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Historical Notes

On the Visibility of Agastya (Canopus) in India

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Abstract

Present paper is an attempt to take a computational approach to the heliacal phenomena of Agastya or Canopus, brought to light recently by Iyengar based on *Parāśara-tantra.* Interpretation given for the Parāśara rule i.e. the Hastā nakṣatra and Canopus had a coeval heliacal rise instead of the solar position on Hastā is re-examined. It has been shown that the correlation seen between the visibility of Agastya and the sun's longitude is very true and based on observations which can be traced back to 3000 BCE. Further, Agastya legends involving Mitrā and Varuṇa had their genesis in the observation of Agastya at northern latitudes like 26.5N where in the heliacal rise at dusk and dawn corresponded to the sun's transit over Jyeṣṭhā (deity is Mitrā) and Śatabhiṣak (deity is Varuṇa) respectively. Parāśara rule dated to 1500 BCE prescribed the solar position in terms of *nakṣatra* for the heliacal rise and set of Canopus. Study also brings out that the Aśvayuja and Kārtika *tithis* mentioned by Parāśara corresponds to different epochs. Existence of sidereal nakṣatra divisions anterior to the hitherto known history of astronomy is illustrated using the textural evidence from *Paňcasiddhāntikā and Maitrāyaṇī Upaniṣad.*

Key words: Agastya, Canopus, Visibility, Pot-born legends, *Parāsara-saṃhita*, Agastyodaya, Sidereal Zodiac, *Nakṣatra Cakra*, *Maitrāyani Upaniṣad, Viṣṇu Purāṇa*

1. Introduction

Iyengar (2014, pp. 223-238) has discussed the heliacal visibility of the star Agastya (Canopus) with reference to Parāśara's six season solar zodiac credited 1350-1130 BCE. Present author begs to differ from the speculation given by Iyengar about the six seasons zodiac defined mathematically and then interpreted seasonally leading to conflicts. As for example, the mathematical six season zodiac presented shows the end of rainy season with the end of Hastā nakṣatra in 1350 BCE which is impossible given the rainy season extending for 3 months in India up to the autumnal equinox. A six seasonal zodioc is artificial for Indian Experience and tracing the origin of Agastya related precepts to artificial seasons gives the impression that term season implies experience. Legends such as the crossing of the Vindhya mountain range by the sage and the correlation given in the ancient literature for Agastya and the Seven Sages (Saptarṣis) are brought out clearly in the discussion.

Against the background of the Vedic references to Agastya, Iyengar presented the discussion in *Parāśara Tantra* to highlight the

[1] Bentlley's work in English uses the word 'enters' and the part of the text is copied here for reference to the *heliacal* rising of *canopus* in his time, which it is proper to notice here. He states, that *" the star Agastya (or Canopus) rises heliacally when the sun enters the Lunar Asterism Hastā, and disappers or sets heliacally, when the sun is in* Rohini."

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sightings of Canopus during 1100 – 1350 BCE. Past studies in the field has been probably ignored because of their irrelevance but the present author would like to record here for completion sake that it was John Bentley (1825) who brought out the astronomical discussions of Parāśara for the first time. Bentley's discussions are somewhat biased against Indian astronomers, yet it qualifies to be remembered when more refined studies are attempted. Bentley (1825, reprint 2013) quotes Parāśara-

> "the star Agastya (or Canopus) rises heliacally when the sun enters the Lunar asterism Hastā and disappears or sets heliacally when the sun is in Rohini"[1]

In continuation, Bentley computed the sun's longitude (from the vernal equinox) for the heliacal rise of Canopus as $145^0 10$ at the epoch 575 BCE and showed that it matched with the beginning of Hasta for the epoch. He has also quoted Varāha Mihira's to bring out that the Canopus rose heliacally at Ujjain when the sun was 7^0 short of Virgo or 23^0 Leo.

The paper under study has brought to light oldest records of observational astronomy in India. But the study has relied exclusively on planetarium software tool and the epochal screen shots do not help in establishing the phenomenon. Visibility dates have been given for Kurukṣetra (30^0 Latitude) and Puṣkara ($26^0.50$N) but their accuracy is limited by the software tool used by the author.For example Iyengar states that –

> "From rise above the horizon to set, the time interval required for star Agastya would be 4-5 hours".

By the standards of modern research, more realistic calculations should be done given the fact that the Declination of Canopus is available for all epochs in all software tools. The diurnal arc for the star can be easily computed and it had varied from 3 hours in 4000 BCE to 5.5 hours in 550 CE.

Kausika's observations can be subjected to a closer examination to settle the confusion in respect of the visibility of Agastya to Indian horizons during the historic period.

2. Agastya at Puṣkara (26.50N) and Kurukṣetra (300N)

Iyengar has quite rightly inferred that Agastya as a new bright star would have been visible at Kurukṣetra for the very first time in the year 3900 BCE from 8th October to 14 October for about 30 minutes before local sunrise. Here the issue of visibility may crop up. Dreyer in his work *History of the Planetary Systems* has referred to the Hipparchus observations of Canopus at Rhodes when the meridian altitude of Canopus had been only $1^0 16'$ and it is well-known that the atmospheric refraction has a lifting effect. The angle of deviation for viewing an astronomical object by an observer or the refraction correction angle applied for a standard atmosphere is 34 arc minutes and the same has been applied in all the computations of altitude presented (Thomas and Joseph, 1996, p. 282). It can therefore be inferred that the Canopus with an altitude of 2^0 above the horizon could indeed command the attention of the ancient Indian observers of the sky.

The precise calculation[2] for the rise and set of Canopus have been carried out at different epochs for Kurukṣetra, Puṣkara with declinations derived from the software Cyber sky 5.0 and the data may be summed up as given in Table-1:

2 Calculations of the dawn and dusk phenomenon are made by the author on excel spread sheet using the respective epochal declinational values of Canopus and other elements from the Sky Map pro software tool and the standard algorithms have been used.

Table-1: Declination of Canopus 4000 BCE to 0 CE

Epoch	Declination Canopus	Meridian Altitude		Remarks
		Lat 26.5 N	Lat 30 N	
4000 BCE	-58.4758	5.03	1.55	Two latitudes chosen for comparison and just visible at 300N with Canopus grazing on horizon
3000 BCE	-56.3267	7.18	3.70	Epoch of the Mythical flood
2000 BCE	-54.6106	8.89	5.42	End of the Harappan Phase
1000 BCE	-53.3628	10.15	6.67	Vedic Phase
0 CE	-52.6101	10.90	7.42	Beginning of Common Era

Results of computation are displayed as plots where in the altitude is plotted against the sidereal longitude for both dawn and dusk defined as the beginning of the astronomical twilight (-18^0 dip of sun). It may be noted here that the sidereal zodiac used Mūlā as the fiduciary star at 240^0 and it had been the seat of autumnal equinox in 4136 BCE. As far as the limits of signs or *rāśis* are concerned (although *rāśī* was not used), the difference between Citrā and Mūlā fiduciary status cause only less than 1^0 difference.

Fig.1 below brings out the salient features of the heliacal rise of Canopus or Agastya. 30^{0}N, 77^{0}E were chosen as representative coordinates for places in the Himalayan Valley where the civilization and different ancient republics have sprouted since antique times. Diurnal phenomena existed for nearly 90 minutes and for nearly 30 days when the astronomical twilight is considered as reference for dawn and dusk at which Canopus could have been observed. Dip at the horizon was taken as (-)34 minutes. Canopus had an altitude of more than 1 degree for 18 days as may be noted from the curve for 4000 BCE and the southern star could be noticed at the earliest when sun transited over Antares or opposite Aldebaran. Acronychal rising of Aldebaran (α-Tauri) coincided with the appearance of Agastya in the south. Equinox had been at 58.2^0 from the sidereal zero point adopted for the epoch 4000 BCE.

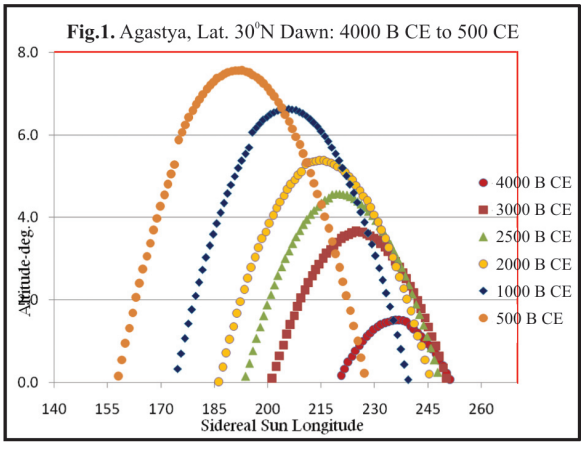

Fig. 1. Agastya, Lat. 30° N Dawn: 4000 BCE to 500 CE

The setting of Canopus likewise is shown in Fig.2. Canopus disappeared below the horizon as the sun transited over the Pleiades after being visible over the horizon with altitude 1^0+ for nearly 20 days.

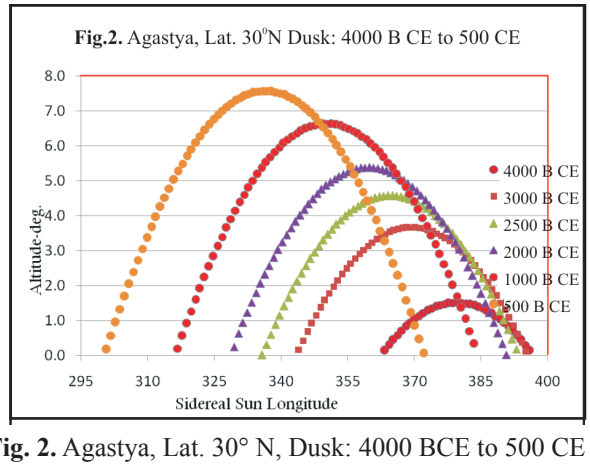

Fig. 2. Agastya, Lat. 30° N, Dusk: 4000 BCE to 500 CE

The heliacal setting below 1 degree altitude happened for the solar transit into Taurus but given the present state of studies on the origin of zodiacal signs, it is quite unlikely that the notion of Taurus division of 30^0 existed at the epoch.

3. Agastya at Puṣkara (26.5° N) – Illustrations 4000 BCE to 500 CE

Puṣkara at 26.5N is one of the locations adopted by Iyengar for Parāśara of 1350 BCE. The lower latitude alters the phenomenon in terms of altitude and the same can be noted from Figs.3 and 4. The celestial configuration of the phenomenon and the correlations with the solar movement *vis-à-vis* luni-solar calendar had been different at the lower latitude of 26.50 N where the Indus-Saraswatī civilization flourished in subsequent times.

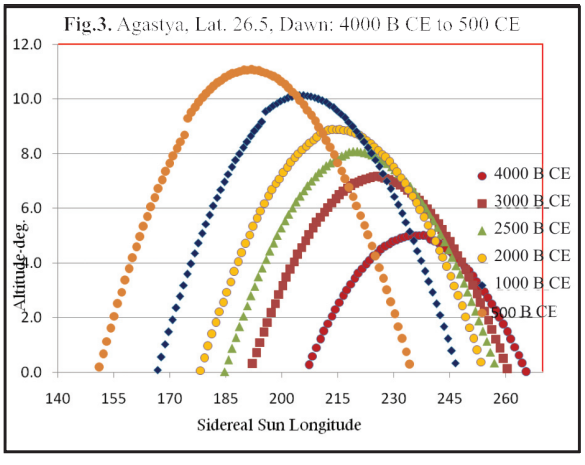

Fig 3. Agastya, Lat. 26.5° N, Dawn: 4000 BCE to 500 CE

For dusk the computational results are presented in Fig.4.

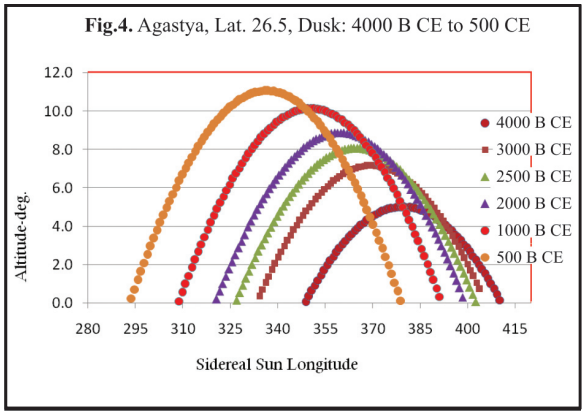

Fig 4. Agastya, Lat. 26.5°N, Dusk: 4000 BCE to 500 CE

Astronomical Configuration of the phenomena

Astronomical configuration of the Canopus rise and set events is worth taking note of as given in later legends on Mitrā (Antares) and Varuṇa as the progenitors of Agastya. The popular legend on Agastya as born in a pot or Kuṃbha, Rk 7.33.13 finds its elaboration in the Bṛhaddevatā of Śaunakā (Macdonnel, 1904, p.62)[3]:

Patton (p.267) has given a English translation of the text.

"A pair was born of her (Aditī) – Mitrā-Varuṇa. Of these two Adityas, having seen the Apsaras Urvaśī in the sacrificial session, the seed was spilled. That (seed) fell into a jar of water that stood overnight. Therefore at that moment virile ascetics came into being, the two *ṛṣis* Agastya and Vasiṣṭhā. The semen having fallen in many fold ways – in a jar, in water, on the ground – the sage Vasiṣṭhā, best of *ṛṣis* came into being on the ground; Agastya came into being in a jar while Matsya of great brilliance in water. Agastya of

[3] त्वष्टापूषातथैवेन्द्रोद्वादशोविष्णुरुच्यते।द्वन्दंतस्यास्तुतज्जज्ञेमित्रश्चवरुणश्चह।तयोरादित्ययोःसत्रेद
ष्ट्वाप्सरसमुर्वशीम्।रेतश्चस्कन्दतत्कुंभेन्यपतझासतीवरे।तेनैवतुमुहूर्तेणवीर्यवन्तौतपस्विनौ।अगस्त्य
श्चवसिष्ठश्चतत्रर्षीसंबभूवतुः।बहुधापतितेशुक्रेकलशेअथजलेस्थले।स्थलेवसिष्ठस्तुमुनिःसंभूतऋषिसत्त

great glory then arose, the measure of a stick *(samaya)*. Because of being measured with a measure, therefore he is here called Manyā. Or because the *ṛṣi* was born from a jar, by a jar also measurement is made"

Available literary evidence did not help us to draw any connection between the Kumbha referred to and the constellation of the same name known in later times. But it is worth noting in the illustrations provided Fig. 2 and 4 that the Canopus rose in the north Indian latitudes and became visible coinciding with the solar sidereal longitude falling within 300 – 330 which included the constellation of Varuṇa (Śatabhiṣak) around 2500 BCE. Also Fig.1 and 3 depicts the visibility of the dawn phenomena coinciding with solar transit of 210-240 which included the constellation of Mitrā (Antares). Deities Varuṇa and Mitrā can be taken as synonyms of the *nakṣatras* Śatabhiṣak and Anurādhā relying on *Taittirīyaśruti* and other related literature as explained by Dikshit (1969, p.81).

In the light of the astronomical configuration emerging from the computations, it can be inferred that the legends relating to Agastya and Kumbha had an astronomical origin in some distant past like the Harappa-Mohenjodaro epoch of 2500 BCE. It is worth remembering that the Tamil tradition also ascribes the name Kuṭamuni to Agastya, implying a connection to Kuṭam or Kumbha.

Illustrations Fig.1 to 4 help us to have more clarity on the visibility of Agastya at different epochs such as 3000 BCE, Harappa-Mohenjodaro 2500 BCE, 2000 BCE, etc and 550 CE.

1. Epoch of the Mythical Flood 3000 BCE

Indus-Saraswatī Civilization had its beginning and many cities emerged south of the 30^0N latitude of Kurukṣetra. The change in 1000 years for the observations at dawn includes the altitude touching nearly 4 degrees and the first visibility shifting from Anurādhā to Viśākhā. Fig.6 of the observations at the beginning of astronomical twilight has driven first visibility to the solar transit over Pisces – to the month of Caitra – and Agastya dipped into horizon when sun transited the Kṛttikā. Here the visibility began with the solar transit over Pisces close to the junction with Aquarius.

2. Harappa-Mohenjodaro epoch 2500 BCE

No astronomical references of the period have come down but the ancient practice of associating the seers with the stars and the use of myths as a means to encrypt wisdom suggests that the myths associated with Agastya may have some astronomical basis. Epoch 2500 BC marks the mature Harappan period and the astronomical elements suggest that the star Canopus could not have missed the attention of the Harappans. Iyengar had taken an altitude of 4^0 as critical for observation of Canopus even though Hipparchus is said to have observed Canopus for even 1^0 altitude at Rhodes. With 4 degree altitude, it is seen that the sun had a sidereal longitude of 165^0 and hence close to the end of Hastā as we find quoted by Parāśara in his *Tantra*. It becomes apparent from the picture that it is meaningless to talk of any precise solar position and an epoch unless and until the reference altitude is mentioned. Iyengar has used Puṣkara as a location for Parāśara and the latitude 26.5N very well serves the Harappan sites also given the known extensions of the Indus-Saraswatī civilization to the regions of Gujarat. The illustrations that gives the impression that the star Canopus is rising out of the zodiacal sign Kuṃbha and the Bṛhaddevatā legend even speaks

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मः।कुम्भेत्वगस्त्यःसंभूतोजलेमत्स्योमहाद्युतिः।उदियाययतोअगस्त्यःशम्यामान्नोमहायशः।मानेनसं मितोयस्मात्तस्मान्मान्यइहोच्यते।यद्वाकुम्भाद्दृषिर्जातःकुम्भेनापिहीमीयते।।

of Matsya as another co-born, an allusion to the zodiacal sign Pisces. Many scholars however do not agree to the origin of the concept of *rāsi* at such early phase.

3. Vedic Phase & Parāśara epoch 1500 BCE

Iyengar has given the picture (Fig.1 of p.234) of the morning (21 Sept -1300 CE) sky from a planetarium software to demonstrate the coeval rise of Agastya and Hastā (Corvus) which does not corroborate with the text. None could have observed Canopus after sunrise and the explanation given for Parāśara's precept is based on the phenomena using software tool which is not realistic.

Astronomical discussion given on the precept ascribed to Parāśara by Iyengar is questionable as may be noted from the following facts:

1. Parāśara rule is – "Agastya rises when sun is stationed in Hasta; sets when sun is in Rohiṇī. Three types of rising times are seen for Agastya; the eighth *(tithi)* or the fifteenth *(tithi)* of the bright fortnight in the month of Aśvayuja or the eight tithi of the Kārtikā month" (Iyengar, 2014., p.226)
2. Iyengar states – "The second sentence above states three lunar positions for first visibility. The month Aśvayuja and Kārtikā being lunar, the corresponding visibility mentioned are not helpful in the absence of evidence on how intercalation was carried out to synchronize the lunar and solar years... "

Intercalation rules of Parāśara are available in *Vedāṅga Jyotiṣa* (Dixit, 1969, p. 69) and even if those are not sufficient, the possible schemes can be worked out based on the present practice and information based on historical calendar reckoning. 8th& 15th of Aśvayuja and also to 8th of Kārtikā indicate a shift of one month in the heliacal rising of Canopus as observed in ancient times. These are demonstrated in the previous section. The result is that the first visibility at dawn had slided west to east on the solar zodiac from Anurādhā to Hastā during 4000 BCE to 1500 BCE.

3. Iyengar interprets the precept of Parāśara of the heliacal phenomena of Canopus with lot of confusing statements. Here the unambiguous statement should be recalled from *Maitrāyaṇi Upaniṣad* about the *nakṣatra* division and the two halves 120^0 - 300^0 anticlockwise from Āśḷeṣā to Dhaniṣṭhā-middle at 300^0 and Maghā beginning with 120^0 and ending at 300^0 clockwise. Parāśara's epoch is $06^040'$ Āśḷeṣā as Iyengar has observed on the basis of the ancient statements and it meant the solstice at the middle of Āśḷeṣā (113020') and the equinoxes across ($23^020'$ to $203^020'$).

Thus the epoch can be easily fixed as around 1460 BC without invoking the complicated arguments which are only qualitative as done by Iyengar.

4. Based on planetarium pictures which do not address the first heliacal visibility of Canopus, Iyengar has interpreted the Parāśara's rule as referring to the constellation rising above the Sun in the east. It is doubtless as to whether any astronomer ancient or modern shall make such a statement. Sun's position stated as for example in Hastā for the visibility of Agastya is interpreted as the mention of heliacally risen constellation of the ecliptic which is possible only when sun is actually in another *nakṣatra* such as Citrā.
5. Parāśara's statement was taken part by part to declare the reference to the lunar dates as ambiguous and the rest as referring to what the author has imagined out of planetarium tool pictures.

We shall focus on the astronomical aspects of the heliacal rise phenomenon of Canopus for 1500 BCE at Puṣkara with the specific illustration

as given in Fig.5 below. Declination of Canopus had been (-) $53^0.9393$.

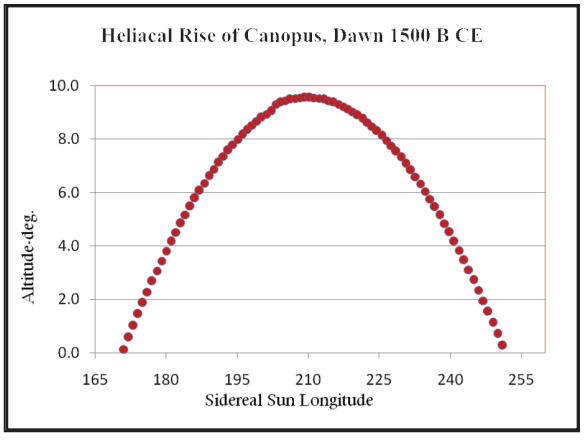

Fig.5: The Parāśara Rule: 26.5N, 1500 BCE

Hasta in the sidereal zodiac began at a longitude of 160^0 and extended to $173^020'$ and it can be easily understood from fig.5 that the star Agastya touched horizon with the Sun's transit of Hastā in 1500 BCE. The equinox had been in the 24th degree of the sidereal zodiac and thus the summer solstice had been at the middle of Āśleṣā and the Hastā solar transit coincided with the wind up of rainy season. The lunar dates given matched the phenomena very well and suggested more antique observations when Agastya was spotted on Kārtikā 8.

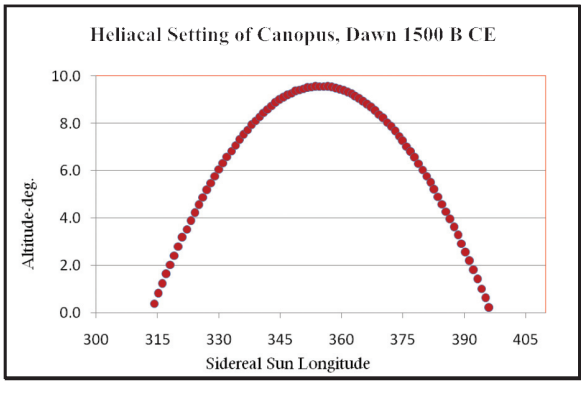

Fig.6: Rohiḥī Sun and Agastya's Dip below horizon 1500 BCE, 26.5N

Equally striking is the truth of Agastya getting heliacally set with the sun's transit into Rohiḥī which extended from 40^0 to 53^020 as shown in the figure 6.

We now look at more direct evidences of observations.

4. Āryabhaṭa's observations of Canopus

Shukla (1977, p. 184) has quoted Mallikarjuna Suri for the Agastyodaya rule of *Āryabhaṭa-ārdharātrika siddhānta* as have become available to us through *Khaṇḍakhādyakā*.

> "Canopus sets when the sun's longitude amounts to 2 signs minus the local latitude. It rises when the sun's longitude is 6 signs minus that. Thus we have stated here the view of the Āryabhaṭa siddhānta as an alternative method"

Figures given above all are illustrative of the above thumb rule that the "60^0– Latitude" rule puts the heliacal setting of Agastya for sun at 30 to 50 degree sidereal longitude. For heliacal rise "180^0 – Latitude" gives the solar position as 150 to 170 degrees sidereal longitude and this too is correct as a thumb rule. In fact, the *nakṣatra* position *vis-à-vis* the sidereal solar longitude and the visibility of Canopus had been under observation for millions of years and the same stands established by the data presented above for the period 4000 BCE to 500 CE. It is well evident from the table-2 below that the epochs were characterized by the meridian altitude of Canopus for a specific sidereal *nakṣatra* position *vis-à-vis* longitude of Sun. The only controversial issue is whether the distant epoch of Parāśara had a sidereal zodiac reckoned from a specific zero point or any star reference such as Dhaniṣṭhā? Given the quote from *Maitrāyaṇi Upaniḍad* and its echo seen in subsequent reference by Varāha Mihira, there can be little doubt about the existence of the *nakṣatra* zodiac (i.e. division of the 3600 ecliptic belt or apparent orbit of the sun in to 27 divisions of 13^020 each, instead of 12 Rasis for depicting the motion of sun) during the time of Parāśara.

Epoch	Meridian Altitude Canopus	HeliacalSet-Agastyamax Alt Sid. Sun	Heliacal Rise Agastya max Alt Sid. Sun
Col.1	Col.2	Col.3	Col.4
4000 BCE	1.51	21	237
3000 BCE	3.66	9.5	225
2500 BCE	4.57	5	220
2000 BCE	5.38	0	215
1000 BCE	6.6	352	205
500 BCE	7.56	336	191

The gain of meridian altitude for Agastya in later epochs made it visible to longer periods around the longitude of sidereal sun indicated in col. 3 and 4 which corresponded to the maximum altitude. Same fact is visible in the precept of Parāśara in 1300 BCE and of Āryabhaṭa in 500 CE. As already demonstrated in an earlier work (Hari, 2008, p.132), the rule of Āryabhaṭa had its genesis in the observations at 10N51 and at 26.5 or 24N00, the rule is not applicable as noted by Brahmagupta in *Khaṇḍakhādyakā*. Figs. 7 and 8 are of interest in this context.

It is apparent that the thumb rule "180 – 2* Latitude" had been true for the observations only in southerly latitudes.

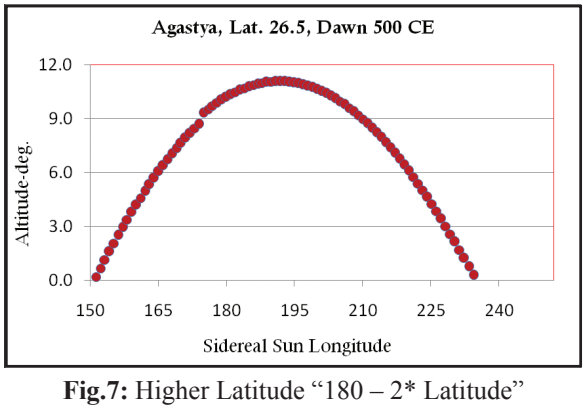

Fig.7: Higher Latitude "180 – 2* Latitude"

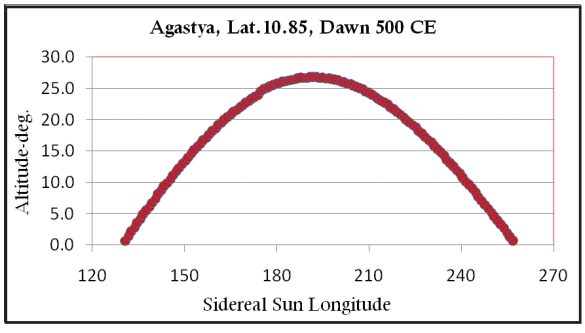

Fig.8: Āryabhaṭa rule at 10.51N – Heliacal Rise

5. Antiquity of Sidereal Zodiac

It is generally accepted that the astronomical references in the Vedic literature are about the seasonal or tropical zodiac reckoned with reference to the cardinal points, equinoxes and solstices. Little attention has been paid to the explicit mention of the sidereal zodiac by Varaha Mihira and texts like *Maitrāyaṇi Upaniṣad, Viṣṇupuraṇa.*

Bṛhat Samhitā (III.1-2)

"There was indeed a time when the sun and southerly course (summer solstice) began from the middle of the nakṣatra Aśleṣā and the northerly one (winter solstice) from the beginning of the nakṣatra Dhaniṣṭhā. For it has been stated so in the ancient works"

Maitrāyaṇi Upaniṣad VI.14

In the following lines we meet with a clear definition of the solar months, each having 9/4 = 2.25 *nakṣatras* of 30^0 and the solstices placed at $113^020'$–$293^020'$.

[4]अन्नंवाअस्यसर्वस्ययोनिःकालश्चान्नस्यसूर्योयोनिःकालस्यतस्यैतद्रूपंयन्निमेषादिकालात्सम्भृतंद्वाद शात्मकंवत्सरमेतस्याग्नेयमर्धमर्धंवारुणंमघाद्यंश्रविष्ठार्धमाग्नेयंक्रमेणोत्क्रमेणसार्पाद्यंश्रविष्ठार्धा न्तंसौम्यम्तत्रैकैकमात्मनोनवांशकंसचारकविधम्सौक्ष्म्यत्वादेतत्प्रमाणमनेनैवप्रमीयतेहिकालःनविना प्रमाणेनप्रमेयस्योपलब्धिःप्रमेयोऽपिप्रमाणतांपृथक्त्वादुपैत्यात्मसम्बोधनार्थमित्येवंह्याह।यावत्योवै कालस्यकलास्तावतीषुचरत्यसौयःकालंब्रह्ममेत्युपासीतकालस्तस्यातिदूरमपसरतीतिएवंह्याह। काला त्प्रवन्तिभूतानिकालाद्वृद्धिंप्रयान्तिच। कालेचास्तंनियच्च्हन्तिकालोमूर्तिरमूर्तिमान्॥॥१४॥

14. ...'Food, verily, is the source of this whole world; and time, of food. The sun is the source of time.' The form thereof is the year, which is composed of the moments and other durations of time, and which consists of twelve [months]. Half of it is sacred to Agni: half, to Varuṇa. From the asterism Maghā to half of Śraviṣṭhā in the [sun's southward] course is sacred to Agni. In its northward course, from *Sarpa* (the Serpent) to half of Śraviṣṭhā is sacred to Soma. Among these [asterisms] each month of Ātman [viewed as the year] includes nine quarters according to the corresponding course [of the sun through the asterisms]. On account of the subtlety [of time] this [course of the sun] is the proof, for only in this way is time proved. Apart from proof there is no ascertaining of the thing to be proved. However, the thing to be proved [e.g. time] may come to be proved from the fact of its containing parts [e.g. moments, etc.], to the cognizance of the thing itself (Online library of liberty).

Attestation of the above and the knowledge of precession with the Indian astronomers (427 CE) find complete demonstration in the *Pañcasiddhāntikā* III.21, which reads[5] –

In the commentary to the verse, Sarma (pp. 61-62) has provided the following explanation –

"From this we can infer that the author knew the precession of the equinoxes. In the *Bṛhatsamhitā* also he says the same thing."Certainly at one time summer and winter solstices were at the middle of Āśḷeṣā and the beginning of Dhaniṣṭhā respectively, because such has been mentioned in the ancient lore. But now the summer solstice is at the beginning of Cancer and the other one at the beginning of Capricorn..."

In contrast to such textural evidence in India of the *nakṣatra* zodiac in 1500 BCE with the equinox in the 24th degree (numerical value of the maximum declination, obliquity of the earth's axis), the Babylonian records (Neugebauer, 1967, p.968) speaks of –

"The equinoxes are then related to a certain solar longitude which is labeled Aries 10^0 in System A, but Aries 8^0 in System B of contemporary ephemerides. In general longitudes are reckoned as sidereal ..."

***Viṣṇupurāṇa* 8.2. 76-78**

In the context of sidereal reckoning of *nakṣatra* divisions, verses as below can never be accidental or scribal mistake when the sacred days are specifically mentioned with sun-moon configuration across the beginning of Kṛttikā and Viśākhā 3rd *pāda*[6].

> "When the sun is in the first *pāda* of the Kṛttikā *nakṣatra* and the moon in the 4th *pāda* of Viśākhā or the sun at the end of the 3rd *pāda* of Viśākhā and moon at the beginning of Kṛttikā, the sacred equinox happens..."

Given the above tradition of spotting equinox at different sidereal *nakṣatra* positions, the reference of Parāśara to sun transiting Hastā cannot be the heliacal rising of Hastā as interpreted by Iyengar.

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[5] आश्लेषार्धादासीद् यदा निवृत्तिः किलोष्णकिरणस्य।
युक्तमयनं तदा*ff*सीत् सांप्रतमयनं पुनर्वसुतः ।।3.21।।

[6] प्रथमेकृत्तिकाभागेयदाभास्वांस्तदाशशी।विशाखानांचतुर्थेम्शेमुन्तिष्ठत्यसंशयम्।।
विशाखानांयदासूर्यश्चरत्यंशंतृतीयकं।तदाचन्द्रंविजानीयात्कृत्तिकाशिरसिस्थितं।।
तदैवविषुवाख्योयंकालंपुण्यो*f*भिधीयते।

6. Conclusions

Detailed examination of the heliacal phenomena of Canopus or Agastya with modern computations reveals correlation of heliacal rise and set of Canopus with the longitude the sun. Meridian transit of Canopus at dawn for 30^0 north latitude in 4000 BCE corresponded to sun's longitude of 237^0 and the heliacal setting phenomenon at dusk had a meridian transit corresponding to 21^0 solar sidereal longitude. As the meridian altitude of Canopus increases for the southern latitudes, the diurnal arc increases along with the days of visibility. By 500 CE, the solar longitude corresponding to the meridian transit of Canopus had shifted westwards to reach the longitude of 191^0 for the heliacal setting at dusk and 336^0 for the meridian transit of the dawn heliacal rise. The visibility of Agastya is better towards southerly latitudes and therefore the observations of Āryabhaṭa are very reliable.

Heliacal rise of Canopus at dawn corresponded in 3000 BCE to the solar position of Jyeṣṭhā nakṣatra (for which deity is Mitra) and it moved back in subsequent epochs to Anurādhā, Viśākhā, Swāti etc for the meridian transit of Canopus. Similarly at dusk the rise began with the Śatabhiṣak (for which deity is Varuṇa) and the phenomena can be interpreted as leading to the Mitra-Varuṇa legend of the birth of Agastya.

Astronomical computations for the times of dawn and dusk (onset of astronomical twilight) reveal that the Parāśara precept corresponded to the actual phenomenon observed i.e. Agastya became visible at dawn for the Hastā transit of sun. The modern astronomical computations can throw more light on the ancient observational records.

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