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PARĀŚARA'S SIX SEASON SOLAR ZODIAC AND HELIACAL VISIBILITY OF STAR *AGASTYA* IN 1350-1130 BC

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Abstract

The bright southern star Canopus is known as *Agastya* in India. The first rise of this star is observed with religious fervour in many parts of the country. Legends say that the Vedic sage Agastya crossed the Vindhya Mountains to go south and eventually remained as the southern star known by his name. This star would not have been clearly visible before 3100 BC in the northern parts of India. The star exhibits all the four visibility phenomena namely, heliacal rise, cosmic setting, acronychal rise and heliacal setting. Hence statements about its heliacal visibility and setting in the *Parāśaratantra* as quoted by Varāhamihira and his commentator are of seminal importance as anchor points of early Hindu astronomy and ancient Indian chronology. This paper analyses the visibility information given by Parāśara in relation to his six season solar zodiac preserved in Utpala's commentary. It is demonstrated that the observations were realistic for 1350-1130 BC, which is also the estimated date of the ancient Indian astronomer Parāśara.

Key words: *Agastya*, Canopus, *Hasta*, Heliacal Rise, Kurukṣetra, *Maitrāyaṇī-Āraṇyaka*, Parāśara, Puṣkara, *Rohiṇī*, Solar Zodiac, *Taittirīya-Āraṇyaka*, Vedic Period

1. Introduction

The bright southern star Canopus of magnitude -0.7 was known to Hindu astronomers since ancient times as *Agastya*. This name is also the name of a venerated sage who migrated to South India in prehistoric times from the northern parts of the country. It is easy to see that similar to the seven stars of U. Major being identified with seven reputed sages of the Vedic period (*Saptaṛṣi*), star Canopus has been named after *Agastya* an ancient seer of cultural and historical importance. Agastya's name appears four times in the *Ṛgveda* (I.170.3, I.179.6, VIII.5.26, X.60.6) but we cannot be sure whether he was the one who traveled south. However, we can infer that naming the southern star as *Agastya* should have happened after the time of the Ṛgvedic *Agastya*. It may be noted here that all Indians owing allegiance to the Vedas trace their canonical genealogy to the Seven Sages of the *Ṛgveda* and *Agastya* the Eighth[1].

The *Taittirīya-Āraṇyaka,* an important text belonging to the *Kṛṣṇa-Yajurveda*, specifically states that the Seven Sages and *Agastya* are stationed with the stars[2]. We have no idea when this recognition happened, but this Vedic text clearly correlates the constellation of the Seven Sages or *Saptaṛṣi* (U. Major) with *Agastya* (Canopus). This text also knows the situation near the north celestial pole as being demarcated by the constellation *Śiśumāra* (Draco) consisting of fourteen stars with *Abhaya-Dhruva* (Thuban) at the tail end on the North Pole. The epoch of *Dhruva* being the Pole Star has been previously discussed at length by the present writer and

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shown to be 3200-2400 BC[3]. Thus the first recognition of the southern star and its identification with *Agastya* seems to have happened *c* 2800 BC. 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[4]. *Agastya* in anger curses the heavenly King Nahuṣa to lose his exalted position to become an ordinary *ajagara* (python or huge serpent; literally goat-swallower). This legend is most likely an allegory for precession being felt in the form of the *Śiśumāra* (Draco) constellation losing its prime northern celestial position, along with star *Agastya* coming into prominence as a new bright star in the south. It may be noted here that the *Mahābhārata* also explicitly refers to movement of the Pole Star *Dhruva* as a bad omen[5].

While the *Saptaṛṣi* constellation (U. Major) was circumpolar for people in North India in Vedic times, *Agastya* must have been visible in the southern sky rising to low altitudes every year but only during certain months, initially for a few days, but extending for longer periods as time progressed. There is no rigorous study on this topic except for a broad visibility calculation carried out by Abhyankar[6]. His inference is that *Agastya* as a new star could not have been easily visible for observers in the Kurukṣetra-Delhi region before 3100 BC. Further north at Jammu, first recognition of this new star in the southern horizon would have been possible around 1400 BC. Rise of *Agastya* is observed as a religious event in many parts of India even to this day. Some of the traditional almanacs provide the dates of first morning rise and last evening set of Canopus, for conducting prescribed rituals in the yearly calendar. Hence the first recognition of Canopus in the southern skies as observed from the northern parts of the country is a signature of seminal importance in delineating ancient Indian chronology and history of Hindu astronomy.

Almost all the Siddhāntic astronomy texts discuss the conditions required for the first visibility of star *Agastya* towards the end of the rainy season. However, Siddhāntic period texts started developing from the beginning of the Common Era separated from Vedic times by two to three thousand years. Hence to understand the impetus for Siddhāntic texts to select computation of heliacal rise of Canopus as important we have to look for more ancient evidences for observation of *Agastya*. Fortunately, Varāhamihira (VM) in his *Bṛhat Samhitā* (*BS*) and Utpala (Bhaṭṭotpala) the commentator of *BS* have preserved parts of *Parāśaratantra* (*PT*) whose author should have preceded VM by more than a millennium. In a previous publication some interesting aspects of the astronomy of Parāśara including planet and comet visibility have been highlighted[7]. In the present paper it is shown that Parāśara had evolved a six season solar zodiacal scheme dateable to 1350-1130 BC, closely coinciding with the winter solstice stationed at the beginning of the *Dhaniṣṭhā* star division as in the *Vedāṅga Jyotiṣa* (*VJ*) of Lagadha[8]. Parāśara had also stated the heliacal rise and heliacal set of *Agastya* in relation to his solar scheme. This is demonstrated to be a remarkable piece of observational astronomy belonging to the above period in the second millennium BC.

In this connection it may be mentioned that tradition recognizes eighteen *siddhāntas* including a text known as *Parāśarasiddhānta*[9]. However, VM does not cite such a *siddhānta* text but cites Parāśara in several places as an ancient authority and specifically names *Parāśaratantra* as an ancient work in his *Bṛhat Samhitā*[10]. Manuscript catalogues list the title *Parāsārasiddhānta*, but no such text is yet published in print form. The manuscript available in the Bhandarkar Oriental Research Institute, Pune consists of only the first

two chapters and is evidently incomplete[11]. This text, like other *siddhāntas*, starts with the definition of a long period called *Kalpa* and states planetary periods as integral number of revolutions in a *Kalpa*. But such concepts are not present in the *tantra* text of Parāśara quoted by VM and his commentator Utpala. More details about the *Parāśaratantra* are available in a book of the same name compiled by the present writer, with reconstructed text, translation and notes[12]. The *Parāśarasiddhānta* text might have been influenced by the corresponding earlier *tantra* text, but this question remains open for future studies.

2. Utpala's *Parāśaratantra* Text

The first chapter of BS is titled *Upanayanādhyāya* or Introduction; where in (1.11) VM refers to non-specific ancient questions, cross questions and stories about creation of planets (*graha*) but brushes them aside as not useful. However, commenting on this verse Utpala quotes *PT* presenting the conversation between Parāśara and his students. This includes creation, legends about Sun, Rāhu, the five planets and *Agastya*, but strangely silent about Moon. The text is too lengthy to be quoted here but the clubbing of *Agastya* along with the other visibly moving celestial objects is interesting. Utpala quotes *PT*;

अथ भगवन्तममितयशसं पराशरं कौशिकोऽभ्युवाच । भगवन् याम्यायां दिशि ज्योतिष्मद्ग्रहरूपमुदितमालक्ष्यते नक्षत्रग्रहमार्गव्युत्क्रान्तचरितं न वेद्मि । किं तत्किमर्थं वा प्राचीं दिशमपहाय दक्षिणेन प्रावृट्कालान्तोदितं शरत्कालान्तोदितं वा कतिपयाहान्यदृश्यं भवति । तन्नो भगवन् वक्तुमर्हसि॥

atha bhagavantam amitayaśasam parāśaram kauśiko'bhyuvāca| bhagavan yāmyāyām diśi jyotiṣmadgraharūpam uditam ālakṣyate nakṣatragraha-mārgavyutkrāntacaritam na vedmi| kim tat kimartham vā prācīm diśam apahāya dakṣiṇena prāvṛṭkālāntoditam śarat-kālāntoditam vā katipayāhāny adṛśyam bhavati| tanno bhagavan vaktum arhasi||

> Then, Kauśika asked Parāśara. Sir, in the southern direction a bright planet-like object is seen. I do not know this object which moves not along the *nakṣatra*-planetary path (ecliptic). Why this object leaving the East rises in the South at the end of the rainy season or at the end of the autumn to be seen for a few days? Please explain this.
>
> (*PT.* 1)

Parāśara in answer to this question explains the celestial object as star *Agastya*, further enlarging on the legend of the migration of sage Agastya to south crossing the Vindhya Mountains. Here the question is as important as the answer for understanding the early stages of Hindu astronomy. Sage Agastya was too important because of his Vedic background and it is likely the first observers in India initially took the eponymous star to be like a planet. This appears natural considering the fact, that for a casual observer, Canopus would have been visible in the early morning sky for a few days in a year and again appearing after several months in the evening sky for a few more days, mimicking planets like Venus the visibility numbers of which are correctly preserved in *PT*. In reality, this could not have been the case since for a diligent observer Canopus remained visible sometime all through the night between its first and last visibility.

The visibility part of *Agastya* as per *PT* is given by Utpala in Chapter 12 of *BS* titled *Agastyacāraḥ* (Movement of Canopus). In verse *BS* (12.14) VM explains that the visibility depends on the location of the observer and that one should predict the first visibility based on calculations. He further states that at Ujjain, where he lived, *Agastya* rose when Sun was at 23° of sign Leo (*Simha Rāśi*). In the same chapter in verse (12.21) VM refers to some portents and to the statement that *Agastya* rises when Sun is in *Hasta* and sets with Sun in *Rohiṇī*[13]. Commenting on this verse Utpala explains that the word *kila* is a reference to the inherited tradition (*āgama*) and even though as per calculations the traditional rise and set

conditions are not correct VM states them as seen by him in ancient texts[14]. The ancient author quoted is Parāśara;

हस्तस्थे सवितर्युदेति रोहिणीसंस्थे प्रविशति । अथास्य त्रिविधचारोदयकालो दृष्टः। आश्वयुग्बहुलाष्टमीपञ्चदश्योः कार्तिकाष्टम्यां वा ॥

hastasthe savitaryudeti rohiṇīsamsthe praviśati| athāsya trividhacārodayakālo dṛṣṭaḥ| āśvayugbahulāṣṭamī-pañcadasyoḥ kārtikāṣṭamyām vā||

(*Agastya*) rises when Sun is stationed in *Hasta*; sets when (Sun) is in *Rohiṇi*. Three types of rising times are seen for *Agastya*; the *eighth* (*tithi*) or the fifteenth (*tithi*) of the bright fortnight in the month of Āśvayuja or the *eighth* (*tithi*) of the Kārtika month.

(*PT.* 2)

The second sentence above states three lunar positions for first visibility. The month *Āśvayuja* and *Kārtika* being lunar, the corresponding visibility *tithi* mentioned are not helpful in the absence of evidence on how intercalation was carried out to synchronize the lunar and the solar years. Hence based on lunar reckoning one can only say that the first visibility of Canopus was towards the end of the rainy season. However the first sentence is remarkable since it specifies Sun's position among the *nakṣatras* for first and last visibility. This gives the observational conditions for the rise and set of Canopus during the time of Parāśara or the epoch of the ancient treatise *Parāśaratantra* that was available to *VM* as a reference text.

Utpala in Chapter 1 of *BS* says the discourse by Parāśara was at *Puṣkara-sthāna*, but the text further quoted by him refers to the Himalayas. Thus we do not know from where exactly the ancient observations were done. Puṣkara (26.5N 74.55E) is in Rajasthan with average elevation of 500 m. In the Himalayas, the place famous as *Parāśara-āśrama* is Gaganāni (30.92N 78.67E) a mountainous region with elevation around 2700 m. To make the text clear it would be useful to have the dates of rise and set over a long period as applicable to locations in north India. Here we take Kurukṣetra (30N 76.75E) and Puṣkara as typical to start with. The visibility results are shown in Table 1 using the astronomical software PLSV 3.1 (www.alcyone.de), which is based on the Bright Star Catalogue of the Astronomical Data Center, NASA, USA (http://heasarc.gsfc.nasa.gov/W3Browse/star-catalog/bsc5p.html). If we take about four degrees altitude as necessary for recognizing a new celestial visitor in the southern horizon, *Agastya* should have been visible early in the morning to viewers in Kurukṣetra from around 2900 BC, in the month of October. The peculiarity of star *Agastya*, for an ancient observer was in its early morning rise on the southern horizon and incremental rise to relatively low altitudes before becoming invisible. Once the rise of the star was observed at a particular time, further daily rise would recede at the rate of four minutes per day. From rise above the horizon to set the time interval required for star *Agastya* would be 4-5 hours. Hence as the local rise time recedes from early morning to midnight the star would be setting just before sun rise known in modern astronomy as cosmic setting. After this morning set, the star would be still visible but only in the night. A casual observer might miss it till the star rises again in the evening (acronychal rise) in the month of March for a few days, before going below the horizon (last visibility). At Puṣkara the rise would be earlier than at Kurukṣetra and also the early morning visibility would be for a longer period. Only by constant night-time observation Parāśara and his students could have come to the conclusion that it was the same celestial object seen apparently twice in a year, once rising before sunrise in autumn and once more setting after sunset as stated in (*PT*.2) above.

Table 1. Visibility dates of Canopus at critical altitude of 4°

Year	Morning before sunrise		Evening after sunset	
	Kurukṣetra	**Puṣkara**	**Kurukṣetra**	**Puṣkara**
-3000	Invisible	14.9-31.10	Invisible	21.2-12.4
-2900	6.10-10.10	13.9-1.11	15.3-20.3	20.2-12.4
-2800	2.10-13.10	12.9-1.11	11.3-23.3	19.2-12.4
-2700	30.9-15.10	12.9-1.11	8.3-25.3	18.2-12.4
-2600	28.9-16.10	11.9-2.11	6.3-26.3	17.2-13.4
-2500	26.9-17.10	10.9-2.11	4.3-27.3	17.2-13.4
-2000	20.9-21.10	6.9-3.11	27.2-31.3	13.2-14.4
-1500	16.9-23.10	3.9-4.11	22.2-1.4	9.2-14.4
-1000	12.9-24.10	31.8-4.11	18.2-2.4	7.2-14.4

With the help of Table 1 we can see why Kauśika, a student of Parāśara, says that *Agastya* becomes invisible within a few days (*katipaya ahānyadṛśyam bhavati*). In the year -2700 it would have been visible, early in the morning, at Kurukṣetra only for 15 days, and in later centuries for a month gradually increasing to a month and half. (If the critical altitude for visibility were to be reduced to 2°, *Agastya* as a new bright star would have been visible at Kurukṣetra for the very first time in history in the year 3900 BC from 8th October to 14th October for about 30 minutes before local sunrise). Again when Kauśika says that it is seen at the end of rains or at the end of autumn the reference might have been to differing opinions in the early observational history of *Agastya*. As one goes to higher latitudes the year of first visibility gets further delayed. Canopus would have been sighted clearly from Gaganāni only by 1800 BC where as people at Puṣkara could have easily seen *Agastya* as early as 3000 BC and also for longer periods than at Kurukṣetra. Some seem to have recognized the star in October-November while others were seeing it much before.

3. Visibility of Star *Agastya*

We have seen above that the question in (*PT.*1) reflects wide spread legendary traditions which were perhaps realistic for different places in different times. The lunar month rise statements could not have helped in observing Vedic rites correctly, till the solar-*nakṣatra* position was firmed up by Parāśara. The condition given is that Sun should be in *Hasta* for first visibility. Similarly for last visibility Sun is stated to be in *Rohinī.* How to interpret this? While, for defining lunar months position of the Full Moon with particular stars has been used in ancient texts, here *PT* is giving the position of Sun with respect to stars which would not be visible if they were to be too close to Sun. Hence the statement has to be taken in the sense of the division of the ecliptic denoted as *Hasta* and *Rohiṇī*. This is how VM and Utpala understood Parāśara. In this case *PT* means that the rise of *Agastya* (Canopus) on the southern horizon was coeval with the visibility of *Hasta* (Corvi) in the eastern sky, when Sun was still below the horizon. The same explanation would apply to the last visibility of *Agastya* after sun set when *Rohiṇī* (Aldebaran) would be still visible but behind Sun. This brings up a new question about how *PT* divided and named the ecliptic in terms of the 27 star divisions. Fortunately this is preserved in Utpala's commentary on *BS* Chapter 3 called *Ādityacāra* in the form of the solar *season-nakṣatra-zodiac* scheme of Parāśara (for more details see Ref: 12).

4. Six Division Solar Zodiac of Parāśara

यदुक्तं पराशरतन्त्रे॥

श्रविष्टाद्यात् पौष्णार्धं चरतः शिशिरः । वसन्तः पौष्णार्धात् रोहिण्यन्तम् । सौम्याद्यात् सार्पार्धं ग्रीष्मः। प्रावृट् सार्पार्धात् हस्तान्तम् । चित्राद्यात् इन्द्रार्धं शरत् । हेमन्तो ज्येष्टार्धात् वैष्णवान्तम् । इति ॥

yaduktam parāśaratantre||

śraviṣṭhādyāt pauṣṇārdhāntam caratah śiśiraḥ| vasantaḥ pauṣṇārdhāt rohiṇyāntam| saumyādyāt sārpārdham grīṣmaḥ| prāvṛṭ sārpārdhāt hastāntam| citrādyāt indrārdham śarat| hemanto jyeṣṭhardhāt vaiṣṇavāntam| iti ||

As said in the *Parāśaratantra:*

> When sun moves from the beginning of Śraviṣṭhā to the middle of Revatī it is Śiśira. From the middle of Revatī to the end of Rohiṇī is Vasantha. From the beginning of Mṛgaśirā to the middle of āśleṣā is Grīṣma. From the middle of āśleṣā to the end of Hasta is Varṣā. From the beginning of Citrā to the middle of Jyeṣṭhā is Śarat. From the middle of Jyeṣṭhā to the end of Śravaṇa is Hemanta. (*PT*. 3)

Śraviṣṭhā same as *Dhaniṣṭhā,* as an isolated star is usually identified with β-Delphini. The statement implies this to be the turning point of sun towards north and hence the winter solstice position. This text was used by British indologists William Jones, Davis and Wilford in the eighteenth century to date Parāśara to 1180-1390 BC[15,16]. In the above statement even though season (*ṛtu*) names are mentioned, this scheme is not about the weather. The boundaries of the felt seasons, as is well known, cannot be accurately fixed since, the changes are gradual and subject to many other vagaries. Hence, the above is an astronomical scheme for linking passage of time on earth to the apparent movement of Sun among the stars. But this model could have originated only out of observation of the said stars rising sometime in the felt seasons. It is obvious from the text, corroborated also by *VJ* that the winter solstice was when Sun was at the first point of star *Dhaniṣṭhā*. But from where to where on the ecliptic the stretch was called by the same name to mark its beginning? There is no direct answer for this except by taking recourse to other statements of *PT* where *nakṣatras* which are identifiable without ambiguity as visible individual stars are available. *PT* is clear about six seasons making a solar year with each season comprising of four-and-half *nakṣatra* divisions. This division of the continuous time-space into discrete parts with an isolated point (visible star) representing a part or division has Vedic philosophical background. To analyze the *PT* zodiac a brief discussion on the older *Maitrāyaṇī āraṇyaka* (or *Maitri Upaniṣad*; *MAU)* text that posits *Time as Brahman* is helpful. In this text the concept of continuous Time, discretization of civil time in terms of year, half-year, months and recognition of the passage of this by means of stars rising with Sun is well stated. The important portion of the text and translation follows.

.. .. सूर्योयोनिः कालस्य तस्यैतद्रूपं यन्निमेषादि कालात् संभृतं द्वादशात्मकं वत्सरम्। एतस्याग्नेयमर्धमर्धं वारुणम्। मघाद्यं श्रविष्टार्धमाग्नेयं क्रमेणोत्क्रमेण सार्पाद्यं श्रविष्टार्धान्तं सौम्यम् । तत्रैकैकमात्मनो नवांशकं सचारकविधं सौक्ष्म्यत्वात् एतत्प्रमाणमनेनैव प्रमीयते हि कालः .. .. ॥

[मै.आरण्यकम् ६.१४]

…..sūryo yoniḥ kālasya tasyaitadrūpam yannimeṣādi kālāt sambhṛtam dvādaśātmakam vatsaram | etasyāgneyamardhamardham vāruṇam | maghādyam śraviṣṭhārdhamāgneyam krameṇotkrameṇa sārpādyam śraviṣṭārdhāntam saumyam | taraikaikātmano navāmśakam sacārakavidham saukṣmyatvāt etatpramāṇamanenaiva pramīyate hi kālaḥ…..||

[*MAU* 6.14]

…… Sun is the birth place of Time. The form of Time is the year, consisting of twelve (months), made up of *nimeṣā* and other measures. Of the year one half is

> *āgneya* and the other half *vāruṇa*. The *āgneya* half begins with the asterism of *Maghā*, and ends with the half of *Śraviṣṭhā*; this being Sun's southern travel. That which is *saumya*, in the reverse order, is from *āśleṣā*, to the half-end of *Śraviṣṭhā*; this is the northern course. And then, there is (the month), one by one, belonging to the year, each consisting of nine-*aṁśa* (2¼) of asterisms, each determined by the Sun moving (with the asterisms). Because Time is too subtle (for sensory perception) this progress of the Sun is its evidence (or proof), and by it alone is Time cognized….
>
> (*MAU* 6.14)

Here only the Sun and three *nakṣatras* are mentioned for our understanding of the months and the year. The two half of the year refer to the northern and the southern movement of the Sun as seen from earth. The northward movement started when sun was at the midpoint of the star division *Śraviṣṭhā* (or *Dhaniṣṭhā*). The other part of the year is stated in reverse order as from *Āśleṣa* to midpoint of *Śraviṣṭhā*. This means that the summer solstice was when Sun was with star *Maghā* at the beginning of its division. The end point of *Āśleṣa* would be same as the starting point of *Maghā*. Hence *sārpādyam śraviṣṭhārdhāntam* in reverse order is from midpoint of *Dhaniṣṭhā* to end of *Āśleṣa*, which is the northern sojourn of Sun. This is the explanation of the commentator Rāmatīrtha[17] also. The translation of Max Mueller, in essence, is not different[18]. Here the star *Maghā* is well recognized as Regulus, but doubts may be raised about the other two stars and the division there of. Nevertheless it can be seen that between *MAU* and *PT* the winter solstice is said to have moved half-*nakṣatra* distance. In modern terminology this would be equal to precession of equinoxes by $6^0 40'$. Even if one were to argue that the star *Dhaniṣṭhā* of the *siddhānta* period should not be imposed on the Vedic period, precession of $6^0 40'$ amounts to a time difference of 480 years between *PT* (3) and *MAU* (6.14). This of course is only a relative chronology but there is no ambiguity in this number. An important terminology of *MAU* is the word *ardhāntam*, meaning the end-of-the-half. This technical word clearly refers to the middle but when Sun's movement is considered the text emphasizes that it is the end of the second quarter of a *nakṣatra* interval. Thus besides individual visible stars at unequal distances, as indicators of moon's position, the concept of star divisions using some support points was in vogue during Vedic times, which was inherited by *PT*.

The main objection of some indologists for dating *VJ* and hence *PT* to c 1400 BC has been the assumption involved in taking the statement of Varāhamihira, who lived in the 6th century, on face value that once upon a time winter solstice was at the first point of star *Dhaniṣṭhā*. This objection is partly valid as far as *Dhaniṣṭhā* is concerned. This constellation is made up of five (or four) stars and there is no unbroken identification of the constituent stars starting from the Vedic to the *siddhānta* to the present period. However the same is not true about *Kṛttikā, Rohiṇī, Maghā, Citrā, Viśākhā* and *Jyeṣṭhā*. These six stars have stood the test of time and are always identifiable with their modern equivalents; Pleiades, Aldebaran, Regulus, Spica, α-Libra and Antares. Here Pleiades like *Kṛttikā* is a group of six stars but its spread is not too wide and hence can be safely represented by η-Tauri or Alcyone. *Rohiṇī* as a group has five stars but identification of its prominent star with Aldebaran is unambiguous. Arcturus has always been identified with *Svāti* but being too close to Spica or *Citrā* it causes some confusion when equal star divisions are considered. In *MAU* the named star is *Maghā* and this should have been within the star division of the same name during the ancient epoch when the summer solstice was noted with the visibility of this star, most probably in the early morning sky, since *MAU* mentions that Sun moves with the stars. This constrains the longitude of the

visible star *Maghā* to have been in the range of 90^0 to $103^020'$. Modern astronomy indicates that the longitude of Regulus varied in the above range during 2340 BC to 1370 BC. This result naturally gives an upper and lower bound date for the solar *ayana-nakṣatra-zodiac* picture of *MAU* (6.14). It is interesting to note here that in the *Atharvaṇaveda* also *ayana* is associated with the star *Maghā*[19].

The concept of seasons determining the year is available in several Vedic texts. For example the *Śatapatha-Brāhamaṇa* states: only by *ṛtu* year is possible to be established[20]. There are texts indicating the year to have five *ṛtu*, which were probably weather indicators. In some places there is mention of even seven *ṛtu* in a year, which refers to the intercalary year[21]. But as the year had only two *ayanas*, due to symmetry six *ṛtu*, three for each *ayana*, evolved as the standard. Now, it is easy to note that Parāśara in *PT* extends these older concepts and gives position of a few more identifiable stars for the six *ṛtus*. The *nakṣatra-ṛtu* (star-season) statement of *PT* can be better expressed as a table of solar zodiac with 2¼ *nakṣatra* divisions per month. The enumeration starts from the first point of *Dhaniṣṭhā* even if the precise identity of the star of that name can be treated as unknown. We however know that it should have stretched for a width of 13^0 20′, which was true for the other 26 stars also.

In Table 2 the terminology used in *PT* for the beginning, middle and end of the star divisions is shown in italics. Since *PT* mentions only the seasons this table is an expansion to include the months and the remaining stars also. As in the previous discussion with *MAU* if we look for the six identifiable stars we find that *PT* specifically names *Rohiṇī, Citrā* and *Jyeṣṭhā* and their corresponding divisions. Since the sequence of the *nakṣatra* names has remained unchanged over several millennia, it is easy to recognize the positions of *Kṛttikā, Maghā* and *Viśākhā* also. It follows that for the epoch of *PT* the equinox should have been at the ¾ point of the *Bharaṇī*-division. From this one can find the divisional position of the selected six single stars in the solar zodiac scheme of *PT*. Based on this information the possible epoch for these stars to be in their prescribed divisions has been determined and shown in Table 3.

The period range shown in Table 3 demonstrates that the *PT* solar zodiac should have been conceptualized in 1350-1130 BC.

Table 2. Solar Season zodiac of Parāśara (*Vernal Equinox or 0° Longitude, The width of the associated divisions are shown in degrees and minutes)

Month	Nakṣatra Division			Season
1	*Dhaniṣṭhādyāt* (13º20′)	Śatabhiṣak (13º20′)	P. Bhādra¼ (3º20′)	Śiśira
2	¼P. Bhādra (10º)	U. Bhādra (13º20′)	*Revatyardhāntam* (6º40′)	
3	*Revatyardhāt* (6º40′)	Aśvini (13º20′)	Bharaṇi¾* (10º)	Vasanta
4	*¾Bharaṇi (3º20')	Krittikā (13º20′)	*Rohinyantam* (13º20′)	
5	*Mṛgaśirādyāt* (13º20′)	Ardrā (13º20′)	Punarvasu¼ (3º20′)	Grīṣma
6	Punarvasu¾(10º)	Puṣya (13º20′)	*Āśleṣārdhāntam* (6º40′)	
7	*Āśleṣārdhāt* (6º40′)	Maghā (13º20′)	P.Phalguni¾ (10º)	Varṣā
8	¾P.Phalguni (3º20′)	U. Phalguni (13º20′)	*Hastāntam* (13º20′)	
9	*Citrādyāt* (13º20′)	Svāti (13º20′)	Viśākhā¼ (3º20')	Śarat
10	¼Viśākhā (10º)	Anurādhā (13º20′)	*Jyeṣṭhārdhāntam* (6º40′)	
11	*Jyeṣṭhārdhāt* (6º40′)	Mūlā (13º20′)	P. Āṣāḍhā¾ (10º)	Hemanta
12	¾P. Āṣāḍhā (3º20′)	U. Āṣāḍhā (13º20′)	*Śravaṇāntam* (13º20′)	

Table 3. Six Prominent Identifiable Stars of *PT*

Single identifiable *Nakṣatra*	***Nakṣatra* Division of *PT* Longitude**	**Valid Period Range BC**
Kṛttikā (η-Tauri)	3°20′- 16°40′	2090-1130
Rohiṇī (Aldebaran)	16°40′-30°00′	1830-870
Maghā (Regulus)	96°40′-110°00′	1850-880
Citrā (Spica)	150°00′-163°20′	1890-930
Viśākhā (α-Libra)	176°40′-190°00′	1500-550
Jyeṣṭhā (Antares)	203°20′-216°40′	1350-400

Winter Solstice as the starting point is explainable because the stationary point of Sun in the sky can be experienced and also recognized by orientation of normal shadows on ground. As in all observations, there would be errors in the *nakṣatra* stretches which have to be taken as estimated boundaries. Originally the rising stars should have helped people to indicate the felt seasons corroborated by weather conditions. But *PT* in course of time formalized this knowledge as a theoretical basis for dividing the year into six equal parts with Sun making one full tropical cycle. Nonetheless *PT* could have arrived at its zodiac only in terms of at least a few isolated stars, among the 27 *nakṣatras* available from the Vedic tradition. It may be emphasized here that even though the well known 27 *nakṣatras* were at unequal distances, *PT* created an equal division of two month long seasons with four-and-half *nakṣatra* spans. With just the cryptic statement *kālakṣetrayoḥ sāmyam,* which roughly means 'time and space are congruent'; *PT* mapped the year of six equal seasons of time expended by humans on earth to six equal spaces of 4½ stars each, on the celestial path along which Sun traversed from winter solstice to winter solstice. It was one more step from here to arrive at the 12 equal divisions of the year and the twelve equal sky parts for Sun travelling through 27 equal star divisions. This was the natural basis for the later twelve *Rāśi* division of the zodiac, but *PT* in the available quotations by later authors does not mention such a nomenclature, nor does it explicitly describe solar months. Parāśara definitely knew the solar tropical zodiac with its first point being the imaginary winter solstice colure in the sky. But there is no reference to any angular measure in the available text attributed to him.

5. Auspiciousness of Time

At this stage one may question how *PT* could have arrived at the names of the equal division *nakṣatras* for demarcating seasons. The answer is contained in the *MAU* model where measure of time is declared as Sun following the *nakṣatras*. It is the early morning rise of the *nakṣatras* that was observed. Some prominent stars, even before *PT,* should have been connected with the natural seasons in popular perception. The nearly equal 13-16 day interval between subsequent rises of some known stars would have given the idea of equal solar *nakṣatra* spans similar to the lunar *nakṣatras* on subsequent nights. To make these points clear in Table 4 the six previously identified *nakṣatras* and their first visibility pattern for the period 1400-950 BC is shown for the location of Puṣkara. In all the six cases the individual star was in the season division assigned to it by *PT*. All the six stars would have been visible in the eastern sky roughly an hour before local sunrise. The visibility dates between the two consecutive stars *Kṛttikā* and *Rohiṇī* differ by about 15 days as expected. The differences between the dates of rise of other stars also fairly match with their position in the scheme of *PT*.

The above points have been over looked by main stream academic indologists who have routinely assumed *nakṣatras* to be the so called lunar mansions meant only for reckoning lunar months by observing the position of moon in the nights. While it is a fact that the *Ṛgveda* clearly implies that month and further the year was measured by the moon, this does not mean over some three thousand years Vedic people had not observed that Sun's position also can be specified with respect to the *nakṣatras*. Concrete evidence for using early morning rise of *nakṣatras* for

ritualistic purpose is available in the *Taittirīya Brāhamaṇa*. The original hymn and its explanation as per the Vedic tradition preserved in the commentary of Bhaṭṭa Bhāskara (10th Century AD) are reproduced below[22].

यत्पुण्यं नक्षत्त्रम्। तद्वट्कुर्वीतोपव्युषम्। यदा वै सूर्य उदेति । अथ नक्षत्त्रं नैति । यावति तत्र सूर्यो गच्छेत्। यत्र जघन्यं पश्येत् । तावति कुर्वीत यत्कारी स्यात् । पुण्याह एव कुरुते ॥
[तै. ब्रा. १.५.२]

yatpuṇyam nakṣattram tadbaṭkurvītopavyuṣam | yadā vai sūrya udeti | atha nakṣattram naiti | yāvati tatra sūryo gacchet | yatra jaghanyam paśyet | tāvati kurvīta yatkārī syāt | puṇyāha eva kurute ||

[*Tai. Brā.* 1.5.2]

[भ भास्करभाष्यम्]
यत्पुण्यमित्यादि ॥ पुण्यकर्मणोऽनुरूपं आत्मनश्चानुकूलं *यन्नक्षत्रं इष्टं तत् बट् कुर्वीत* । बडिति सत्यनाम । तत् सत्यं चिह्नं कुर्वीत । तेन वा चिह्नमाकाशं कुर्वीत । अस्मिन् आकाशावकाशे इदं नक्षत्रमिति । *उपव्युषं* उषस्समीपे विवासनकाले । छान्दसो ङः समासान्तः । पुनः कालं विशिनष्टि – *यदा सूर्य उदेति अथ* तत्पुण्यं *नक्षत्रं नैति* न तिरोहितं भवति तादृशे विवासनकाले तत्पुण्यं नक्षत्रं यत्राकाशावकाशे तिष्ठति तं प्रदेशं सत्यं कुर्वीत अविपर्यस्तं जानीयात् । अथैवं ज्ञात्वा तस्मात् चिह्नितात् प्रदेशात् *जघन्यं* पश्चाद्भागत्वेन *यत्र पश्येत्* तत्राकाशप्रदेशे *यावति* काले *सूर्यो गच्छेत् तावति* ततः प्रागेव *कुर्वीत* अविपर्यस्तः स्वं तत्कर्म *यत्कारी* यत्कर्मकरिष्यन् *स्यात्* । *पुण्याह एव कुरुते* । एवं क्रियमाणं सत्स्वपि दोषेषु पुण्याहे कृतं भवति । अज्ञातानामपि मुहूर्तादि दोषाणां शान्त्यै भवतीति भावः॥

One has to confirm a *nakṣatra* which he prefers for some auspicious work. He has to mark also in the sky 'this space is for this *nakṣatra*'. This has to be done before sunrise, nearer to day break. When Sun comes up, that auspicious star will not be seen. Hence that particular space in the sky wherein the star remains still visible has to be confirmed. Or knowing this part of the sky marks may be done. The rite has to be completed before the time taken by Sun to cover that space.

The word *baṭ* refers to fixing or confirmation. This could also mean making a mark by some means for the position of the desired star. *Uṣas* is the twilight period. But *upavyuṣam* is when the sky is still illuminated for the star to be visible. The lower point or mark denoted as *jaghanyaṃ* is such that the person is confident of the visibility interval of the star. One is asked to view the desired *nakṣatra* when it is visible in the eastern sky before sun rise and also to mark or make sure of a point below. This point at a lower altitude is such that as Sun reaches this point the star vanishes from sight. The dictum of the Vedic text is to observe the rise of a desired star among the twenty seven recognized *nakṣatras* early in the morning and to have an estimation of the time taken for Sun to make the selected asterism invisible. The work done in such a period is deemed to have been done at an appropriate time without any doubt about the auspiciousness of the time. Quite interestingly this belief in the auspiciousness of time, an hour-and-half before sunrise continues to this day in many parts of India. This practice of early morning observation, in the absence of any other time measuring instruments, would have made the visible *nakṣatras* as supports for getting a sense of elapsed time. The commentary of Sāyaṇācārya (14th Century AD) on the above text is similar in its emphasis on early morning observation of the rise of the *nakṣatras*[23]. The above practice, in course of time, would have demonstrated to the observers that a particular *nakṣatra* appears for the first time in a year in the east before sunrise to be followed by the next *nakṣatra* in the sequence after 13-14 days.

Table 3 and Table 4 demonstrate that if all the six prominent stars should have been visible and stationed within their eponymous divisions the possible epoch has to be accepted as 1350-1130 BC. This result naturally brackets the most probable date of Parāśara's solar zodiac scheme.

6. Rise of *Agastya* and Sun in *Hasta*-Division

The background for *PT* specifying that *Agastya* rises when Sun is in *Hasta* is made reasonably clear by the season zodiac discussed

above. As per *PT* season *Varṣā* ends at the last point of *Hasta* division which is same as the beginning of season *Śarat*. *Agastya* rose when Sun was in this *Hasta-nakṣatra* division. Quite obviously the lunar month *tithi* positions of (*PT*.2) would have been too approximate to time the rise of *Agastya* correctly for observing prescribed Vedic rites. This should have been a strong motivation for *PT* to continuously observe *Agastya* and arrive at its novel solar zodiac scheme of equal *ṛtu* divisions of 4½ *nakṣatra* lengths. However, like with the six individual stars being heliacally visible some time during the notional astronomical seasons, *Agastya* should have risen when constellation *Hasta* was visible in the eastern sky, such that Sun was still below the horizon. This point needs some further discussion with respect to the place of observation. As we have seen previously, *PT* has connections with the *Kṛṣṇa-Yajurveda* texts that prescribe observation of early morning rise of stars. Hence Kurukṣetra as a reference place for *PT* appears reasonable. To be on the safer side we include Puṣkara and Gagnāni also as possible alternates for further analysis. As a preliminary interpretation of (*PT*. 2) the early morning sky picture at Kurkṣetra on 21st September of year -1300 when *Agastya* would be visible on the southern horizon is shown in Fig.1 using the Stellarium software (www.stellarium.org). It can be observed that sun was still 10º below the horizon and the constellation *Hasta* would be clearly visible in the eastern sky. The predominant star γ-Corvi was more than 8° above the horizon at Kurukṣetra. Hence for the epoch of *PT* a relation between *Hasta* and *Agastya* was natural. Within a few minutes it would be day light and the star becomes invisible. Thus any naked eye observer would remember the position of Sun as that patch below or very near to the constellation *Hasta*.

On similar lines the evening sky view for Puṣkara on 16th April -1200 is shown in Fig.2. Canopus was approaching its last visibility which was on 24thApril. Star *Rohiṇī* would have been visible in the western sky very near its last visibility. Again it may be noted that the setting of Canopus was coeval with the western visibility of Aldebaran. Like with its rise, the setting of *Agastya* got observationally associated with Sun being near to *Rohiṇī*. The above two sky pictures indicate the reason for Parāśara to bring in solar *nakṣatra* divisions of (*PT*.3) in stating the visibility

Table 4. First Visibility of six prominent stars (critical altitude = 4°) at Puṣkara, during 1400-950 BC. Results are from the PLVS software with separate provision of arcus visionis for each star depending on its magnitude

Support Star	***Nakṣatra* Division Long.**	**Star position Long.**	**F. V Date**	**Sun at F.V. Long.**	**Sun rise L.T**	**Star rise L.T.**	***ṛtu***
Kṛttikā (η-Tauri)	3°20′-16°40′	12º51′-19º03′	12.5-15.5	37º42′-43º 29′	5.51-5.46	4.44-4.39	Vasanta
Rohiṇī (Aldebaran)	16°40′-30°00′	22º36′-28º48′	27.5-30.5	51º58′-57º46′	5.39-5.37	4.45-4.40	Vasanta
Maghā (Regulus)	96°40′-110°00′	102º54′-109º04′	6.8-10.8	120º12′-126º57′	5.47-5.49	4.49-4.51	Varṣā
Citrā (Spica)	150°00′-163°20′	156º44′-162º56′	28.9-2.10	172º52′- 179º34′	6.18-6.22	5.27-5.29	Śarat
Viśākhā (α-Libra)	176°40′-190°00′	177º59′-184º10′	25.10-28.10	193º07′-199º49′	6.35-6.37	5.16-5.20	Śarat
Jyeṣṭhā (Antares)	203°20′-216°40′	202º38′-208º50′	13.11-16.11	219º38′-225º18′	6.48-6.51	5.54-6.00	Śarat-Hemanta

condition for *Agastya*. It is equally well possible the importance of the visibility and set of *Agastya* provided the motivation for developing the season solar zodiac.

The above analysis helps one to get a better understanding as to how ancient should have been the tradition of *PT* during the time of VM. The difference in the epochs of VM and Parāśara can be visualized by the simulation of the early morning rise of *Agastya* at Ujjain shown in Fig.3 for 530 AD. The constellation of *Hasta* was well below the horizon and naturally *PT* statement would have been taken as incorrect by VM and by his commentator Utpala. The star that was rising at the eastern horizon at Ujjain can be easily identified as Regulus. As per *BS*, Sun was 7° behind the beginning of sign Virgo. That is Sun was in *Simha Rāśi*, at longitude 143° and this was quite accurate for the era of VM as per the twelve *Rāśi* zodiac taking the equinox to coincide with the first point of star *Aśvinī*. The amount of precession between the epoch of *PT* and that of *BS* would be 23º20′ which number was first computed by William Jones correctly though not with reference to rise of star *Agastya*.

The above discussion helps us to understand that the phrase *hastasthe savitari* in (*PT*. 2) should not be taken in its literal sense as Sun staying at/in/near star *Hasta*. It is the star division of that name as defined by the season zodiac of (*PT*. 3) in which Sun is said to be stationed. This does not mean that the stars γ-Corvi (Gienah) and Aldebaran should not have been visible within a few days interval. It is the near

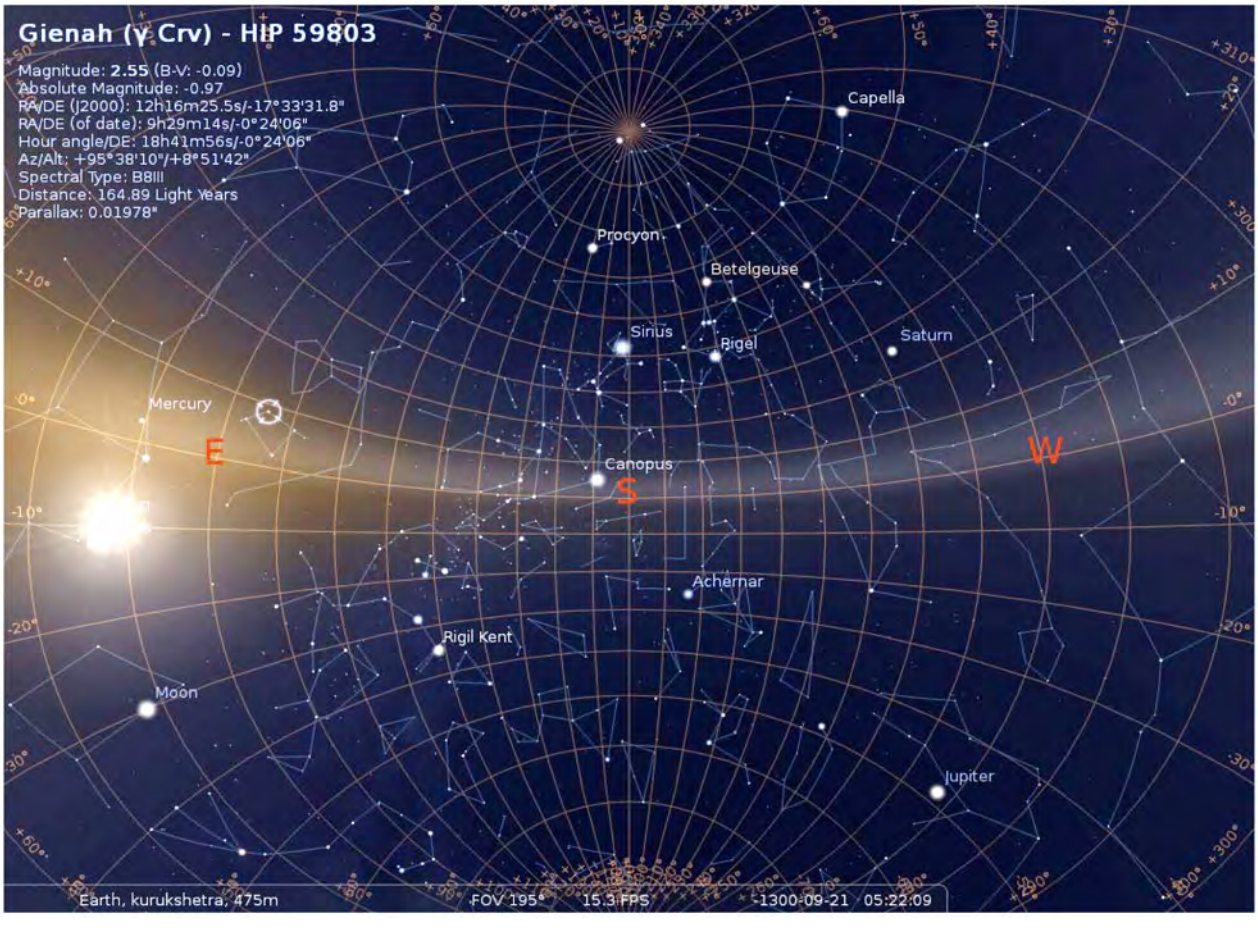

Fig. 1. Early morning sky picture at Kurukṣetra for 21st September -1300 with Agastya in the southern sky and constellation Hasta (Corvi) rising in the eastern sky.

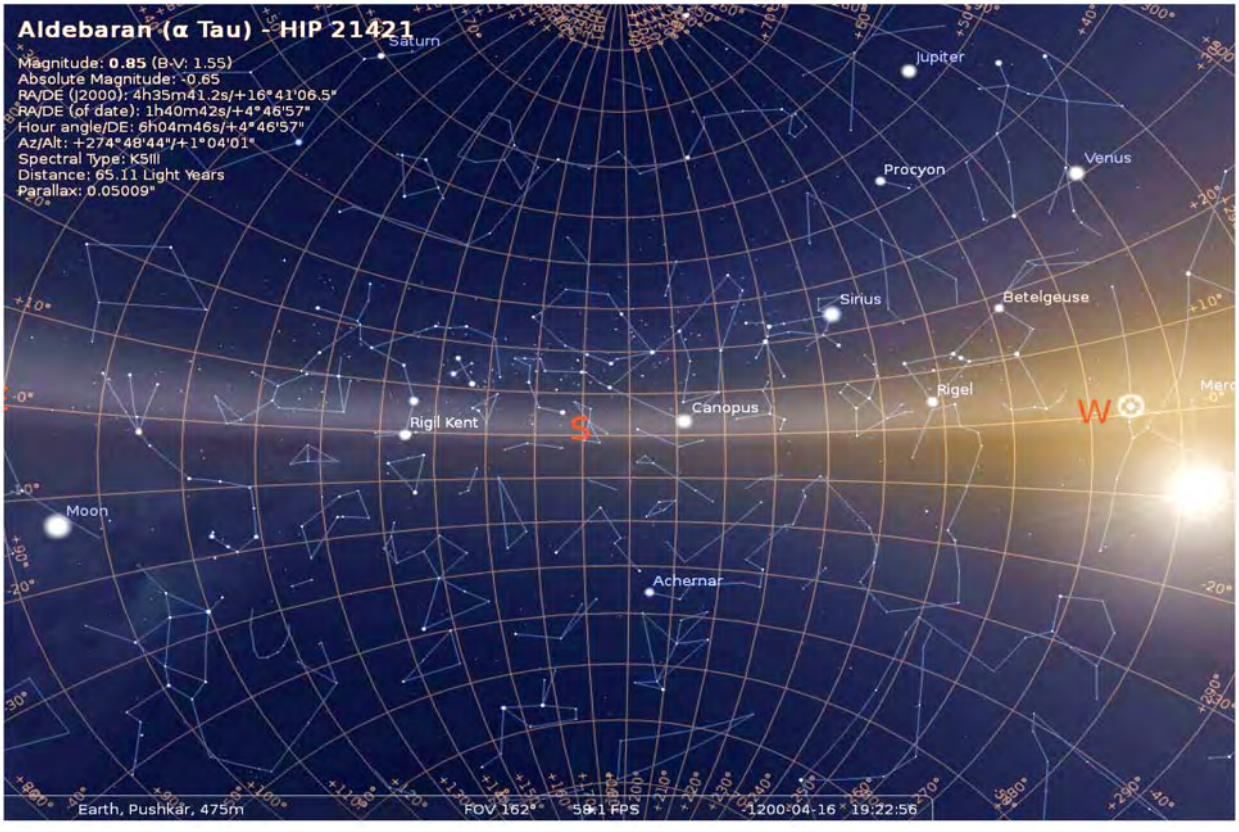

Fig. 2. Evening sky picture at Puṣkara for 16th April -1200 with Agastya in the southern sky near its last visibility for the year. Rohiṇī was visible in the vicinity of the date in the western sky after sun set.

simultaneity of the first visibility *(udaya*) and last visibility (*praveśa, pravāsa, asta*) of *Agastya* with the respective morning rise and evening set of the above two *nakṣatras* that has lead to the concept of referring to Sun being in those star divisions.

7. First and Last Visibility Dates

To complete the analysis of Parāśara's observations on *Agastya* one more step is remaining. This is to acquire the visibility dates and longitude of Sun for the epoch of *PT*. The software PLVS comes in handy for this purpose. This has provision of varying *arcus visionis* that is the minimum vertical separation needed between sun and a chosen star for visibility of the star on the same horizon. The software also has option for changing the critical altitude of visibility of a star to account for atmospheric perturbations at the horizon. But this parameter is unknown for ancient star observations. We can however reason out that for the naked eye visibility of star *Agastya*, emerging from below the horizon for the first time near the end of the rainy season, on a yet unknown date, some altitude would have been essential. On the other hand once it was visible in the evening sky nearer to the spring equinox the observer had to only follow it and hence could see it vanish almost at zero altitude. Dates of first and last visibility of *Agastya* at three different locations for two altitude values are shown in Table 5 and Table 6.

These tables provide a further rational basis for understanding the statements of *PT*. The *Hasta-division* in the scheme of *PT* extended from 136º40′ to 150º00′. As per the first visibility shown in Table 5 for altitude values of (0º- 4º) *Agastya* would have been visible at Puṣkara when Sun was in the *Hasta-division*. For other places also this

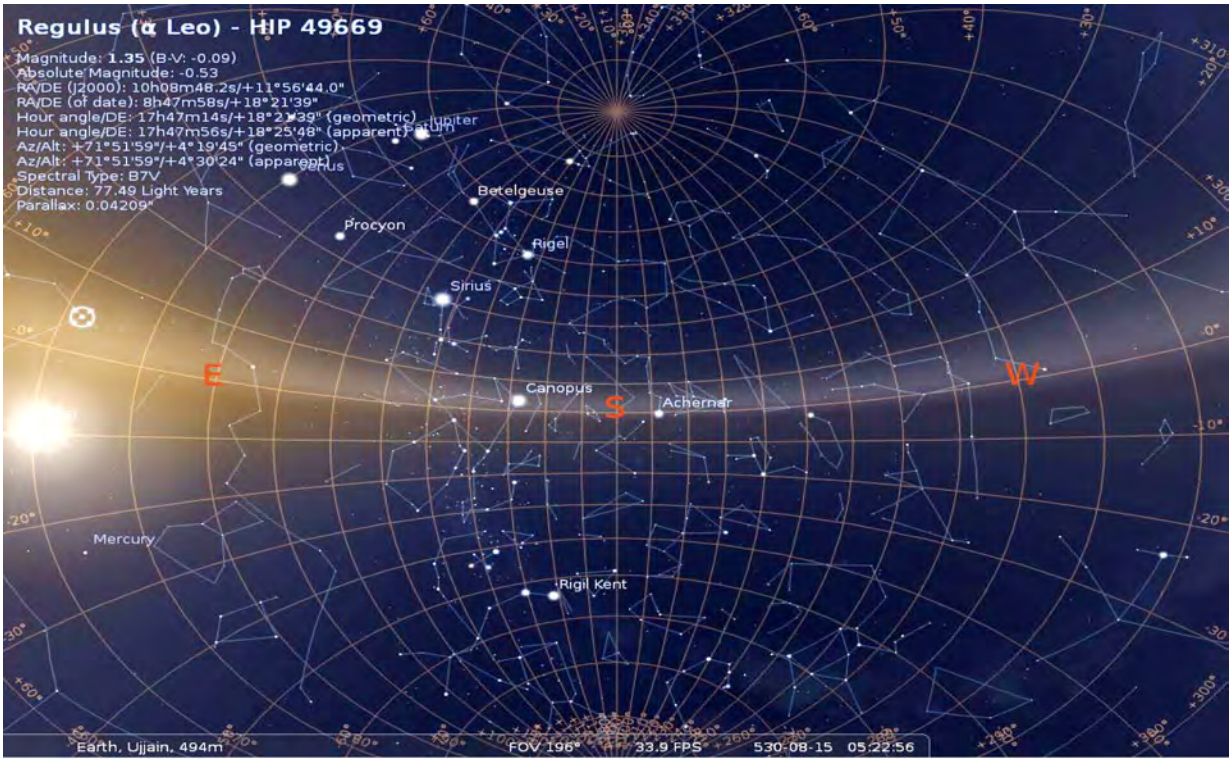

Fig. 3. First Visibility of Agastya (Canopus) at Ujjain on 15th August 530 AD. Constellation Hasta was well below the horizon. Star Maghā (α-Leonis) was above the horizon.

would be valid if the altitude for observing *Agastya* were to be reduced to zero degree which, however does not appear to be realistic.

The *Rohinī-division* of Parāśra's zodiac was from 16º40′ to 30º00′. Again the condition of Sun in the *Rohiṇī-division* gets satisfied at Puṣkara for altitude of visibility between 0º and 4º. But at the other two places the condition is not satisfactory. We have previously noted that for last visibility zero altitude may be sufficient. Under this argument at Kurukṣetra, Sun in *Rohiṇī-division* would be acceptable but the observation year slides towards *c* 950 BC. These results point in the direction of *Puṣkara* as the place of composition of *PT* where, Parāśara is said to have held his discourse.

8. Conclusion

The efforts of Parāśara culminated in proposing a zodiac with six equal *seasons*, which were not strictly experiential based on weather, but each of four-and-half *nakṣatra* length along the ecliptic harmonizing with the heliacal visibility of some of the prominent *nakṣatras* and the southern star *Agastya*. Fixing the solstice point precisely might not have been possible, but this as the starting point was the best naked eye observational option. Some of the Vedic *nakṣatras* could not have been observed before sunrise in their assigned periods simply because they were at unequal distances. But taking an astronomical definition of six equal divisions of the year, each comprising of 4½ *nakṣatras*, at least some of the stars handed down by the Vedic tradition could be seen in the putative seasons. The solar season scheme of (*PT*.3) represents a scientific development of considerable significance in the history of Hindu astronomy. The six division *ṛtu* zodiac evolved as an improvement over the older two division *ayana* zodiac of *MAU*. Vṛddhagarga seems to have changed the notation of *six-ṛtu* to

Table 5. First visibility condition for *Agastya* (Canopus) in the period 1400-950 BC

Star Agastya	**Puṣkar 26º30′N76º33′E**		**Kurukṣetra 30ºN76º45′E**		**Gaganāni 30º55′N 78º40′E**	
Critical altitude	F.V. Date	Sun's Longitude	F.V. Date	Sun's Longitude	F.V. Date	Sun's Longitude
0°	23.8-22.8	136°55′-138°44′	1.9-30.8	145º50′-146º37′	4.9-2.9	148º48′-149º35′
4°	3.9-1.9	147º49′-148º36′	15.9-12.9	159º47′-159º31′	19.9-16.9	163º48′-163º30′

Table 6. Last visibility condition for *Agastya* (Canopus) in the period 1400-950 BC

Star Agastya	**Puṣkar 26º30′N76º33′E**		**Kurukṣetra 30ºN76º45′E**		**Gaganāni 30º55′N 78º40′E**	
Critical altitude	L.V. Date	Sun's Longitude	L.V. Date	Sun's Longitude	L.V. Date	Sun's Longitude
0°	25.4-25.4	22°06′-25°01′	16.4-16.4	13º30′-16º24′	13.4-14.4	10º37′-14º29′
4°	14.4-14.4	11º35′-14º29′	1.4-2.4	359º07′-2º57′	28.3-29.3	355º15′-3º59′

six-rāśi, where the word *rāśi* meant a group of 4½ *nakṣatras*. This we see clearly in the commentary of Somākara on the fifth verse of the *Vedāñgajyotiṣa*, where Garga is quoted[24]

> *nakṣatrāṇām sarvāsām ṣa**ḍrāśītānām***
> *ādiḥ śraviṣṭhā |*

This essentially means that the beginning of the six *rāśis* (groups) of the 27 stars was taken from *Śraviṣṭhā*, which was the winter solstice indicator in the *PT* and in the *Vedāñgajyotiṣa*. *Vṛddhagarga-saṃhitā* under variant names is available in the manuscript libraries. Two such manuscripts[25, 26] have been verified by the present writer for the correctness of the above statement.

The later twelve *rāśi* solar zodiac must have been a natural development of the above model. The concept of the equinoctial-day with day and night being equal would have been certainly available to *PT*, but this is not strongly reflected in the available text portions. It is surmised that the idea of the ecliptic and the celestial equator intersecting at the equinoctial point had to wait for some more years so that the zero point of the Vedic solar zodiac could be shifted from the winter solstice to the spring equinox, for which progress of Indian astronomy Parāśara had laid the foundation.

The date of *c* 1400 BC proposed previously as the starting period of the *PT* tradition is still valid as per the analysis of the position of six prominent visible stars in the scheme of Parāśara. The *Parāśaratantra* solar *nakṣatra* division statements on the heliacal rise and set of *Agastya* were correct for the epoch of 1350-1130 BC and the observations were most probably carried out in the Puṣkara-Kurukṣetra region.

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Notes & References

1. *viśvāmitro jamadagnirbhāradvājo'tha gautamaḥ| atrirvasiṣṭhaḥ kaśyapa ityete saptaṛṣayah|| saptānām ṛṣīnām agastyāṣṭamānām yadapatyam tadgotramityācakṣate||*
(*Āśvalāyana Śrauta Sūtra; Pariśiṣṭa*)

2. *ṛṣayah saptātriśca yat| sarve'trayo agastyaśca| nakṣatraiḥ śaṃkṛto'vasan||*
(*Taittirīya- Āraṇyaka* 1.11.2)

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4. *Mahābhārata, Udyoga Parvan*, Ch.17, v. 14-18. (BORI, Pune Critical Edition).

5. *dhruvaḥ prajvalito ghoram apasavyam pravartate* (*MB Bhīṣma-parvan* Ch.3, v. 17b)

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10. *prākṛtāvimiśrasañkṣiptatīkṣṇayogāntapāpākhyāḥ| sapta* ***parāśaratantre*** *nakṣatraiḥ kīrtitā* gatayaḥ || (BS 7.8)

11. *Parāśarasiddhāntaskandhāḥ*, Catalogue No.103 of 1873-74; cupboard 29. BORI, Pune.

12. Iyengar, R.N. *Parāśaratantra; Reconstructed text with Translation & Notes*, Jain University Press, Bangalore 2013.

13. *dṛśyate sa kila hsatagate'rke rohiṇī-mupagate'stamupaiti|| (BS 12.21b)*

14. *yadyapi atra gaṇitasāmyam na bhavati tathāpi ācāryeṇa pūrvaśāstradṛṣṭatvāt kṛtam||* [Utpala's commentary on *BS* (12.21)]

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17. *Maitrī* or *Maitrāyaṇīya Upaniṣad with Commentary of Rāmatīrtha* (Ed. Transl.) E.B. Cowell London, 1888.

18. *Sacred Books of the East; The Upanishads* Vol.2, (Transl). Max Mueller, 1888.

19. *punarvasū sūnṛtā cāru puṣyo bhānuraśleṣā ayanam maghā me|*
(*Atharvaṇa Veda Samhitā* 19.7.2b*)*

20. *ṛtubhirhi samvatsaraḥ śaknoti sthātum|*
(*Śatapatha Brāhmaṇa* VI.7.1.18)

21. *tasya ṣḍvimśatirardhamāsāstrayodaśamāsāḥ saptartavo dve ahorātre |*
(*Śatapatha Brāhmaṇa* VIII.4.1.25)

22. *Taittirīya Brāhmaṇa with Commentary of Bhaṭṭa Bhāskara*. Vol. I (Ed.) A. Mahadeva Sastri, Oriental Research Institute, Mysore, 1908.

23. *Taittirīya Brāhmaṇa with Commentary of Sāyaṇācārya.* Vol. I (Ed.) Narayana Shastri Godbole, Anandashrama Series No.37, Pune, 1979.

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25. *Vṛddhagargasaṃhitā*, Mss. No. 8199(2)-ASB, f.44. The Asiatic Society, Calcutta.

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