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Correspondence

Date of *Mahābhārata* War Based on Astronomical References: A K Bhatnagar

B N Narahari Achar*

A recent addition to the literature on the date of the Mahābhārata war, is the article in *IJHS* [52.4 (2017):359-364] by Ashok K Bhatnagar, Additional Director General of Metrology (Retd). Not surprisingly Bhatnagar focusses on the seasons, location of equinoxes and solstices and other astronomical events referred to in the epic *Mahābhārata*. He uses astronomical information taken from 52 verses from 10 different *parvan*-s and uses modern planetarium software, mainly Platinum Gold 4.1(this product uses the Gregorian reckoning in contrast to the usual planetarium software products) and Stellarium 0.10.6.1 to simulate the sky view at Delhi. He claims that the various events described in the epic can be fitted to dates in the early part of the 18th century BCE and that the great war began on 14th October 1793 BCE (Gregorian reckoning). He also claims that for the traditional reckoning with the *Kaliyuga* there are serious contradictions with the corresponding seasons, equinoxes and solstices. In view of these results namely that the date given by him, 1793 BCE for the *Mahābhārata* war is in serious disagreement with tradition and that his claim that his software simulations of the various astronomical references from the epic show disconnect with the traditional date of the war has prompted us to examine the assumptions, methodology and conclusions of Bhatnagar and present these comments.

1. The date of the *Mahābhārata* war, according to what the epic itself says

The epic itself does not give a specific date of the war anywhere, except for a very general statement:

> *antare caiva saṃprāpte kalidvāparayorabhūt | samantapañcake yuddhaṃ kurupāṇḍava senayoḥ* || (*MB* 1.2.9)
>
> The war between the Kaurava and Pāṇḍava armies took place at *sāmantapañcaka* at the *sandhi* between *Dvāpara* and *Kaliyugas*.

The *Yādavas* fight among themselves and kill each other and Kṛṣṇa exited from this world thirty six years after the war.

There is a very clear reference to seasons.

> *kaumude māsi revatyāṃ śaradante himāgame | sphītasasya sukhe kāle kalyāḥ sattvavatāṃ varaḥ* || (*MB* 5.81.7)
>
> In the month of Kārtika, on the day of Revati after the passing away of *śarada ṛtu* and in the dewy season, and at a time when the earth had an abundance of crops on it that foremost of men of prowess (set forth for Hastināpura).

This is an absolutely clear reference to seasons when Kṛṣṇa sets out for his peace mission.

This is what we have from the epic about *Kaliyuga* and the seasons and no where the epic says when *Dvāpara* ended or when *Kali* began, although there are indications that *Kali* may have already started before the war.

*Professor Emeritus, University of Memphis, Memphis TN USA, Email: nachar@memphis.edu

However, there is a date, 17/18th February 3102 BCE (Julian calendar) used as the beginning of *Kaliyuga* by the makers of *pañcāṅga*-s who use this date as the zero point for their (*ahargaṇa*) calculation of planetary configurations. In the popular mind this is associated with the diffused transition from *Dvāpara* to *Kali* mentioned in the epic and hence the traditional reckoning that the war took place about 5000 years ago. It is difficult to see how any software product could show serious disconnect with the traditional reckoning with such a diffuse transition unless there are additional assumptions.

There is additional information from outside the epic. One is from the *Bhagavata* tradition according to which the *Kaliyuga* started the day Kṛṣṇa exited from this world. This would mean that the war took place 36 years before the start of *Kaliyuga*. It should be emphasized that the epic is silent on this and as noted already there are indications that *Kaliyuga* may have already started before the war began. *Viṣṇu purāṇa* offers an explanation: *Kaliyuga* may have already started but *Kali* did not have his full influence on earth as long as the lotus feet of the Lord were on this earth. The Lord's departure from earth may therefore be taken as the beginning of the full influence of *Kali*.

2. The disconnect with traditional reckoning (Bhatnagar section 3.2)

The important assumption of Bhatnagar is the use of the Gregorian calendar together with the information about the rainy season in Delhi at present and extrapolating it over several millennia with the assumption that seasons are reasonably constant in the Gregorian calendar. Bhatnagar finds that the Platinum Gold software yields the date of vernal equinox to be nearly fixed around March 21-22 over 5000 years and that the calendar dates remain almost fixed with reference to seasons. He finds that 'Kārtika *paurṇimā'* falls in the rainy season as per his simulation with Platinum Gold software for the dates around 3102 BCE and hence he declares that there is a serious disconnect between the traditional reckoning of the date of the war and the season for the war declared in the epic itself

This procedure is seriously flawed. The precession of equinoxes is a real effect arising from the dynamics of earth's motion. It is the cause of the change of the pole star over the ages. The constancy of the date of Vernal Equinox (VE) in the Gregorian calendar around March 21-22 over five thousand years is an artifact and arises by the artificial labeling of the months in the Christian calendar. The real position of the VE does change and the following table shows the position of VE along the Ecliptic over the 5000 year period.

Date	nearest star to the position of VE
2000 CE	Omega Pis.
1000 CE	Delta Pis.
1 CE	Omicron Pis.
1000 BCE	Aśvinī
2000 BCE	Bharaṇī/Kṛttikā
3000 BCE	Rohinī

More importantly, over the whole cycle of the precession, the relative orientation of the axis of rotation of the earth changes, the duration of a season say the summer season, can change from about 94 days to about 88 days. The Ecliptic being an ellipse, the earth may be near the perihelion during the winter season in the northern hemisphere (as it is at present) and change over to being near the perihelion when it is summer in the northern hemisphere. These changes have drastic effect on the rainy season and the author is not aware of any theory detailing the variations there of. All this is to say that it is very simplistic to assume constancy of the date of VE and the constancy of the seasons over millennia and draw conclusions from it.

3. Autumn-Kārtika link as indicator of Equinox position (Bhatnagar section 3.3)

It is in this section that Bhatnagar presents the arguments based on the reference *MB* (5.81.7) for considering the date of the war to be around 1800 BCE. His argument can be summarized as follows: On Kārtika *paurṇimā*, the moon is located in Kṛttikā *nakṣatra* (eta-tauri) and the sun should

be found exactly opposite, between Anūrādhā (del-Scorpi) and *Viśākhā* (eta-librae). Autumn season implies that the sun should be close to the autumnal equinox (AE). This fixes the position of the AE between *Anūrādhā* and *Viśākhā* and this occurred on September 22, 1768 BCE (Gregorian). AE would remain near one *nakṣatra* for about 960 years. This limits the search for roughly from 2250 BCE to 1280 BCE. Beyond these limits *Kārtika* month begins to lose its connection with autumn season. Then Bhatnagar fine tunes his date to 1793 BCE using arguments based on other astronomical data such as eclipses.

A moment's reflection will bring out the fallacy of this argument. The point is that on Kārtika *paurṇimā*, the moon may be located anywhere from Bharaṇī to Rohiṇī, and not just in Kṛttikā. (This is true for any of the twelve full moons, that there is a three *nakṣatra* interval to be considered.) This means that the connection of Kārtika month with autumn season extends roughly from about 1800 BCE to 3200 BCE. This also means that the war could not have taken place much earlier than 3200 BCE or much later than about 1800 BCE. Bhatnagar's date is closer to the lower limit. His earlier argument about the disconnect between the traditional date and the seasons completely loses significance.

4. Eclipses and the beginning the war on an *Amāvāsya* (Bhatnagar Sections 3.5 and 3.8)

Bhatnagar discusses the lunar eclipse on Kārtika *paurṇimā*, followed by a solar eclipse on the following *amāvāsya* at Jyeṣṭhā and believes that the war started on that *amāvāsya*. However, in his discussion the various references to eclipses are all mixed up and there is confusion about the proper sequence of events. The following discussion will clarify the issue and show why the war could not have started on the *amāvāsya*.

The sequence of events to be considered begins with the time when after the peace talks fail, Kṛṣṇa leaves Hastināpura. He is accompanied by Karṇa and has a lengthy conversation with the latter. Kṛṣṇa asks Karṇa to take a message to Bhiṣma, Droṇa and Kripa,

> *saptamāccāpi divasāt amāvāsyā bhaviṣyati | sangrāmaṃ yojayet tatra tāmhyāhuḥ śakradevatām* || (*MB* 5.140.18)
>
> Seven days from now falls the New Moon day, with Indra as the Deity for the *nakṣatra* of the day. (i.e. Jyeṣṭha *nakṣatra*). Let things be readied for the war[1] starting on that day."

Karṇa tells Kṛṣṇa

> *somasya lakṣṇa vyāvṛttaṃ rāhurarkamupeṣyati* || (*MB* 5. 141. 10)
>
> The moon lost its luster and Rāhu is approaching the Sun.

These two verses establish the sequence of events. When Kṛṣṇa arrives in Hastināpura there was a lunar eclipse on the Kārtika *paurṇimā* day, and Karṇa refers to it here. Kṛṣṇa refers to the New Moon day at Jyeṣṭha *nakṣatra*, that follows in seven days and Karṇa remarks that it is going to be a solar eclipse day. The word '*yojayet'* should be interpreted as 'getting ready', for a similar use is also found in Rāmāyana, cited below. *Sangrāmaṃ yojayet* should not be interpreted as 'let the war be started', but 'let preparations for the war be started'.

Kṛṣṇa cannot declare the war, only Duryodhana or Yudhiṣthira can declare it as happens subsequently. Kṛṣṇa sends the message to Bhiṣma, Kripa and Droṇa and not to Duryodhana. Hence this statement cannot be interpreted as a declaration of war by Kṛṣṇa. He is only suggesting starting the war preparations.

Also the sequence of events is to be noted: Lunar eclipse on Kārtika *paurṇimā*, solar eclipse on *amāvāsyā* at Jyeṣṭha *nakṣatra* and then the war. At the time of Kṛṣṇa-Karṇa conversation, the solar eclipse has not yet taken place.

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[1] In Rāmāyana (II. 70.12) a similar phrase occurs when Bharata is summoned to go to Ayodhya after Rama has been banished to the forest: "*yujyatāṃ cāpi te rathaḥ*" | "Let your Chariot be readied".

Vyāsa meets Dhṛtarāṣṭra on the eve of the war and tells him

> *alakṣyaḥ prabhayāhīnaḥpaurṇimāsīñca kārtikīm*| (*MB* 6.2.23)
>
> On the full moon night of Kārtika, the moon with fiery tinge was hardly visible, devoid of glory, and the horizons were also of the same hue,

referring to the lunar eclipse and by the statement a few verses later, *arkaṃ rāhustathāgrasat* | (*MB* 6.3.11) Vyāsa refers to the solar eclipse at Jyeṣṭha *nakṣatra* which has already taken place.

The solar eclipse had not yet occurred at the time of Kṛṣṇa- Karṇa conversation, but had taken place by the time Vyāsa makes these statements. Since Vyāsa meets Dhṛtarāṣṭra before the war, and the solar eclipse at Jyeshtha has already taken place, the war could not have started on the *amāvāsyā* at Jyeṣṭha *nakṣatra*.

Furthermore, there is the graphic description of the war on the fourteenth day, when Jayadratha is killed at sunset, but the battle continues into the night, breaking all rules; Ghatotkaca is killed and the battle stops only in the wee hours of the morning just as the moon rises. If the war had started on an *amāvāsyā*, it would be waged during *śuklapakṣa* and on the fourteenth night it would be near *paurṇimā* and the moon would rise at the time of sunset not in the wee hours of early morning.

Thus it is clear that the war did not start on an *amāvāsyā*.

Thus we have shown that the fundamental assumptions of Bhatnagar, namely

(a) the micro structure of the current rainy season in Delhi can be mapped on to Hastinapura 5000 years ago, based on the constancy of VE in the Gregorian calendar, which is an artifact and ignores the dynamic variation of the rotation axis of the earth due to precession and also ignores that the Ecliptic is an ellipse and hence the seasons can vary in length

(b) the limits of the Autumn season can be fixed by considering that on Kārtika *paurṇimā*, moon is just in Kṛttikā, ignoring that for Kārtika *paurṇimā*, the moon can be anywhere from Bharani to Rohini

(c) the war started on an *amāvāsyā*, clearly ignoring all the evidence from the text of the epic

are all unjustified. The methodology of using the Gregorian reckoning masks the real dynamic effects. Hence his conclusions must be rejected.

Further discussion of his paper would involve lengthy discussions of many topics such as the rules of proper interpretations of the Sanskrit verses. The word '*graha'* could also refer to comets, in addition to planets. Astrological concepts such as '*rāśi dṛṣṭi'* from Varāhamihira cannot be extended to *nakṣatra* based astronomy of *Mahābhārata* without proper foundation. While referring to Varāhamihira, one cannot ignore that Vyāsa mentions twelve comets in Varāhamihira's list by name. And lastly, non-reference to important earlier literature, all these would only further point out the defects of the paper and it is considered unnecessary.

The date 1793 BCE for the *Mahābhārata* war as suggested is however not acceptable.

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Rejoinder by the Author
(Ashok K Bhatnagar, 21.03.2018)

As to the opening remarks by Professor B N Narahari Achar about my background in Meteorology (not *Metrology* as mentioned by him), I wish to submit that I have been trained and worked as professional astronomer for 28 years before taking up higher responsibilities in India Meteorological Department (IMD). It would be relevant to mention here that the responsibility for providing scientific inputs for implementing Calendar Reform in India and framing a uniform Indian Calendar lies with IMD since 1957. For this purpose, IMD maintains an office called Positional Astronomy Centre, where I worked for 19 years. The essence of calendar reform in India and all over the world has always been to stop the

shift of calendar dates against equinoxes/solstices in order to bring the dates in step with the seasons (Saha and Lahiri, 1955, p.204). Gregorian calendar dates, after the reform in 1582, are now tied to the equinoxes and seasons (Calendar — Britannica Online Encyclopaedia, 1998-2018). A reading of the above will clarify many doubts about connection of the equinoxes with the calendar dates. As regards the methodology in the paper, we used references to the prevalent seasons along with description of calendric elements (sidereal) to determine the location of autumnal equinox among stars, which is found to be perfectly consistent with the direct description of location of winter solstice in ***MB***. From these deductions, based on the rate of precession, we compute a time window, when the equinox and solstices were located in the indicated *nakṣatras*. Within that time window, we then examine references to eclipses. Only one eclipse pair in the year 1793 BCE, over the entire period of 970 years thus arrived, satisfies the condition of its occurrence in a year in which, winter solstice occurred on Māgha *Śukla* 8 (±1) on the day of Bhīṣma Pitāmaha's demise. Once this year is determined, scientific analysis of all other direct references yields consistent dates including the date of 14 October, 1753 BCE of the Great War, without resorting to any extraneous interpretations beyond what is stated in the text. My para-wise comments on Achar's remarks follow:

1. The date of the *Mahābhārata* war…

Achar rightly points out that the epic does not say anywhere as to when *Dvāpara* ended or when *Kali* began. The point has been adequately discussed in our paper under Section 3.1. Further, Āryabhaṭa I (5-6 c CE) has used an epoch for calculation of *Ahargaṇa* in his text *Āryabhaṭīyam*. From the value of *Ahargaṇa* used by him, the epoch works out as midnight of 17/18 February 3102 BCE (Julian) for his *Ardharātrika* system and as sunrise of 18 February 3102 BCE (Julian) in the available *Audayika* system; both calculations were done by him for Laṅkā. Since his time, this epoch and the era has come to be known as *Kaliyuga* era and become part of Indian astronomical tradition. It is widely used as the starting point in *Tantra* texts and *Pañcāṅgs* for counting of total number of civil days elapsed (*Ahargaṇa*) for computing the mean positions of planets for a given date. On this point, Rao (2014, pp.43-44) mentions that "Actually, Āryabhaṭa does not use the word '*Kaliyuga'*. He says*, when sixty times sixty years and three quarter yuga had elapsed…*(*Ā Bh* iii 10)*".* In this context, Saha and Lahiri (1955, p.252-254.) had earlier made a thorough astronomical analysis of the date of beginning of Āryabhaṭa's *Kaliyuga* Era and concluded thus: *"It is thus clear that the beginning of the Hindu astronomical Kaliyuga was the result of a back calculation wrong in its data, and was thus started wrongly".* In popular belief, however, this *Kali* Era beginning in 3102 BCE as defined by Āryabhaṭa has come to be identified with the *Kaliyuga* mentioned in *Mahābhārata.* In any case, use of an era beginning is a matter of convention and it need not be identified with a specific event. About the 3102 BCE date, Achar rightly points out that popular mind associates it with the diffused transition from *Dvāpara* to *Kali* mentioned in the epic and hence the traditional reckoning that the war took place about 5000 years ago. It is not the intention here to disturb or reform the existing *Kaliyuga* era used by *Pañcāṅga* makers, but only to show that there is no connection between the ***MB*** and the 3102 BCE date. About his query as to how a software product can do that, it is to be mentioned that software is to be used only as a tool for ease of computation/ simulation. We have simulated the *MB* events in sky with a programme that uses tropical calendar so that the dates of the event will relate directly to seasons/solstices and equinoxes in remote past also. And if simulation of an astronomical event like a given *nakṣatra* of a sidereal lunar month said to be occurring in autumn shows a tropical date associated with rainy season, it surely indicates a disconnect between the text and the date of simulation. Our aim is to find a date when the two things connect. Achar goes on further

citing mythological Bhagavata tradition, which cannot be considered for scientific inquiry.

2. The disconnect…

Achar, talking about the 'disconnect' mentioned in Section 3.2 of the paper, appears to be utterly confused in his understanding of the tropical calendars, sidereal calendars and their relation to movement of equinoxes/solstices among the background stars. There are numerous articles available on this elementary subject in astronomy, which has been the basis for Gregorian calendar reform of 1582 and the reform of Indian calendar proposed by Saha (1955) Committee. It does not matter what calendar or which software one uses, as long as one can convert from one dating system to the other. Use of *Ahargaṇa* in the Indian system or Julian Day Numbers in the western system removes the confusion as the number of days can then be converted to any known calendar system- Gregorian, Julian or *Nirāyaṇa* (sidereal) calendar. One can also use the other software and get dates in Julian system for the same events, only to be converted later to Gregorian system. We have explained this in detail under Section 2.1 of the paper.

Anyhow, let us refresh on the topic of precession and its impact on calendar once more. The phenomenon of General Precession occurs due to the combined gravitational effect of the Sun, the Moon and planets on the Earth. As a result, the equinoxes move westward along the ecliptic relative to fixed stars at the rate of about 50.3 seconds of arc per year and complete a full circle (360 degrees) through the ecliptic constellations in about 26,000 years. In other words, the equinoxes and solstices move through 1 degree every 71.6 years on an average. As a consequence, festivals and dates determined according to sidereal Indian Calendar slowly slip against seasons/ equinoxes/ Gregorian-dates, e.g. *Uttarāyaṇa* has shifted from 21 December in 285 CE to 14 January in 2018. Conversely, the seasonal phenomenon of monsoon, which presently begins on average at a given place in northern India, say, in Aṣādha month of *Nirāyaṇa* (Sidereal) Indian calendar, will shift in reverse order to Vaiśākha by the year 6000 CE. As an equinox would go round the full *ṇakṣatra* belt in about 26000 years, any reference to its location can be converted to the time when it occurred. We find several references in MB, which help us to locate autumnal equinox and winter solstice in proximity of certain star or star groups (*ṇakṣatras*). Since the rate of precession is accurately known, such references serve as important clues to determine the time bracket of the particular observation. This principle has been used in the paper to first constrain the date of Mahābhārata to the time domain of 2250 BCE to 1280 BCE. Achar has himself shown a table giving the movement of Vernal Equinox (VE) through ecliptic constellations but has not realized its meaning for converting VE position into time. Perhaps he does not differentiate between the tropical and sidereal calendars. By definition, the tropical year corresponds to seasonal year. The average length of year in Gregorian calendar corresponds very closely to mean tropical year. The Gregorian dates of equinoxes and solstices. are therefore very nearly constant. As seasons are tied to them, it is obvious that they would also repeat on the same Gregorian dates every year on an average. Coming to the behaviour of rainy season (monsoons) in Northern India, they do show inter-annual and intra-seasonal variability, but there is absolutely no evidence - observational or theoretical - that their average onset and withdrawal dates are shifting continuously in one direction over Gregorian calendar. A one way shift of 20 days over 4-5 millenia in this context is huge. The minute variations in Earth's orbit cause climate changes over very long periods. The period of over 11000 years after the last ice-age is known to be fairly stable. Moreover, the happy description of the rainy season in ***MB*** 3.179/9 does not indicate either floods or draught that characterise the monsoon variability over short periods. We have therefore no reason to justify that Kārtika *Pūrṇimā* and Autumn season would have occurred in August and early September (tropical), which were

rainy months over Delhi and neighbouring region in 3102 BCE and 3138 BCE. Besides, there are many other astronomical observations discussed under Section 5 of the paper that do not match for the year 3102 BCE or earlier (related to *Kali*). For example, If we go back 36 or 37 years from 3102 BCE, we arrive at WS dates of 19 Dec 3138 BCE and 19 Dec 3139 BCE. We find that the *tithis* on these dates are *K* 13 and S 16 respectively and not Māgha S 8 as per ***MB***. Kārtika *Amāvasya* in these two years falls on 23 September 3138 BCE and 4 October 3139 BCE respectively. If war is taken to begin on any of these dates, the interval to Winter Solstice (WS) in the two years works out to 87 and 77 days and not 68 days as mentioned in the epic. All this shows the *disconnect* between the 3102 date and *MB*.

3. Autumn-Kārtika link…

The objection is that Kārtika full moon does not always occur in Kṛttikā. We know that the mean sidereal month is shorter than the mean synodic month by about 2.2 days. As a result, the moon, starting with a given *ṇakṣatra* (star) and a given phase, after one revolution, has to move further by nearly 2.2 *nakṣatra* to gain the same phase. This means that after 12 lunar months, moon ends up covering 26.4 extra *ṇakṣatra*, coming back to nearly 27th *nakṣatra*. We further know that 12 synodic lunar months (mean) fall short of a mean tropical solar year by 10.8751 days. Therefore, an intercalary month is required to be inserted at suitable intervals to bring the lunar months in step with the solar year (seasons/ equinox). Besides, the perturbation of the moon's orbit by the Sun causes further change in the former's true position among *nakṣatra*. The combined effect is that the full moon may not always be seen exactly against the *nakṣatra* after which the concerned month has been named. However, its average position taken over several years will not deviate from the mean *nakṣatra*, unless the period exceeds 960 years when the effect of precession takes over and moves the mean to the next *nakṣatra*. We have established in Section 3.10 of the paper that the calendar followed in *MB* is the *Vedāṅga Jyotiṣa* (*VJ)* calendar. In *VJ* calendar, year begins with winter solstice and the months are lunar with their names derived from the *nakṣatra* in which the full moon occurs in the middle of the month (Saha and Lahiri, 1955, pp. 220-226). The *VJ* scheme equates 1860 *tithis* (62 Synodic months) and 1809 *nakṣatra* (67 sidereal months) to 1830 solar (civil) days (60 solar months) for intercalation. The intercalation was perhaps done as and when required as per observation (Saha and Lahiri, 1955, p. 224). Thus, after 62 synodic months (1830.8965 days) or 67 sidereal months (1830.5512 days) the mean *nakṣatra* of naming the month was repeated. Therefore, mean *nakṣatra* for Kārtika month over the above period would remain Kṛttikā. Any observed deviation would be corrected as and when required through adequate intercalation. The intercalation further ensures that the month remains linked to the equinox/solstice. Even when the full moon is one *nakṣatra* away and not in Kṛttikā, the intercalation would so name the month (Kārtika) that the autumnal equinox would remain opposite as per the description. The specific mention of Kārtika *Pūrṇimā* in autumn season with unambiguous description of post-rainy-season autumn in MB 3.179/9,10,11,12,16 and MB 5.81/7 leaves no doubt about the Sun being close to Autumnal equinox, between Anurādhā (δ Scorpii) and Viśākhā (η Librae) *nakṣatra* opposite to full moon in Kṛttikā. So there is no fallacy in the method or the argument.

4. Eclipses and beginning the war…

I would like to invite a reference to a more careful reading of Section 3.5 on Eclipses in the paper. The eclipse pair mentioned at *MB* 6.3/28,29 has been identified after studying 75 pairs visible over the region over the period of 970 years and reported in the paper as Solar Eclipse of Apr 19, -1792 {Julian May 4, -1792} and Lunar Eclipse of Apr 05 -1792{Julian Apr 20, -1792}. The eclipses occurred during the year of war more than 6 months before it began. So the sequence begins 6

months before the war and not with Kṛṣṇa- Karṇa *Samvāda* just before the war as perceived by Achar. The lunar eclipse on Kārtika *Pūrṇimā* (MB 6.2/23) on Sep 28, -1792 {Julian October 13, -1792}, 16 days before the war begins, provides further confirmation of the year of war. That there was another solar eclipse on the following *Amāvasya*, which was not visible in India has been mentioned in passing in the paper and is not used for confirmation of any statement in *MB*. However, this very reference is being interpreted by Achar as "*Karṇa remarks that it is going to be a solar eclipse day"*. There is a tendency among some *MB* researchers to interpret any mention of Rāhu as eclipse. Is Achar creating a fantastic landmark in the history of astronomy that solar eclipse prediction was done in India, according to him in 3102 or 3067 BCE? He again presumes mention of Rahu in *MB* 6.3.11 as confirmation of a solar eclipse and from nowhere adds its location in Jyeṣṭha and out of these imaginary eclipses makes a sequence of events to prove that the war did not begin on Kārtika *Amāvasya* that occurred in Jyeṣṭha.

Coming back again to ***MB*** 5.140/17,18, on Kṛṣṇa - Karṇa *Samvāda* shortly before the war, he asserts that "Kṛṣṇa cannot declare the war…". We can only go by what the text contains. His assertion over Kṛṣṇa's authority would be valid had there been another equally direct and unambiguous statement on beginning the war and if one had to make a choice between the two. Similarly, from his interpretation of *MB* 5.140.18 that it was a suggestion by Kṛṣṇa to Karṇa for making preparations for war rather than a direct and serious declaration of war, it appears that it is being done for convenience of fitting a preconceived date.

Achar is citing a reference to battle on the night of the fourteenth day of the war and a crescent moon rising in the wee hours of the morning. Perhaps he has not noted that we have already examined the same in detail under Section 4.2 at the last paragraph on page 386 of the paper and shown how it is untenable. In our paper, we have taken the translation from standard source only and we neither tried to read between the lines nor interpreted anything beyond the text. If a particular statement is found completely inconsistent with the rest of the scenario, we have given our reasons to exclude it.

Finally, a few remarks on his conclusions

(a) He is expressing doubts about the science of Earth's orbital motion and its impact on climate. The science is well understood. He seems to be suggesting some new dynamical effects without elaborating them. Our explanation to the point is given at (2) above. There is no evidence of one way shift in the monsoon dates (Gregorian) over the past several thousand years.

(b) The point is astronomically explained at (3) above

(c) The war started on an *Amāvasya* day is directly mentioned in *MB* 5.140/18 as shown with simulations under Section 3.8 of the paper. There is no other direct statement on war beginning on any other date in *MB*. Most of the alternatives are the result of misinterpretations. He wants to reject the conclusions of the paper because "The methodology of using the Gregorian reckoning masks the real dynamic effects". I think such unscientific remarks do not deserve to be published in a reputed scientific journal.

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