitâs*. These are the commentary of Utpala (10th cent AD) on *BS*² and more importantly the *Adbhuta-sâgara* of Ballâla-sena⁹ (11-12th Cent AD), wherein the original texts, at least in part, are reproduced as lengthy quotations. Parâûara's text, denoted here as *Parâûara-samhitâ* (abbr. *PS*) is in prose, a literary form rare in Sanskrit. Many of the sentences in *PS* end with the word *iti* typical of Vedic Brâhmaṇa texts. As per Roy¹⁰, William Jones in 18th century had access to a copy of Utpala's commentary, which had quoted Parâûara with accents common to Vedic texts. In the available published version Utpala refers to *PS* as *Parâûara-tantra*, a technical name for the same prose composition². Varâha-mihira himself cites this *tantra* in *BS* (Ch. VIII 8-13) on Mercury's transit. He presents the same visibility information given in *PS* as quoted by Utpala.

Adbhuta-sâgara (*AS*) is a book belonging to the genre of compilations focusing on anomalous phenomena. The compiler of this book was Ballâla-

sena about whom considerable historical information is available^{11,12}. Ballāṣena was a king ruling at Mithilā, but his origins were in Karnataka. He collected information on anomalous happenings from available sources and named his book aptly *Adbhuta-sāgara* (Ocean of Wonders). His intention was perhaps to bring in one place scientific information, myths and religious beliefs prevalent during his time about natural phenomena. *AS* repeats the statements of Varāhamihira, Garga, Asita, Devala, Atharva-muni, Parāūra, Vṛ Garga and a few others. *AS* has three sections, called celestial (*divya*), atmospheric (*antarikṣa*) and terrestrial (*bhauma*) anomalies (*utpāta*). It is the first part, with fourteen chapters, that is important for our study. Among the above authors, it is Parāūra in prose, who attracts our attention. A comparison of *AS* with Utpala's commentary clearly brings out that the unique prose text of *PS* was widely known in India till at least 12th Cent AD. *PS* preserves a tradition of *nakṣatra* (stars along the ecliptic) as the background for observing the sky. *PS* indicates the seasons also in terms of *nakṣatra* divisions and is unaware of the twelve zodiacal signs or *Rāui* of siddhāntic astronomers. This tradition appears to have been continued by Vṛ Garga with significant additions. As is typical of ancient Indian authors, the identity of the above persons is not known. Moreover, Parāūra and Garga being family names there are several claimants for the authorship of the *saṃhitā* connected with these authors. Pingree's *Census*¹³ lists more than twenty-five individual titles attributed to Garga and Parāūra with several hundred manuscripts spread over libraries in India and abroad. With this constraint in the background, here the material preserved in *AS* and corroborated by Utpala is considered further. Fortunately *PS* distinguishes itself from others by being in prose. To be on the safe side we omit verses attributed to Parāūra and also limit our attention among the various Gargas, to the statements of only Vṛddha Garga, that is, Garga the senior. Interestingly, the preserved texts of these two pre-siddhāntic astronomers provide a consistent list of comets through which a dim historical basis can be established for the first Flood that finds mention in Vedic, Epic and Purāṇa literature. The text of *PS* preserved, which is probably a fragment of the original, is too long to be reproduced here. Hence only such portions connected with observations are presented with a brief working translation, omitting myths and portents associated with purported anomalies.

DATE OF PARĀŪARA'S TRADITION

In the second chapter of *AS* titled, *Sūrya-adbhuta-āvarta* or sun's wonder, the position of solstices as stated by Varāhamihira is given. This corresponds to summer solstice being at the third quarter of star *Punarvasū* (β -geminorum). This is followed by the position during Ballāla-sena's time, when summer solstice was observed to be at the beginning of *Punarvasū*. This amounts to a precession of 7^0 - 8^0 indicating a time difference of 500-600 years (72 years per degree) between Varāhamihira and Ballāla-sena. Allowing for errors of naked eye astronomy, the above observation appears quite realistic, since we know that Varāhamihira lived in the 6th century whereas *AS* was composed in the 12th century. Next the relation between seasons and sun's position among stars as per Parāūara is quoted:

[तथा च स्वकालिकम् ऋतुक्रमम् आह पराशरः ।]

तस्य श्रविष्ठाद्यात् पौष्णान्तम् चरतः शिशिरः । वसन्तः पौष्णार्धात् रोहिण्यान्तम् । सौम्यात् सर्पार्धम् ग्रीष्मः । प्रावृट् सर्पार्धात् हस्तान्तम् । चित्राद्यात् ऐन्द्रार्धं शरत् । हेमन्तो ज्येष्ठार्धात् वैष्णवान्तम् इति ॥

[*tathā ca svakālikam ṛtukramam āha parāūarah*]
tasya ūraviṣṭhādyaṭ pauṣṇāntam carataḥ ūūirah | *vasantaḥ pouṣṇārdhāt rohiṇyāntam* | *soumyāt sarpārdham grīṣmaḥ* | *prāvṛṭ sarpārdhāt hastāntam* | *citrādyaṭ aindrārdham ūarat* | *hemanto jyeṣṭhārdhāt vaiṣṇavāntamiti*||

[Parāūara said (the following) order of the seasons during his time]

“Ūiūira (cold season) is when he (Sun) transits from beginning of Dhaniṣṭhā till middle of Revatī. Vasanta (spring) is from middle of Revatī till end of Rohiṇī. Grīṣma (summer) is from beginning of Mṛgaūirā till middle of Āūleṣā. Varṣā (rainy season) is from middle of Āūleṣā to end of Hastā. Ūarat season is from Citrā to middle of Jyeṣṭhā. Hemanta (dewy season) is from middle of Jyeṣṭhā to end of Ūravaṇa”.

There is a scribal mistake in the first sentence, which should read *pauṣṇārdham*, as seen from the next statement, which is correct. Utpala's *PS* text reads exactly as above with the correct phrase *pauṣṇārdham* in place of *pauṣṇāntam*. This is the *nakṣatra* system of astronomy, using stars along the ecliptic as background for sky observations. Since the winter season started at the first point of star *Dhaniṣṭhā* (β -delphini) this would be same as the year beginning of *Vedāṅga-jyotiṣa*, which is a well discussed topic^{1,5}. Varāhamihira whose time may be taken as 530 AD provides sun's position at winter solstice as the first quarter of star *Uttarāṣāḍha* (σ -sagittari). He also says

that before his time once it was observed to be at the beginning of star *Dhaniṣṭhā*. Utpala, attributes this ancient observation to Parâûara quoted above. This movement amounts to a precession of 23°20'. From this information the era of *PS* has to be assigned to 1150-1370 BC, same as that of *Vedāṅga-jyotiṣa*. It is noteworthy that *PS* does not indicate the seasons in terms of the twelve zodiacal signs or *Râûi*, as done by Varâhamihira and Brahmagupta. However, it is possible Parâûara himself or his family members might have observed variations to the above positions and remarked them as anomalous. This is inferred from a statement about the position of solstices.

यद्यप्राप्तो वैष्णवमुदग्मार्गं प्रपद्यते। दक्षिणमाश्लेषां वा महाभयाय इति ॥

yadyapraṅpto vaiṣṇavamudagmârgam prapadyate | dakṣiṇamâuleṣâm vâ mahâbhayâya iti ||

“If (sun) goes north without reaching [the last point of] star Úravaṇa and goes south without reaching [the midpoint of] star Âuleṣâ, it causes great fear”.

Such drift in the solstices could have been observed after one or two generations due to precession. Hence *PS* might have been edited over time. However, the initial point of the tradition should be assigned to *circa* 1400 BC.

PLANETS AS PER PARĀÚARA

The archaic astronomy of *PS* is quite unlike that of later *siddhântas* that give the number of revolutions of different planets in a long period of years called *kalpa*¹⁴. *PS* on the other hand knows all the planets but is too primitive in describing their motion. Thus, this seems to belong to the early stages of Hindu astronomy, when the subject was still rooted in empirical observations without appeal to computations. *PS* treats many configurations as anomalous and hence portentous. To conclude an observation to be anomalous one has to have an idea of what is normal. This average behaviour could have only come out of long observations. About Sun, besides the seasons in terms of four-and-half *nakṣatras* stated above, colours in the various seasons and sunspots are described. Position of Sun at solstices is mentioned. Moon is described in terms of its colour, shape and position with the stars. Association of moon with other planets and possibility of occultation of Mars, Venus, Jupiter and Saturn by Moon is mentioned. Next, Râhu the

imaginary dark planet responsible for causing solar and lunar eclipses is discussed. Concept of Râhu as the node or point of intersection of the lunar orbit with the ecliptic is not present. *PS* mentions about prognosis of eclipses based on precursors related with the shape, colour and such other observable anomalies of Sun and Moon. Obviously the real causes for either solar or lunar eclipses were not known. Varâhamihira in *BS* strongly criticizes the precursors of Parâûara as invalid. Nevertheless *PS* contains statements, which presuppose systematic observations as can be inferred from the following:

षण्मास्या चन्द्रमसस्ततो अर्धषष्टे चादित्यस्याभिपूजितमाहुः आचार्याः।

सप्तदशत्रयोदशपंचत्रिंशत् मासिकानि चेन्दोस्त्रीणि विसन्धि ग्रहणानि।

*ṣaṇmâsyâ candramasastato ardhaṣaṣṭe ca âdityasyabhipūjitamâhuḥ acâryâḥ |
saptadaśatrayodaśapañcatriṃśat māsikāni cendostrīṇi visandhi grahaṇāni ||*

“Our teachers said: moon gets eclipsed at six months and sun at three months interval. Seventeen, thirteen and thirty-five monthlies are the three Visandhi eclipses of moon”.

The above statement implies that there were several lunar eclipses observed at six full moons apart. Perhaps once a new eclipse in such a series started the subsequent ones were predictable. The exceptions mentioned, as *Visandhi* should have been the observed intervals of eclipses that were not at six months. *PS* also introduces a three-and-half year cycle of *Parvan* (syzygy) at six months interval, which has been borrowed by *BS* and other later writers. *PS* classifies eclipses based on colour, the way the shadow spreads and moves out of the solar and lunar orbs. Even though both solar and lunar eclipses are covered under one heading called *Râhu-adbhuta* in *AS* and *Râhu-câra* in *BS*, it is the lunar that has received more attention. All the five planets are described at length, starting with Mars. Tracking Mars should have been difficult, since unlike other planets no visibility or movement number is given. But considerable effort has been made to verbally describe the retrograde motion of Mars. The movement of Mercury is traced in seven lines depending on its station with the stars along the ecliptic:

अथास्य गतयःसप्त प्राकृता विमिश्रा संक्षिप्ता तीक्ष्णा घोरा पापा योगान्तिका च । तत्र प्राकृता याम्याग्नेयरोहिणीवायव्यानि । मिश्रा सौम्यार्द्रा मघाश्लेषा च । संक्षिप्ता पुष्यार्यमृगभाग्यादित्यानि । तीक्ष्णा अजापदतस्चत्वारि ज्येष्ठा च । घोरा त्रीणि श्रवणादीनि त्वाष्टं च । पापा सावित्रेन्द्राग्निमैत्राणि । योगान्तिका मूलमाषाढे ॥ अथ चत्वारिंशत्त्रिंशद् द्वाविंशत्यष्टादशपञ्चदश एकादशनवरात्राणि गतिक्रमादुदितौ अभिदूश्यते तान्येवास्तमितौ भवति।

*athāsya gatayaḥ sapta prākṛtā vimīūrā samkṣiptā tīkṣṇā ghorā pāpā
yogāntikāca | tatra prākṛtā yāmyāgneyarohiṇīvāvyāni | miūrā
soumyārdrāmaghāūleṣāca | samkṣiptā puṣyāryamṇabhāgyādityāni | tīkṣṇā
ajāpadascatvāri jyeṣṭhāca | ghorā trīṇi śravaṇādīni tvāṣṭamca | pāpā
sāvitreन्द्रāgnimaitrāṇi | yogāntikā mūlamāṣādhe || atha
catvāriṃūattriṃūadvāviṃūatyasṭādaūapañcadaūa ekādaūanavarātrāṇi
gatikramamudito abhidṛśyate tānyevāstamito bhavati ||*

“Mercury’s paths are seven: prākṛtā, vimīūrā, samkṣiptā, tīkṣṇā, ghorā, pāpā and yogāntikā. Prākṛtā is with stars Bharāṇi, Kṛttikā, Rohiṇi, Svātī. Miūrā is followed with stars Mṛgāśīrā, Ārdṛā, Maghā and Āuleṣā. Samkṣiptā is with stars Punarvasū, Puṣya, Pūrva- and Uttara-phalgunī. Tīkṣṇā includes the four stars from Pūrvaḥādra and Jyeṣṭhā. Ghorā is along Ūravaṇa, Dhaniṣṭhā, Ūatabhiṣak and Citrā. Pāpā is along Hastā, Viūākhā and Anūrādhā. Yogāntikā is along Mūla and the two Āṣāḍha. Along these seven paths it (Mercury) is visible for 40, 30, 22, 18, 15, 11 and 9 days respectively. It sets in the same way for the same duration”.

The above text is not available in *AS*, but is given by Utpala while commenting on *BS* (VII.8-13). He remarks that even though the above figures are not correct as per calculations, Varāha has reported them as Parāūrā’s opinion. The months when Mercury can be seen are also mentioned. But in the available text no specific cycle is stated. The sidereal motion of Jupiter is clearly enunciated as:

सपादमृक्षद्वयमब्देन प्रविचरन् सस्यसम्पत् करोति ।

sapādamṛkṣadvayamabdena pravīcaran sasyasampat karoti |

“Jupiter, traveling two-and-quarter nakṣatras in a year leads to good crops”.

This motion amounts to the well-known twelve year sidereal cycle. *PS* lists portents related to Jupiter’s rise in conjunction with different stars, starting from Kṛttikā, but makes no mention of Jovian years or of the associated sixty year cycle. The motion of Venus as per Parāūrā is not stated by either Varāhamihira or Utpala, but is detailed in *AS*:

प्राक्प्रतीच्योः उदयास्तमयात् उदङ्मध्यदारुणाः (दक्षिणाः?) त्रयो मार्गाः तेषां
दक्षिणोत्तरमध्यमोत्तरमध्यममध्यमदक्षिणा गत्यन्तरालदेशं पञ्चधाविभज्य पञ्चमार्गाः कल्पनीयाः
। प्रागस्तमित उत्तरोत्तरमध्यममध्यमानुत्तरदक्षिणेषु मार्गेषु पञ्चपञ्चाशत्
षष्टिपञ्चसप्तत्येकाशीतिनवतिभिर्दिवसैः पश्चाद्दर्शनमुपैति । प्रतीच्यां अस्तमितः
षडष्टद्वादशपञ्चदशचतुर्विंशतिभिरहोभिः प्रागुदयते ॥ प्रागुदितो नवभिर्मासैः एकविंशति
नक्षत्राणि चरति । प्रतीच्यां अष्टाभिरेकोनविंशति नक्षत्राण्याप्तः शुभाशुभफलः ॥

*prâkpraticyoh udayâstamayât udaṅgmadyadârūṅṅḥ (dakṣṇāḥ?)
 trayomârgaḥ teṣâm dakṣiṇottaramadhyamottaramadhyamamadyadakṣṇâ
 gatyantarâladeûam pañcadhâvibhajya pañcamârgâḥ kalpanîyâḥ |
 prâgastamita uttarottaramadhyamamadyamânuttaradakṣiṇeṣu mârgeṣu
 pañcapañcâiatsaṣṭipañcasaptatyekâûîtinavatibhirdivasaiḥ
 paucâddarûanamupaiti | praticyâmastamitaḥ
 ṣaḍaṣṭadvâdâiapañcadaûacaturvimûatibhirahobhiḥ prâgudayate ||
 prâgudito navabhirmâsaiḥ ekaviṃsati nakṣatrâṇi carati praticyâm
 aṣṭâbhirekonaviṃsati nakṣatrâṇyâptaḥ iubhâiubha phalaḥ ||*

“(For Venus), in east and west three routes called north, central and south are prescribed for rise and setting. Further, dividing the intermediate space five fold as, south, north, central, north-central and south-central, five routes are devised. Setting in east, (Venus) rises in the west along north, north-central, central, south-central and south routes after fifty-five, sixty, seventy-five, eighty-one and ninety days respectively. Setting in west it rises in east after six, eight, twelve, fifteen and twenty-four days (along the above routes respectively). Rising in east it travels twenty-one stars in nine months. Rising in west it travels nineteen stars in eight months”.

As per *PS*, the visibility in east is for 270 days followed by an average invisibility of 68 days. Similarly in the west visibility is for 240 days followed by 13 days of invisibility on average. Thus, the Venus cycle according to Parâûara is of 591 days. As per modern astronomy, it is known that Venus as morning star is seen for some 263 days and afterwards it remains invisible for nearly 50 days. Then it rises in the west to be seen for another 263 days and to be invisible for about 8 days before rising in the east. The average synodic period of Venus is 584 days. The visibility of the planet depends sensitively on several parameters and hence the figures stated by Parâûara have to be taken as remarkably accurate. The last planet is Saturn described in terms of its sidereal motion:

तस्य अष्टाविंशतिवार्षिकः सप्तविंशतिनक्षत्रचारः । त्रिमार्गस्तत्र । प्रवासक्रमात् सप्तविंशति
 त्रिंशतधिकोना चाहामन्यथा त्वहितः ॥

*tasya aṣṭâvimûativârṣikaḥ saptavimûatinakṣatracâraḥ | trimârgastatra |
 pravâsakramât saptavimûati trimûatadhikonâ câhnâmanyathâ tvahitaḥ ||*

“His (Saturn’s) travel through twenty-seven stars is for twenty-eight years. There are three paths. The setting period (in the three paths?) will be 27, 30 and a day more or less. Otherwise it is a bad omen”.

It is noted that *PS* could only be describing an observational tradition. Sun's association with seasons and the corresponding position of sun with the stars along the zodiac was known. Reasons for eclipses were not known, but observations were done to note that lunar eclipses were to be expected at six months interval, with some exceptions. The naming and counting of seven *parvans* in a sequence, at six-month interval is an interesting exercise the reasons for which are lost. Among the eight celestial objects considered above, *Rāhu* and thus the eclipse phenomenon gets more textual space. But Parāśara conspicuously devotes more attention to *Ketu* or Comet than to *Rāhu*.

COMETS OF PARĀŚARA

Ketu-adbhuta (Comet-wonder) is the 8th chapter in *AS*. Parāśara classifies comets into eleven groups making a total of 101 comets:

शतमेकोत्तरं केतूनां भवति तेषां षोडशमृत्युनिःश्वासजाः। द्वादशादित्यसम्भवाः। (एका) दशदक्षयजविलयने रुद्रक्रोधजाः। षट् पैतामहाः। पञ्चदशक्रुद्धोद्दालकसुताः। पञ्चप्रजापतेर्हासजाः। सप्तदशमारीचिकश्यपललाटजाः। त्रयो विभावसुजाः। चतुर्दश मथ्यमाने समुद्रे सोमेन सह संभूताः। धूमोद्भव एकः। एकस्तु ब्रह्मकोपजः इति॥ एभ्यः षड्विंशतिरुदयैः फलमावेदयन्ति। तन्नामतोरूपतः फलतस्तत्कालतो अभिधास्यामः।

śatamekottaram ketūnāṃ bhavati teṣāṃ ṣoḍaśamṛtyuniḥvāsajāḥ | dvādaśādityasambhavāḥ | (ekā) daśadakṣayajñavilayane rudrakrodhajāḥ | ṣaṭ paitāmahāḥ | pañcadaśakruddhodḍālakasutāḥ | pañcaprajāpaterhāsajāḥ | saptadaśamāricikaiyapalalāṭajāḥ | trayo vibhāvasujāḥ | caturdaśa mathyamāne samudre somena saha sambhūtāḥ | dhūmodbhava ekaḥ | ekastu brahmakopajāḥ iti || ebhyaḥ ṣaḍviṃśatirudayaḥ phalamāvedayanti | tannāmatorūpataḥ phalatastatkālato abhidāsyāmaḥ ||

“There are 101 comets. Among them 16 are born out of *mṛtyu* (Death), 12 are from *āditya* (Sun), 10 (11?) are due to anger of Rudra, 6 are out of *Pitāmaha* (Brahmā or Creator), 15 are children of angry Uddālaka, 5 are from the laughter of Prajāpati, 17 are from the forehead of Mārīci and Kaūyapa (stars of U. Major), 3 are from Vibhāvasu, 14 are coeval with Moon when the ocean was churned. One is born of Dhūma (smoke or dust) and one is from the anger of Brahmā. From the rising of twenty-six of these effects are expressed. We shall describe them by name, form, effect and their time”.

तत्र मार्त्यवाः त्रय उदयन्ति। एकैकशो वसाकेतुरस्थिकेतुः शस्त्रकेतुर्वा॥ तत्र वसाकेतुः स्निग्धो महान् उदगायतशिखः त्रिंशत् वर्षशतम् प्रोष्य संप्लवेषु पश्चिमेनोदितः सद्यो मरकफलः सौभिक्षकरः। रूक्षो अस्थिकेतुः असौभिक्षकरः तुल्यप्रवासकालफलः। पूर्वेण स्निग्ध एव शस्त्रकेतुः शस्त्रवृत्तराजविरोधमरकफलः समो रूक्षः इति ॥

tatra mārtyavâḥ trayaudayanti | ekaikaūo vasâketurasthiketuḥ ūastraketurvâ | tatra vasâketuḥ snigdho mahânudagâyataūikhaḥ trimūatvarṣaūatam proṣya samplaveṣu paūcimenoditaḥ sadyomarakaphalaḥ saubhikṣakaraḥ | rūkṣo asthiketuḥ asaubhikṣakaraḥ tulyapravâsakâlapalaḥ | pūrveṇasnidha eva ūastraketuḥ ūastravṛttarâjavirodhamarakaphalaḥ samo rūkṣaḥ iti ||

“Therein arise three related to Death namely, Vasâketu, Asthiketu and Ūastraketu one after another. Elapsing 130 years in the Floods, Vasâketu, big and sharp, with its crown bent towards north having risen in the west, causes immediate destruction. Harsh Asthiketu appears in the same period causing famine. Sastraketu rising sharply in the east results in destruction of weapon handling kings”.

The alternate reading for *samplaveṣu* is *samplave yuge*. This would mean *in the era of the Floods*. *Asthiketu* (Bone-comet) and *Vasâketu* (Marrow-comet) are said to have the same transit period. The two may be identical, seen first in the west and later in the east. The text of Utpala is almost similar, with *bhârgavâḥ* in place of *mārtyavâḥ*. Varâhamihira writes about the same comets, perhaps borrowed from the same source, but never refers to the year number and the Floods. The word denoting the year number needs attention in its interpretation. The year number of *Vasâketu* is stated as *trimūat-varṣa-ūatam*. In contemporary Sanskrit use, this would be taken to mean 3000. This is how Bhat³ has translated the above word. However, ancient evidence indicates the meaning to be different. This is seen in the explanation offered for a similar compound word. Garga is quoted by Utpala and Ballala-sena about *Vīuvarūpâ*, which are celestial objects causing fire. Garga describes them as:

तेऽग्निपुत्रा ग्रहा ज्ञेया लोकेऽग्निभयवेदिनः। विंशत्यहशतम् घोरम् विश्वरूपेति नामतः॥

te 'gniputrâ grahâ jñeyâ loke 'gnibhayavedinaḥ | viṁūatgrahaūatam ghoram vīuvarūpeti nāmataḥ ||

“The count is here given as *viṁūat-graha-ūatam*. Ballâla-sena explains this as: *viṁūatyadhikham ūatam ityarthah* | Varâhamihira in *BS* (11.23) and Utpala in his commentary on the same verse give the number of *Vīuvarūpâ* as 120 without ambiguity. Thus, in ancient India, twenty-above-hundred (not twenty-times-hundred) was the accepted meaning of the above number word. Hence *trimūat-varṣa-ūatam* should be taken to mean 130 years. With this in the background the further comet sequence is given following *AS*”.

तत्र कुमुदकेतुः वसादिकेतुचारसमाप्तौ वारुण्यां दर्शनमुपैति। गोक्षीरविमलस्निग्धप्रभां पूर्वेणाभिनतां शिखां कृत्वेकरात्रं चरन् स दृष्ट एव सुभिक्षमुत्पादयति दशवर्षाणि प्रजानामविरोधम्। प्रतीच्यां च मुखरोगावरोधकप्रतिश्यायपाण्डुरोगज्वरैः प्रजां बाधते इति॥

आदित्यजानां कपालकेतुर्दयते। अमावास्यायां पूर्वस्यां दिशि सधूमार्चिःशिखो नभोविषयार्धे चरन् दृश्यते। पञ्चविंशतिवर्षशतं प्रोष्य त्रींश्च पक्षानमृतजस्य कुमुदकेतोश्चरान्ते स दृष्ट एव दुर्भिक्षानावृष्टिव्याधिभयमृत्यूपद्रवान् जनयति। यावतो मासान् दृश्यते तावतो मासान् मासैर्वत्सरान् सप्तपञ्चप्रस्थं च शारदधान्यस्यार्धं कृत्वा प्रजानामर्धमुपयुङ्क्ते॥

tatra kumudaketuḥ vasâdiketucâra samâptau vârunyâmdarûanamupaiti | gokṣîravimalasnigdhaprabhâm pûrveṇâbhinatâm ûikhâm kṛtvekarâtram caran sadṛṣṭa eva subhikṣamutpâdayati dauavarṣânîprajânânavirodham| pratîcyâm ca mukharogâvarodhakapratîûyâyapânḍurogajvaraiḥ prajâm bâdhate iti || âdityajânâm kapâlaketurudayate| amâvâsyâyâm pûrvasyâm diûi sadhûmârciḥûikho nabhoviṣayârdhe caran drîyate| pañcavimûativarṣaiûatam proṣya trîmûcapakṣânâmr̥tajasya kumudaketoûcârânte sa dr̥ṣṭa eva durbhikṣânâvr̥ṣṭivyâdhibhayamṛtyûpadṛavân janayati | yâvato mâsân drîyate tâvato mâsân mâsairvatsarân saptapañcaprastham ca ûâradadhânyasyârdham kṛtvâ prajânâmardhamupayun̄kte ||

“There Kumudaketu is seen in the west at the end of the transit of Vasâ and other comets. It is seen for one night like a bright spray of cow’s milk, with its head bent eastwards. This does good to people for a period of ten years. In the west it causes various diseases to the citizens. Kapâlaketu among the offspring of Âdityas, rises in the east. It is seen on a new moon evening with a smoky flaming crown, moving in the center of the sky. Seen 125 years and three fortnights after Kumudaketu, it induces drought and famine upon appearance. For years equal to the months of visibility, it reduces the autumn grain yield by half and also uses away (destroys) half the population.”

मणिकेतुरपि कपालकेतोश्चावसाने प्रतीच्यामुदयन्नुपतापयति। प्रसूक्ष्मो अरुन्धतीतारकमात्रः क्षीरप्रतीकाशया पूर्वाभिनतया स्तब्धया स्निग्धया शिखया शर्वर्यामेकमदृश्यः। स उदयात् प्रभृति अर्धपञ्चमान् मासान् क्षेमसुभिक्षमुत्पादयति। क्षुद्रजन्तु प्रादुर्भावं करोत्यतिमात्रकालदृष्टः इति॥ अथ दक्षयज्ञे रुद्रक्रोधोद्भवः कलिकेतुः त्रीणिवर्षशतानि नवमासान् प्रोष्योदयते। पूर्वेण वैश्वानरपथे अमृतजस्य मणिकेतोश्चरान्ते श्यावरूक्षताम्राणुणां शूलाग्रकारसदृशीं शिखां कृत्वा नभसस्त्रिभागचारीशस्त्रभयरोगदुर्भिक्षानावृमिरकैर्विद्रावयन् दिशान्ते दृश्यते। यावन्मासान् दृश्यते तावद्वर्षाणि त्रिभागशेषां प्रजां कृत्वा अर्धचशारदधान्यस्याष्टाढकं व्रजति इति॥

maṇiketurapi kapâlaketoucârâvasâne pratîcyâmudayannupatâpayati | prasûkṣmo arundhatîtarakamâtraḥ kṣîrapratîkâûyâ pûrvâbhinatayâstabhayâ snigdhayâ ûikhayâ ûarvaryâmekamadṛîyah | sa udayâtprabhṛti ardhapañcamânâsân kṣemasubhikṣamutpâdayati | kṣudrajantuprâdurbhâvaḥ karotyatimâtrakâladr̥ṣṭaḥ iti || atha dakṣayajñe rudrakrodhodbhavaḥ kaliketuh trîṇivarṣaiûatâni navamâsân proṣyodayate | pûrveṇa vaiûvânarapathe amṛtajasya maṇiketoûcârânte

*úyâvarûkṣatâmrâruṇâm úûlâgrakârasadrûim úikhâm kṛtvâ
nabhastrîbhâgacârî úastrabhayarogadurbhikṣânâvrṣṭimarakairvidrâvayan
diûante drûyate | yâvanmâsân drûyate tâvadvarṣânI tribhâgaúeṣâm prajâm
kṛtvâ ardhamca úâradadhânyasyaṣṭâḍhakam vrajati iti ||*

“At the end of Kapâlaketu’s transit, Maṅiketu is seen in the west for a night, subtle like the star Arundhatî (Alcor in U.Major), with its milky white sharp and stationary crown bent towards east. Starting from its rise, for a period of two-and-half months it produces health and abundant food for people. If seen for a longer period it increases generation of inferior life forms (insects and worms). Kaliketu, born out of Rudra’s anger during the sacrifice of Dakṣa, rises after 300 years and 9 months. From the east, along the ecliptic, with a harsh copper-red colour head like the tip of a trident, it travels one-third (three parts?) of the sky to be seen at the horizon. For years, equal to the number of months seen, the comet having reduced the population to one-third, leaves eight measures of the grain yield”.

अथ पैतामहः चलकेतुः। पञ्चदशवर्षशतं प्रोष्योदितः पश्चिमेनांगुलिपर्वमात्रं शिखां दक्षिणाभिन्तां कृत्वा कलिकेतोश्चरान्ते नभस्त्रिभागमनुचरन् यथायथा चोत्तरेण व्रजति तथातथा शूलाग्रकारां शिखां दर्शयन् ब्राह्मनक्षत्रमुपसृज्यात्मना ध्रुवं ब्रह्मराशिं सप्तर्षीन् स्पृशन् नभसः अर्धमात्रं दक्षिणमनुक्रम्यास्तं व्रजति। यः स्ववर्गे दारुणकर्मा स्ववर्गप्राप्तत्वादेवं कृत्स्नमभिहितस्ति। लोकमपि वा भूमिं कंपयित्वा दशमासान् मध्यदेशे भूयिष्ठं जनपदमवशेषं कुरुते। अन्येष्वपि च क्वचिच्छत्रुदुर्भिक्षव्याधिमरकभयैः क्लिश्नात्यष्टादशमासान् इति॥

*atha paitâmahah calaketuh | pañcadaúavarṣaúatamproṣyoditah
paucimenânguliparvamâtrâm úikhâm dakṣiṇâbhinatâm kṛtvâ kaliketoúcârânte
nabhastrîbhâgamanucaran yathâyathâ cottareṇa vrajati tathâtathâ
úûlâgrakârâm úikhâm darûayan brâhmanakṣatramupasṛjyâtmanâ dhruvam
brahmarâúim saptarṣin sprûan nabhasah ardhamâtram
dakṣiṇamanukramyâstam vrajati | yah svavarge dâruṇakarmâ
svavargaprâptatvâdevam kṛtsnamabhihinasti lokamapi vâ bhûmiṃ kampayitvâ
daiamâsan madhyadeúe bhûyiṣṭham janapadamavaúeṣam kurute | anyeṣvapica
kvacicchatrudurbhikṣavyâdhimarakabhayaiḥ
kliunâtyaṣṭâdaúamâsân iti ||*

“Then (appears) Calaketu related to Pitâmaha. Having risen 115 years after Kaliketu in the west, with a crown of the size of a finger joint, bent southwards, following one-third of the sky, as it travels north exhibiting a head like the tip of a trident, it moves close to the star of Brahma (Abhijit), touches Brahmarâúî, Saptarṣi (U.Major), Dhruva (Pole Star) and returns half the sky to set in the south. It does horrible deeds in the sky, shakes the universe and the earth for a period ten months and destroys a populous province in madhya-deúa. It troubles other places also for 18 months by occasional fear of enemies, drought, disease and death”.

Kaliketu and Calaketu are described as producing ill effects on earth. The word Kali may imply *difficulty or evil*, as in the word Kali-yuga. Calaketu means *moving-comet* and aptly its movement to north and then sudden turn southwards before setting is described. This is one among the few cases where our ancients have noted the transit of the comet with respect to stars. The extent of both the comets is described by the word *nabhas-tri-bhâga*. This would mean one-third of the visible sky, approximately 60° in extent. The comet trail should have been spectacularly long. Calaketu is said to have risen in the west, that is after sun set. We may speculate that this could have been so because of the nearness of the comet to Sun and consequent invisibility in daylight. This may imply that Calaketu could have traversed between Sun and Earth. Among the background stars mentioned, Saptarṣi refers to U.Major, without much confusion. Dhruva can not be taken as α - U.Minor, since before *c*1500 BC the pole star was α -Draconis (Thuban). After this period till about 500 BC there was no recognizable pole star. Mention of both *Brâhma-nakṣatram* and *Brhama-râûi* brings in difficulties in interpretation. From the context, these should be indicating two different stations of the comet. Following Varâhamihira (*BS* 11.33-36) if we take one of this to be star *Abhijit*, the other may refer to the region around star Rohiṇî (Aldebaran), since this has Prajâpati or creator as its deity. Presently, following medieval Indian astronomy, *Abhijit* is identified with star Vega¹⁴, which is far north of the ecliptic. But, in more ancient times, *Abhijit* was well recognized to have been along the ecliptic, between stars *Uttarâṣâḍhâ* and *Śravaṇa*¹⁵. *Mahâbhârata* metaphorically records the vanishing of *Abhijit* from the sky¹⁶. *Madhyadeûa*, literally means middle country and its boundaries have changed over long periods of time. As per Varâhamihira this includes Prayâga (Allahabad), Avanti, Ujjayini and Puṣkara forest in present day Rajasthan. In the north this region was up to River Devikâ. What constituted the middle-land before Varâha's time? Bharadwaj¹⁷ identifies the *madhyadeûa* of Vedic times to have been between Rivers Sarasvati and Dṛṣadvati, including Kurukshetra. This matches with the description of *madhyadeûa* as per *PS*, given in a later chapter on astro-geography¹⁸. Not all comets brought in misery, some of them were benevolent like *Jalaketu*.

अथ जलकेतुः पैतामहस्य चलकेतोर्नवमासावशिष्टे कर्मणि कृतं प्रवर्तयति। पश्चिमेनोदितः स्निग्धः सुजाततारः पश्चिमाभिनत शिखः स नवमासाभ्यन्तरे क्षेमसुभिक्षारोग्याणि प्रजाभ्यो धत्ते। अन्यग्रहकृतानां चाशुभानां व्याघाताय इति॥ अथ जलकेतोश्चारसमाप्तौ ऊर्म्यादयः

शीतान्ता अन्ये प्रादुर्भवन्ति। ते त्रयोदशचतुर्दशाष्टदशवर्षान्तरिता दृश्यन्ते। स्निग्धाः सुभिक्षक्षेमाय विपर्याय विपरीताः। क्षुद्रजन्तूनां वधाय च इति॥ तेषामष्टानां कर्मण्यतीते भवकेतुर्दृश्यते पूर्वणैकरात्रम्। या कृत्तिकानामुत्तरतारा तत्प्रमाणया स्निग्धया (रूक्ष) प्रभया सिंहलांगूलसंस्थानया प्रदक्षिणनताग्रया शिखयोदितः स यावन्मुहूर्तान् दृश्यते तावन्मासान् भवत्यतीव सुभिक्षम्। रूक्षः प्राणहराणां रोगाणां प्रादुर्भावाय च इति॥

atha jalaketuḥ paitāmahasya calaketornavamāsāvaiṣṭe karmani kṛtam pravartayati | paūcimenoditaḥ snigdhaḥsujātātāraḥ paūcimābhinataūikhaḥ sa navamāsābhyantare kṣemasubhikṣārogyāṇi prajābhyyodhatte | anyagrahakṛtānām cāsubhānām vyāghātāya iti || atha jalaketoūcārasamāptau ūrmyādayaḥ ūitāntā anye prādurbhavanti | te trayodaūacaturdaūaṣṭādaūavarṣāntaritaḥ drūyante | snigdhaḥ subhikṣkṣemāya viparyāya viparītāḥ | kṣudrajantūnām vadhāyaca iti || teṣāmaṣṭānām karmānyatīte bhavaketurdṛūyate pūrveṇaikarātram | yā kṛttikānām uttaratārā tatpramāṇayā snigdhayā (rūkṣa) prabhayā simhalāngūlasamsthānayā pradakṣiṇanatāgrayā ūikhayoditaḥ sa yāvanmuhūrtān drūyate tāvanmāsān bhavatyatīva subhikṣam | rūkṣaḥ prānāharāṇām rogāṇām prādurbhāvāyaca iti ||

“Jalaketu (Water-comet) having appeared when nine months of work of Calaketu is still remaining initiates Kṛta. Rising in the west with its head bent to the west, with a well-formed star it gives within nine months health and plenty of food to the people. It compensates for the bad effects of other celestial objects. Comets Ūrmī and others ending with Ūita appear at intervals of 13, 14 and 18 years. If they are sharp they produce good effects, otherwise the opposite (effects are indicated). They destroy inferior life forms. After the work of eight of these, Bhavaketu is seen in the east for a night. It is of the size of the north star of the Kṛttikā cluster (Pleiades) with the crown bent clockwise, like the tail of a lion. It produces plenty of food for months equal to the muhūrtas it is seen. If it is harsh (to look at) it produces fatal diseases”.

Ten out of the twenty-six comets of Parāūara are covered in the above paragraph. The word *Kṛta*, here means *good-period* in contrast with the word *Kali*. Utpala also quotes *PS* giving the names of comets between *ūrmī* and *ūita*. No year number is given for *Jalaketu* and *Bhavaketu*. But indirectly the eight comets starting with *ūrmī* account for an interval of nearly 120 years between the above two comets.

अथ उद्दालिकीश्चेतकेतुः दशोत्तरं वर्षशतम् प्रोष्य भवकेतोः चारान्ते पूर्वस्याम् दिशि दक्षिणाभिनतशिखो अर्धरात्रकाले दृश्यः। तेनैव सह द्वितीयः प्रजापतिसुतः पश्चिमेन कनाम ग्रहः केतुः युगसंस्थायी युगपदेव दृश्यते । तावुभौ सप्तरात्रदृश्यौ दशवर्षाणि प्रजाः

पीडयतः। कः प्रजापतिपुत्रो यदाद्व्यधिकम् दृश्येत तदा दारुणम् प्रजानाम् शस्त्रकोपम् कुर्यात्। तावेव स्नेहवर्णयुक्तौ क्षेमारोग्यसुभिक्षदौ भवतः॥

atha uddālīkī ūvetaketuḥ dauṅottaram varṣauatamproṣya bhavaketoūcārānte pūrvasyāṃ diūi dakṣiṇābhinataūikho ardharātrakāle drīyaḥ | tenaiva saha dvitīyaḥ prajāpatisutaḥ paūcīmena kanāma grahaḥ ketuḥ yugasamsthāyī yugapadeva drīyate | tāvubhau saptarātradrīyau dauavarṣāṇi prajāḥ pīdayataḥ | kaḥ prajāpatiputro yadādvvyadhikam drīyeta tadā dāruṇam prajānām ūastrakopam kuryāt | tāveva snehavarṇayuktau kṣemārogyasubhikṣadau bhavataḥ ||

“Then, Ūvetaketu offspring of Uddālaka is seen, 110 years after Bhavaketu’s transit, in the east at midnight, with its crown bent southwards. Along with it is seen in the west a comet named Ka, second offspring of Prajāpati, staying like a yoke. Both, visible for seven nights, trouble people for ten years. If Ka is seen for twice the duration (14 nights) it will cause horrible effects of weapon on people. The two turning to oily (friendly?) colour give good health and plentiful food”.

Ūvetaketu or White-comet is the nineteenth member in this list. It is said that along with this was seen another comet denoted by the single syllable *Ka*. Utpala’s text is similar except for some grammatical peculiarities. *PS* describes *Ka* as *yūpa-sansthāyī*. *Yūpa* is a technical word, in Vedic parlance, indicating a column in the sacrificial altar. Varāhamihira describes the comet *Ka* as *yugākṛti*. The intended meaning appears to be that *Ka* looked straight like a yoke or a column. It is qualified as being both a *graha* (planet or seizer) and a *ketu* (comet). Astronomers may like to comment on the possibility of two comets such as the above being simultaneously observed. The names of the two comets are equally intriguing. *Ūvetaketu* the son of Uddālaka is a famous name in Vedic literature, particularly the Upaniṣads¹⁹. His name appears in *Mahābhārata* also as a social reformer living before the time of Pāṇḍavas²⁰. His relation with his eponymous comet is not known. The word *Ka* is usually used as a pronoun meaning *Who*. However in the Vedas *Ka* has been used as the name of a deity also²¹. This raises the important question about the possibility of some of PS comets being linked with Vedic deities.

अथातः पद्मकेतुः श्वेतकेतुफलसमाप्तौ पश्चिमेनाह्लादयन्निव मृणालकुमुदाभया शिखयैकरात्रं चरन् सप्तवर्षाण्युच्छ्रितं हर्षमावहति॥ अथ काश्यपः स्वधिकेतुः पञ्चदशवर्षशतं प्रोष्य ऐन्द्र्यां सोमसहजस्य पद्मकेतोश्चरान्ते श्यावरूक्षो नभसस्त्रिभागमाक्रम्य अपसव्यनिवृत्तो ऊर्ध्वप्रदक्षिणाकारशिखः। स यावतो मासान् दृश्यते तावन्ति वर्षाणि दुर्भिक्षमावहन्ति। मध्यदेश आर्यगणानामादानं औदीच्यैश्च भूयिष्ठं सत्रिभागशेषां प्रजामवशेषयति इति॥

*athâtaḥ padmaketuḥ ūvetaketuphalasamâpatu paucimenâhlâdayanniva
mṛṅâlakumudâbhayâ ūikhayaikarâtram caran saptavarṣaṅyucchritam
harsamâvahati || atha kâûyapaḥ svadhiketuḥ pañcadaûavarṣaûatam proṣya
aindryâṃ somasahajasya padmaketoûcârânte ūyâvarûkṣo
nabhasastribhâgamâkramya apasavyanivṛtto ūrdhvapradakṣiṅâkârâûikhaḥ |
sa yâvato mâsân dṛûyate tâvanti varṣâni durbhikṣamâvahanti | madhyadeûa
âryagaṅânâmâdânaṃ audicyaiûca bhûyisṭhâṃ satribhâgaûeṣâṃ
prajâmavaûeṣayati iti ||*

“At the end of the effects of Ūvetaketu (after 10 years) Padmaketu rises in the west with its crown coloured like a lotus stalk. Moving one night, it brings immense happiness for a period of seven years. Kâûyapa Svadhiketu is seen, 115 years after the transit of Padmaketu, with star Jyeṣṭhâ (Antares). It is dark and harsh occupying one-third of the sky recedes anti-clockwise, with a crown rotating clockwise above, like a lock of hairs. For years equal to the number of months seen, it reduces the population of the Aryan groups in the middle region and north to one-third”.

अथावर्तकेतुः स्वधिकेतोः कर्मण्यतीते अपरस्यामर्धरात्रेण शंखोदगरुणाभया प्रदक्षिणनताग्रया शिखयोदितः स यावन्मुहूर्तान् निशि दृश्यते तावन्मासान् भवत्यतीव सुभिक्षं नित्यं यज्ञोत्सवश्च जगतः॥ अथ रश्मिकेतुः विभावसुजः प्रोष्य वर्षशतं आवर्तकेतोश्चरान्तं कृत्तिकासु धूम्रशिखः श्वेतकेतोः सदृश फलः॥ अथ संवर्तकोवर्षशतमष्टोत्तरं प्रोष्य पश्चिमेनास्तंगते सवितरि सन्ध्यायां दृश्यते। तन्वीं ताम्ररूक्षशूलाभां धूमं विमुञ्चन्तीं सुदारुणां शिखां कृत्वा नभसस्त्रिभागमाक्रम्य स यावन्मुहूर्तान् निशि तिष्ठति तावद्वर्षाणि परस्परं शस्त्रैर्घ्नन्ति पार्थिवाः। यानि नक्षत्राणि धूपायति यत्र चोदेति तानि दारुणतरं पीडयति तदाश्रितांश्च देशान् इति॥

*athâvartaketuḥ svadhiketoḥ karmanyatîte aparasyâmardharâtreṇa
saṅkhodarârûṅâbhayâ pradakṣiṅanâtâgrayâ ūikhayoditaḥ sa yâvanmuhûrtân
niûi dṛûyate tâvanmâsân bhavatyatîva subhikṣam nityam yajñotsavaûca jagataḥ
|| atha raûmiketuh vibhâvasujaḥ proṣya varṣaûatam âvartaketoûcârânte
kr̥ttikâsu dhûmraûikhaḥ ūvetaketoḥ sadrûaphalaḥ || atha samvartako
varṣaûatamaṣṭotaram proṣya paucimenâstaṅgate savitari sandhyâyâm dṛûyate
| tanvîm tâmrarûkṣaûûlâbhâṃ dhûmaṃ vimuñcantîṃ sudârûṅâṃ ūikhâṃ kṛtvâ
nabhasastribhâgamâkramya sa yâvanmuhûrtân niûi tiṣṭhati tâvadvarṣâni
parasparamûastrairghnanti pârthivâḥ | yâni nakṣatrâni dhûpâyati yatra codeti
tâni dârûṅataram pîdayati tadâûiritâmûca deûân iti ||*

“Âvartaketu rises in the latter half of the night, after the work of Svadhiketu with a head like the trunk of a conch, bent clockwise, portending happiness to the world. For months equal to the muhûrtas seen, it produces happiness and daily celebration in the world. Raûmiketuh born of Vibhâvasu, 100 years after Âvartaketu, appears in the star cluster Kṛttikâ (Pleiades) with a smoky head. Its effects are similar to that of Ūvetaketu. Samvartaka is seen, after a

lapse of 108 years, in the evening after the sun has set in the west. It occupies one-third of the sky, with a thin dreadful copper coloured spear-like head, ejecting a jet of smoke. For years equal to the muhûrtas of its stay, kings fight among themselves. Whichever star it covers with its smoke, the countries associated with those stars are troubled”.

धूमकेतोः प्रागुदयनिमित्तानि। अग्नेर्विचलनं अग्नेः प्रभामान्द्यं प्रधूमनं दिशां शीतोष्णविपर्यासः अतिरूक्षवायुसम्भवश्च॥ अथ अनियतकालरूपवर्णसंस्थानो धूमकेतुः पराभविष्यतां देशानां राज्ञां जनपदानां च वृक्षपुरपर्वतवेश्मध्वजपताकाशस्त्रवर्मायुधावरण रथनागोष्ठ पुरुषशय्याभांडेषु वा दृश्यते। स एव च दिवि स्निग्धो विमलः प्रदक्षिण जटाकारशिखः गोगजनागवीथीं चोत्तरेण व्रजन् सुभिक्षं क्षेमारोग्यं चावहति ॥

dhûmaketoḥ prâgudayanimittâni | avanervicalanaṃ agneḥ prabhâmândyaṃ pradhûmanaṃ diûâṃ úitoṣṇaviparyâsaḥ atirûkṣavâyusambhavaúca || atha aniyatakâlarûpavarṇasaṃsthâno dhûmaketuḥ parâbhaviṣyâtâṃdeûânâṃ râjnâṃ janapadânâṃ ca vṛkṣapuraparvataveûmadhvajapatâkâûastravarmâyudhâvaranarathanâgoṣṭra puruṣaúayyâbhâṇdeṣu vâ drûyate | sa evaca divi snigdho vimalaḥ pradakṣiṇajataḥâkâraúikhaḥ gogajanâgavîthîṃ cottareṇa vrajan subhikṣaṃ kṣemârogyaṃ câvahati ||

“The precursors of Dhûmaketu are, earthquake, dullness of fire, dust veils, exchange of heat and cold (seasons), and very harsh wind. Dhûmaketu having no fixed colour, shape, location and time, appears on the trees, towns, mountains, houses, flags, chariots, elephants, camels, men, bedstead and vessels of the loosing countries and their kings. It portends good when it is clear, sharp, with a clockwise shaped crown leaving the *Go*, *Gaja* and *Nâga* paths to its north”.

Dhûmaketu or the smoky-comet is the last in the list of Parâûara. Varâhamihira calls this *Dhruvaketu*. Utpala’s text of Parâûara also gives the same name. However, considering the popularity of the word *Dhûmaketu* in the sense of a comet, the text of *AS* appears more acceptable. VṚ Garga, to be discussed later, also names the last in the sequence as *Dhûmaketu*. The paths called *Go*, *Gaja* and *Nâga* are specific regions in the night sky defined with respect to the stars²². For example the region to the north of stars Kṛttikâ, Rohinî, Maghâ and Viûâkhâ is called *Nâga-vîthî*. The above celestial objects described by Parâûara are unambiguously comets. Varâhamihira in *BS*, has only repeated in verse form whatever Parâûara had already said about comets. Since he explicitly held the view that comets were beyond mathematics (*BS* 11.1), he appears to have omitted the year numbers, even if he knew them. Utpala some four hundred years later commenting on *BS* quotes *PS* at length including the chronology starting with the Flood, pin

pointing the original source of Varaha. However, since Varaha wrote about comets in an arbitrary order, Utpala's *PS* text does not read in the correct sequence. For example, Utpala mentions Kapālaketu, which is supposed to be seen after Kumudaketu at verse 11.31 of *BS*. But *BS* presents Kumuda after several other comets in verse 11.43. Fortunately Ballala-sena has preserved *PS* in the correct sequential order. Thus one has to note that while Parāúara's comet list in *AS* is internally consistent, Varāha's list in *BS* is not consistent. The mentioned year numbers are perhaps approximate time intervals between two sightings, expressed as elapsed time. How Parāúara was able to obtain this list is not apparent. It should have been only a tradition, which interestingly started its initial point with the Flood.

THE FLOOD

As per internal evidence in the text, the *saṃhitā* of Parāúara should have started around 1400 BC. The statement about the twenty-six comets and the interval between some of them could be a chronological artifice to link the initial time of *PS* with the *Samplava* or the Flood. The total number of years in the list adds to about 1300 years, which indicates that the Flood (inundation or deluge) should have occurred before 2500-2700 BC. These figures can be easily in error by a few centuries. The oldest evidence to the Flood appears in *Úatapatha Brāhmaṇa*, which is later than *Ṛgveda* but belongs properly to Vedic literature²³. The primary contents of this ritualistic text have been dated to *c* 3000 BC based on the statement that Kṛttikā (Pleiades) were not moving from the east¹. The comet tradition preserved in *PS* supports this dating. *Atharvana Veda* mentions about the breaking of a boat, which may also be an indirect reference to the above Flood²⁴. There is a tradition that the Floods occurred around 3100 BC the starting of Kaliyuga. There have been efforts to show that this event should have been dated based on conjunction of planets, particularly Saturn and Jupiter^{14,25}. However, *PS* connects this Flood of about the same date, with the simultaneous appearance of two comets, with no reference to planets. The Flood story connected with, Manu's escape from the deluge and a boat being tied to a peak in the Himalayas is recounted in *Mahābhārata* also, but as belonging to a bygone era²⁶. Hence the Flood of *PS* should be taken to have occurred several centuries before the inundation of Dvārakā, the capital city of Kṛṣṇa²⁷. The latter event itself gets dated to the middle of the 2nd millennium BC, possibly around the same time as the start of *PS*.

VṚDDHA GARGA

Among the various Garga related authors quoted by Utpala and Ballāsa-sena, Vṛ. Garga stands out as being different and interesting. He recounts almost all of *PS*, in verse form, but with additional information that seems based on observations. A few further details about comets that help one to understand *PS* better are presented here. He accepts the same grouping as in *PS*, but lists all the sixteen comets of the Mṛtyu group, naming one of them as *Parâûara*²⁸. This indicates that his composition belongs to a date later than that of *PS*. He does not state the initial era of the observations, but mentions that *Asthiketu*, as soon as it is sighted, inundates earth with water²⁹. He adds here and there more details to the descriptions in *PS*. For example, the interval between *Kaliketū* and *Úñkha* is given as eighteen years and six months. Similarly, *Agniketū* was seen three-and-half years after *Ávartaketū* near star *Jyeṣṭhâ* (Antares) remaining visible for one-and-half months. Vṛ.Garga mentions about *Gadâketū* (Mace comet) seen on *Mârgaûira amâvâsya* (November-January) in the region of stars *Árdrâ* (Betelgeuse), *Punarvasu* (Pollux), *Puṣya* (Asellus) and *Áûleṣâ* (Minhar) but gives no year number³⁰. Probably this was seen during his lifetime, after the close of the list of *PS*. For *Calaketū*, the orbit is more explicitly stated as starting from west and proceeding along stars *Brâhmam* (near Vega), *Brahma-hṛdayam* (Aurige), *Dhruva* the Polestar and then *Saptarṣi* or U.Major to turn south before setting. The total years as per Vṛ.Garga adds up to nearly same as 1300 years, but he specifically mentions thousand year as the elapsed period before the last two comets namely, *Samvartaka* and *Dhûma* to be seen. The descriptions of these two are also somewhat different from that given in *PS*.

नक्षत्रचक्रमाकाशे यथैव परिवर्तते । केतुचक्रं तथैवेदमाकाशात् परिवर्तते॥

ततो वर्ष सहस्रान्ते दृश्येते चोदितौ दिवि । केतुमालाग्रहस्यान्ते धूमसंवर्तकौ ग्रहौ॥

nakṣatracakramâkâûe yathaiiva parivartate | ketucakraṃ tathaiivedamâkâûât parivartate ||

tatovarṣasahasrânte drūyete coditau divi | ketumâlâgrahasyânte dhûmasamvartakau grahau ||

“Like the stellar wheel rotating (repeating) in the sky, the comet-wheel also repeats in the sky. At the end of 1000 years, at the end of the comet strand, two comets Dhûma and Samvartaka appear together”.

Vṛ. Garga gives in detail, the tragedy that these two bring on earth. These lead to fall of meteorites, with the ten directions becoming air-less. Earthquakes occur with oceans and mountains getting disturbed. He should have been a keen observer, as he says *Dhûma-ketu*, before setting, sends a jet of smoke away from Sun (*astamana-kâle tu raveḥ dhûmam vimuñcati*). He seems to be wary of myths and folklore, when he states ‘those with ignorant eyes do not see the starry nature of this object’ (*nâsya târâmayam rūpam paūyanti ajñâna-cakṣuṣaḥ*). He describes the other comet *Samvartaka* as the one famous for reducing the world (*samvartaka iti khyâtaḥ kṣayâya jagatâm iti*).

The other authors quoted in *Adbhuta-sâgara* namely, Garga, Gârgya, Gârgîya, Atharva-muni, Devala, Bhârgava and Varâhamihira have nothing seriously original to add to the comets of Parâûara and Vṛ.Garga. They increase the total number of objects to 1000 and add new groups such as Jupiterian (65), Saturnian (60) etc. Association of comets with planets might have had an observational basis but the numbers appear to be arbitrary. Whether the mentioned objects were comets is also unclear. For example, *Guru-sutâḥ* (Jupiter’s offspring) are described as white stars without hair (*Vikacâḥ*) seen in the south. Similarly, the Venus group is a cluster of 84 white-stars called *Visarpaka*, seen in the northeast direction. *Âṅgiras* is a form seen on Sun, like a person sitting in a chariot. Comet *Aruṇa* is not starry, but dark red in colour and dust like, with diffused light. *Kaṅka* is a comet shining like moon but clustered like a clump of bamboos. None of these authors gives the era of appearance or the time interval between any two of the comets. Their main contribution is in preserving a tradition of celestial objects, other than nakṣatras and planets, being known as *Aruṇa*, *Âṅgirasa*, *Ka*, *Kaṅka*, *Kabandha*, *Kiraṇa*, *Vîuvarûpâ*, *Brahma-daṇḍa*, *Taskara*, *Tvaṣṭâ*, *Triûiras*, *Triûikha*, and *Vibhâvasu*.

DISCUSSION

The text of Parâûara, even though available in fragments as quotations by later authors, represents an ancient observational tradition of Hindu astronomy which got merged into the algorithmic siddhântic astronomy of later centuries. Internal evidences point to the tradition starting around 1400 BC, but evolving over centuries. A critical appraisal of *PS* and its successors is at present not possible. Once the texts attributed to Parâûara and Garga

available only in manuscript form are edited and published the structure of this pre-siddhântic astronomy could be better understood. From whatever that has been presented above, it appears that Parâûara and VṚ. Garga were preoccupied with comets rather than planets. This is in contrast to later astronomers, Āryabhaṭa, Varâhamihira, Brahmagupta and others who remained silent about even a few comets they might have observed in their own lifetime. We may surmise that in ancient India comets should have been observed with some care, much before the systematic observation of planets including Râhu, started. The rudimentary nature of planet data given in *PS* supports this inference. However, the only way we can discuss this issue further is with reference to Vedic literature, which is not astronomical in the modern sense, but would have had a strong correlation with the then visible sky. Sun, moon and *Svarbhânu* causing solar eclipses find place in the Ṛgveda (RV). Even though the name *Râhu* is absent, quite interestingly, the word *Ketu* and its derivatives appear more than seventy times in the Ṛgveda, with conspicuous absence in the second Maṇḍala. All the celestial objects named previously, such as *Ka*, *Tvaṣṭâ*, *Vîuvarûpâ*, *Triûikhâ*, *Taskara*, *Aṅgirasa*, *Vibhâvasu* are in fact deities sung in the Vedas. The popular word for comet in Sanskrit is *Ketu* often referred as *Dhûma-ketu*. Currently this word is used in almost all Indian languages in the sense of comet. *Ketu* originally could have meant a hairy flag like object, synonymous with words such as *ûikhî* and *keûî*. *Amara-koûa*, a standard reference on ancient meanings, provides two meanings: namely *agni* (fire) and *utpâta* (anomalous phenomenon) for the word *dhûma-ketu*³¹. The first meaning is obtained by interpreting fire as smoke-bannered. It is obvious the latter meaning of *utpâta* refers to a comet. In what sense the word *Dhûma-ketu* could have been used in *RV*? We speculate that since *Fire* is only a derived meaning, the word *Dhûma-ketu* appearing in some places of *RV* could have comet imagery in the background. *Atharva-veda* has a famous prayer for peace to the shaking earth hit by meteorites and to Sun, Moon, planets, Râhu and Death named *Dhûmaketu*³². Still more detailed reference to the nine planets and their worship is available in *Atharva-veda-pariûiṣṭa* (*AVP*), which is an appendix to the *Atharva Veda*³³. It is a guidebook for Vedic religious observances. It includes topics like earthquakes, eclipses and comets, the purported ill effects of which were to be mitigated through prescribed rituals. This appears to have been compiled over a period of time and parts of it may be later than Pâṇini and Garga, who are cited with reverence. There appears to be a popular opinion that *Ketu* in the *Nava-*

graha-pûja (worship of nine planets), which is still in vogue widely, is the descending lunar node. This is a misunderstanding based on wrongly equating later astrological mythology with Hinduism based on astronomical concepts. *AVP* (52.12.1) clearly states the ninth *graha* as

नवमश्चैव विज्ञेयो धूमकेतुर्महाग्रहः।

navamaûcaiva vijñeyo dhûmaketurmahâgrahaḥ |

“The ninth should be understood as Dhûmaketu the mahâgraha”.

Further, the *Úântikalpa* of *Atharva Veda* has the following canonical hymn for invoking *Ketu* during religious worship³⁴.

यस्य दीर्घा शिखा मुखं च परिमण्डलं । तमहं ब्रह्मणः पुत्रं केतुं आवाहयामीह ॥

yasya dîrghâûikhâ mukhaṃca parimaṇḍalam | tamahaṃ brahmaṇaḥ putraṃ ketuṃâvâhayâmîha ||

“I invoke here, Ketu son of Brahma, who has a long lock of hair and whose face is circular”.

In contemporary worship following *Ṛgvedic* recension, the prayer for *Ketu* is in plural number as³⁵

पालाशधूम्रसंकाशान् तारकाग्रहमस्तकान् । रौद्रान् रुद्रात्मकान् घोरान् तान् केतून् प्रणमाम्यहम्॥

pâlâûadhûmrasaṅkâûân târakâgrahamastakân | raudrân rudrâtmakân ghorân tân ketûn praṇamâmyaham ||

“I bow to Ketû who are of the color of palâûa smoke, who have starry heads, are ferocious, awesome and have Rudra for their soul”.

There is a version of the above verse using the words in singular, without affecting the meter. In any case it should be clear that the most ancient practice of *navagrahapûja* included in its fold the visible *Ketu* the Comet and not the imaginary lunar node. Both Parâûara and Vr.Garga in line with Vedic belief, after the *Ṛgvedic* period, mention *Râhu* as the sole cause of both solar and lunar eclipses. The other ancient materials, roughly belonging to the period of *PS* and available for comparative study are archaeological artifacts. *PS* in its classification mentions about a single comet born out of the anger of Brahma, but in the description it is not clear which this specifically means. But Garga mentions *Brahma-dañḍa*, offspring of Brahma as being three coloured and three headed³⁶. In *PS*, *Calaketu* is said to have had a trident like (*ûûla-sadrîû*) head. In reality this *ûikhâ* or head could be referring to the comet split in three parts. *Triûikhâ* and *Triûirâ* are also celestial objects

listed by all the ancient authors. In the *Yajurveda* we read that *Vīvarūpa* son of Tvaṣṭra had three heads hinting at a comet imagery³⁷. This *Triūiras* has a parallel in the Harappan seal of a three-headed animal. The painted grey ware pottery unearthed from Hastināpura and other Mahābhārata sites by B.B. Lal³⁸ show designs of circles attached to hair or tail like extensions resembling comets.

SUMMARY AND CONCLUDING REMARKS

The prose text of Parāśara as preserved in the works of Utpala and Ballāla-sena represents an ancient observational tradition of Hindu astronomy prior to the Siddhānta period. This text called here *Parāśara-saṃhitā*, consists of planet and more interestingly of comet observations. The date of the information appears to belong to the middle of 2nd millennium BC. The visibility and invisibility periods of Venus are quite accurate for naked eye observations. The sidereal periods of Jupiter and Saturn and visibility of Mercury are given, even if they are approximate. Movement of Mars seems to have been difficult to follow since no numbers are given in the quoted text. The list of twenty-six comets ending with *Dhūma-ketu* should be of interest to historians and lay people to gain insight into Indian culture. It establishes a historical basis for the Great Flood, which has been the starting point of much of Indian mythology. The text of Vṛ.Garga, as quoted in *Adbhuta-sāgara*, indicates some further developments not found in *PS*. For example, the *Saptaṛṣi* era and the Jupiter year are due to Vṛ.Garga. He was the first person to state that comets appear in a cycle and to have remarked that the tail of a comet extends away from the sun. Existence of synchronism between comet names of *PS* and Vedic deities makes a case for comets being mentioned in the *Rgveda*. This calls for detailed investigation of the voluminous Vedic literature from archaeo-astronomical perspective. Once the manuscripts claiming to be of texts composed by Parāśara and Garga are published with critical apparatus, it should be possible to trace the development of Indian astronomy before the siddhāntic period in better detail than attempted here.

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REFERENCES AND NOTES

1. S.B. Dikshit "Bharatiya Jyotisa Sastra" Govt. of India Press, Calcutta, 1969
2. *Brihat Samhita of Varâhamihira with Sanskrit commentary of Utpala*, Edited by K. C. Dvivedi, Sampurnananda Sanskrit Univ. Varanasi. 1996.
3. *Brihat Samhita of Varâha Mihira*, Sanskrit Text with English transl. by M.R.Bhat., Motilal Banarsidass, N.Delhi, 1981.
4. *Nârada Samhitâ Sanskrit text with Hindi transl.* by V.R.Sharma, Venkateswara Steam Press, Bombay,1906. This text should belong to the siddhantic period, since it works in terms of the twelve Râûis (Meṣa, Vṛsabha etc) and the seven week days.
5. *Vedânga Jyautiṣa of Lagadha*, (Transl. and Notes) by T.S.K. Sastri, (Ed). K.V.Sarma., INSA, N.Delhi, 1984.
6. S.R.Das, "Scope and Development of Indian Astronomy", *Osiris*, 2 (1936) 197-219
7. Parâûara and Garga are ancient names mentioned in *Mahâbhârata*. The former is assigned to 1528 BC by S.B.Roy in Ref.10.
8. See Ref.1.p.88: "The name of Garga has occurred a number of times in *Pâtanjala-mahâbhâṣya*; and one comes across the names of Parâûara and Garga even in *Pânini* (4.3.110, 4.10.105)".
9. *Adbhuta Sâgara of Bllâḷa Sena*, Sanskrit Text. (Ed.) Muralidhar Jha, Prabhakari & Co, Benares Cantt. 1905.
10. S.B.Roy, *Date of Mahâbhârata Battle*, The Academic Press, Gurgaon, 1976. "The original works of Parâûara and Garga are now lost but Bhaṭṭotpala has preserved the crucial quotations (see Sir W. Jones, *AR* Vol. II p.39). In fact, Sir W. Jones has noted carefully that the text of Parâûara was modulated i.e. pitch-accented and in old Vedic prose." (p.126)
11. C.P.N. Sinha, *Mithila under the Karnatas*, Janaki Prakashan, Patna, 1979.
12. R.C.Majumdar, The Chronology of the Sena Kings, *J. of Asiatic Soc. of Bengal*, 17 (1921) 7-16.
13. D. Pingree, *Census of the Exact Sciences in Sanskrit*, Series A, Vol.2, American Philosophical Society, Philadelphia, 1971.
14. S.N.Sen and K.S. Shukla (Ed.) *History of Astronomy in India*, 2nd Revised edition. INSA, N.Delhi, 2000.
15. *Taittirîya Brâhmaṇa* I.5.1, *Atharva Samhitâ* 16.7.
16. *Mahâbhârata* (Vana Parvan 229.8-11) mentions Abhijit to have vanished from the sky. There is an indirect allusion to the missing *Abhijit* in *Taittirîya Samhitâ* (3.3.6.4). For further details see reference 27.
17. O.P.Bharadwaj. *Studies in the Historical Geography of Ancient India*. Sundeep Prakashan, Delhi, 1986.

18. Parāūra in AS, chapter titled *Ṛkṣādyadbhuta (wonders of stars)*
*atha madhyadeūa āryāvarta itica ākhyāyate | tatra janapadāḥ ūrasena-uddaihika-
 madra-aīvattha-nīpa-kāñcanaka-kaurava-uttama-jyotiṣa-bhadrārīmeda-mādhyamika-
 sālva-sāketa-matsya-kapiṣṭhala-dauleya-māṇḍavyāḥ | pāṇḍunagara-gauragrīva-
 pāriyātra-maru-kukura-audumbara-yāmuna-gajāhva-ujjihāna-kālakotī-mathurā-
 uttaradakṣiṇapāñcāla-dharmāraṇya-kurukṣetra-sārasvatāḥ ||*
19. Upaniṣad: *Brihadāranyaka* 6.2.1-8, *Chāndogya* 5.3, *Kauṣītakī* 1.
20. *Mahābhārata* Adi Parvan, Chapter 113.
21. *Taittirīya Saṃhitā* Text and Translation by R.L.Kashyap, SAKSVIC, Bangalore, 2002.
 “Who (ka) yokes you? Let him yoke you he says. *Ka* is Prajāpati....” (I.6.8.5, I.7.6.12).
22. *gajavithī rohiṇyādīni trīṇi | govithī prakrouṣṭapadāni catvāri*
23. *Śatapatha Brāhmaṇa*. I.8.1. Flood Legend. 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.”
24. *Atharvaṇa Veda*. XIX. 39.8; “*yatra nāvaprabhraṃūanāṃ yatra himavataḥ ūraḥ*”.
 This reference to the abandoning of the ship near a peak of the Himalayas is linked to
 the flood episode in the previous reference of *Śa. Br.*
25. D. Pingree, “Astronomy and Astrology in India and Iran”, *Isis*, 54.2 (1963) pp.229-246.
26. *tacca naubandhanam nāma ūṛṅgam himavataḥ param | khyātam adyāpi kaunteya
 tadviddhi bhātarāṣabha || (MB Vana Par. 185.47)*
 This statement in *MB* describes the story as ancient. Also the peak in the Himālaya
 where the boat was anchored is called *naubandhanam*. O.P.Bharadwaj (Ref.21) identifies
 this place with present day Nahān in the Sirmur region of Himachal Pradesh.
27. R.N. Iyengar. “Some Celestial Observations Associated with Kṛṣṇa-lore”, *IJHS*, 41.1
 (2006) 1-13.
28. Vṛddha Garga quoted in *AS*
*darāḥ stabdaḥ ūramo mohāḥ ūyāvaḥ saro atyayastathā |
 parāūaraḥ tamo vṛṣṭiḥ ūṣaṇo ati prabhaṇjakāḥ ||
 asthiketuh vasāketuh ūastraketuradarūanaḥ |
 ete nihūvāsajā mṛtyoḥ nāmataḥ parikīrtitaḥ ||*
29. Vṛddha Garga quoted in *AS*
 अस्थिकेतुर्जनान् हन्यात् दुर्भिक्षमरकाग्निभिः। स दृष्ट एव पृथिवीं आप्लावयति वारिणा।।
*asthiketurbanān hanyāt durbhikṣamarakāgnibhiḥ | sa drṣṭa eva pṛthivīm āplāvayati
 vāriṇā ||*

30. Vṛddha Garga quoted in *AS*
 मार्गशीर्ष्या अमावास्यां गदाकेतुः प्रदृश्यते। आदित्यरौद्रसार्पाणि बार्हस्पत्यं तथैव च॥
 कोष्ठागारं च शिखया धूपयन्नरुणाभया। गदानिभो गदाकेतुः हन्यात् दृश्यो नभो गतः॥
mārgaśīrṣyāṃ amāvāsyāṃ gadāketuḥ pradṛīyate | ādityaraudrasarpāṇi bārhaspatyaṃ
tathaiva ca ||
koṣṭhāgāraṃ ca śikhayā dhūpayannaruṇābhayā | gadānibho gadāketuḥ hanyāt dṛśyo
nabho gataḥ ||
31. *Agnyutpātau Dhūmaketū: Amara-kośa* (3rd Book; *tānta-varga*)
32. *Atharvaveda Saṃhitā*; (19.9.8-10). *ūam no mṛtyurdhūmaketuḥ*
33. *Atharvaveda Pariśiṣṭa*, (Ed.) G. M. Bolling and J. von Negelein, Leipzig, 1910
34. *Ūāntikalpa of the Atharvaveda*, (Ed.) G.M.Bollong and H.E.Johnston, *J American Oriental Society*, 33 (1913) 265-278.
35. *Ṛgvedīya Navagraha Pūjā (Japa) Vidhi*, Srimanmadhva siddhanta granthālaya, Udupi. 11th edition, 2004.
36. Garga as quoted by Utpala and Ballāla-sena
 एको ब्रह्मसुतः क्रूरः त्रिवर्णास्त्रिशिखान्वितः । सर्वास्वाशासु दृश्येत ब्रह्मदण्डो भयावहः ॥
eko brahmasutaḥ krūraḥ trivarnaśtriśikhānvitaḥ | sarvāsvāśasu dṛīyeta brahmadanḍo
bhayāvahaḥ ||
37. *Taittirīya Saṃhitā* (2.5.1) *viūvarūpā vai tvāṣṭraḥtasya trīṇi ūrṣāṇi*
38. B.B.Lal, “Excavation at Hastināpura and other Explorations in the Upper Gangā and Sutlej Basins, 1950-52, Ancient India”, *Bull. Arch. Survey of Ind.* No.10 &11, pp. 5-151.

NOTE ON THE PAPER BY THE REFEREE

The author has described the main features of the astronomy in Parāūara and Garga saṃhitās giving original Sanskrit quotations and their English translations. It is a valuable addition to the modern literature on ancient Indian astronomy. It provides concrete Pre-Siddhāntic evidence for the knowledge about the periods of planets and contains a list of 27 comets. As the epoch of Parāūara is shown to be around 1400 BC this knowledge should enable the researchers to trace the links between Vedic and Siddhāntic astronomies.

KD Abhyankar (IJHS, Vol. 26, 1991 pp. 1-8) has identified the original 28 nakṣatras. According to him the present Ūravaṇā was the original Abhijit, present Dhaṇiṣṭhā was the original Ūravaṇā, Beta Aquarii was the original Dhaṇiṣṭhā and Fomalhaut was the original Ūatabhisag. About Vṛddha Garga, K D Abhyankar and G M Ballabh (IJHS, Vol. 31 1996 pp. 19-34) have argued that Vṛddha Garga had discovered the rate of precession (*ayanacalana*) and he lived in 5th century BC.

Parāūara’s description of comets is quite realistic as most of the comets are seen in the west (after sunset) and in the east (before sunrise) and they possess a head and an

hairy and dusty tail. There is no mention about the time of the year or their position among the stars, except in a few cases, Although this is not sufficient for their scientific study they are listed in Table 1 below giving the available information and a possible epoch based on an assumed epoch of 2700 BC of the so called Flood. In this connection it appears that Gadaketu of Vṛddha Garga might be Halley's comet which should have appeared in 468 BC and 544 BC (Vṛddha Garga's epoch) with a period of 76 years from its earliest recorded appearance in 240 BC. It should be possible to check this as its path is given by Vṛddha Garga. Other comets which span one-third of sky and could be identified with Halley's comet are: No. 26 (1416 BC), its path is known and Nos. 1, 2, 3 (2566 BC).

Table 1. List of comets in *Paraśara saṃhitā*

No.	Name	Rise/Head	Description	Epoch* BC
1.	Vasāketu	West/North	Big and sharp	2570
2.	Ashthiketu	West/North	Bone like	2570
3.	Úastraketu	East	Weapon-like	2570
4.	Kumudketu	West/East	Lily-like/spray of milk	2560
5.	Kapāketu	East/New Moon	In sky center/	2435
6.	Manketu	West/East	Crystal-like	2433
7.	Kaliketū	East 1/3 sky	Red, Trident like 1/3 sky, travels South to North	2132
8.	Calaketu	West/South		2017
9.	Jalaketu	West/West		2016
10-17	Urmi-Úita			2003-1971
18.	Bhavaketu	East/Clockwise		1815
19/20.	Úvetaketu	East/South		1741
21.	Ka		Yoke or lotus - like (?)	1741
22.	Padmaketu	West	Lotus stalk	1731
23.	Swadhiketu	West/North of star Jyeṣṭhâ	1/3 sky, dark hard hairlike	1616
24.	Avartaketu	Latter half of night	Vortex-like	1616
25.	Rasmiketu	Near star Kṛttikâ	Smoky red	1516
26.	Samvartaka	West/1/3 sky	Copper red, Spear like	1408
Garga	Gadaketu	Mârgaśirṣa amāvasyâ	Stars Ārdrâ to Āśleṣâ	5th century BC

*Epochs based on assumed epoch of so called flood 2700 BC.