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EVOLUTION OF DATING SYSTEM

A. K. CHAKRAVARTY*

The inscriptions left behind by ancient Indian rulers like the Kuṣāṇas and the Guptas contain valuable informations on the early calendrical astronomy of India. The object of the present paper is to investigate this calendrical astronomy using these inscriptions as source material.

Key-words : *Ahargaṇa*, Gupta era, Jovian year, Śaka era.

INTRODUCTION

Astronomical studies are perhaps as old as human civilization, but a systematic dating process, identification of any day in terms of months, years reckoned from an epoch, week days etc. for purposes of recording chronology is of later origin. We propose to restrict our discussions on origin and development of dating in the context of India.

The science of dating developed in India in three distinct successive stages. Firstly, in the Aśokan period it was introduced by Aśoka, then, the Śaka and Kuṣāṇa rulers used datings in the Kharoṣṭhī inscriptions left by them and finally, the rulers of the Gupta dynasty also used datings in their inscriptions. All these datings very clearly belong to three distinct schools of astronomy. Unhappily, the datings in the Aśokan inscriptions cannot be fully deciphered, those in the Kharoṣṭhī inscriptions can only be partially deciphered but the dates of Gupta inscriptions can only be deciphered with some amount of certainty. Of course, datings have been used by many other rulers in their respective inscriptions, but all these belong either to the Aśokan or the Gupta school.

We start from a summary review of the astronomical studies in ancient India.

The earliest treatise on astronomy so far found in India is a small text, *Vedāṅga Jyotiṣa*, containing some guidelines on calendrical calculations. From astronomical references found in this text it is estimated to have been formulated around 1500 BC. Unfortunately major part of the text is obscure and no rational meaning of the complete text can be found out. Different commentators have emended these obscure verses differently and so the meaning of the text differs so widely in all these hands

*Phulbag South Gate, Mahishadal 721628.

that it is almost impossible to know what the original author intended to say.

However, the text has formulated a calendar based on the following crude astronomical parameters :

(a) A solar year and a lunation consist of 366 days and $29\frac{16}{31}$ days respectively. Thus 62 lunations fit into 5 solar years. This cycle of 5 years is called a *yuga*. A *yuga* commences from a new moon at winter solstice when the sun and moon are in conjunction at the star β Delphini. Months in this scheme are lunar, two lunations are intercalated in a *yuga*, one at the middle and the other at the end of a *yuga*. The initial year of a *yuga* is called a *Saṃvatsara* or simply *vatsara*.

(b) Days are designated by *tithis* or the *nakṣatra* in which the moon stays on that day and not by ordinal numbers. Moon's orbital motion has been estimated as $\frac{1830}{1809}$ days per *nakṣatra*. There is no reference to any era or epoch in the text.

We quote some instances to illustrate how this scheme was applied to designate days.

Mahābhārata, (Śalya – 35) : Balarāma says "Today is the 42nd day since I started for pilgrimage. I left my home on *Puṣyā nakṣatra* and returned on *Śravaṇā nakṣatra*".

Arithmetically, Balarāma's account is correct if the statement means that the moon, starting from Puṣyā made a complete sidereal revolution and then moved to Śravaṇā ($\frac{1830}{1809} \times 41 = 41.4$ days). But this is not proper dating since we neither know the month nor the year (from any epoch) when he started for the pilgrimage.

Auspicious bathings or fastings are in all cases recommended in such terms as full moon at *Citrā,* new moon following a full moon at *Viśākhā* and so on.

The Jainas developed their own school of astronomy, but they adopted this 5 yearly calendrical theory in its entirety with some minor adjustments only. In this school, the *yuga* commences from a full moon when the sun reaches summer solstice at the middle of *Aśleṣā*. However, this school also did not develop any dating system.

Regnal Years of Aśoka

From archaeological and historical evidences it is now known that dating was first introduced in India by the *Mauryan* Emperor Aśoka.

Aśoka has left behind some inscriptions (called edicts) in *Brāhmī* scripts and *Prākrit* tongue. None of these edicts mention any month or day, yet, in some edicts reference to the regnal year of Aśoka has been made as year of the *Piyadasi* (Priyadarśi) We do not call it dating proper, yet it was the first step towards introduction of dating system in India.

The epoch of this *Piyadasin* or *Aśokan era* is the day of coronation of Aśoka and hence it is called the Regnal year of Aśoka. No astronomical or historical evidence is available to ascertain this day of coronation i.e. the epoch of this era and so the time of Aśoka is only estimated to be anything between 273 to 264 BC. As this era was discontinued after Aśoka, therefore the Indian chronology in ancient period cannot be faithfully reconstructed.

We first quote a few instances of Aśoka's edicts before going into details of it[1]:

1. Rock Edict XIII : The Kaliñgas were conquered by the beloved of the gods, King Priyadarsin (when he was) crowned eight years.

2. Pillar Edict VII : This Dharma script has been caused to be written by me (when) crowned twenty seven years.

3. Pillar Edict V : On these *caturmasis*, on the three days during *Tiṣya* full moon, 14th, 15th and *pratipada*, fish are inviolable. On the 5th *tithi* of every *pakṣa*, on the 14th and 15th *tithi*, on *Puṣyā*, on *Punarvasū*, on *caturmasi* bulls are not to be castrated.

We note that days are designated by *tithis* or moon's *nakṣatra*, a convention of the 5 yearly cycle of calendar. That a 5 yearly cycle of the Jaina school was followed here is also further evident from the following consideration.

The social custom and tradition in Mauryan India, the administrative policies of the government concerning law, taxation etc. are described in a book *Arthaśāstra* composed by Kauṭīlya, the chief courtier of Emperor Candragupta, the founder of Mauryan empire and grandfather of Aśoka. The XX th chapter of this book deals with time measure in contemporary India.

There are some interpolations in later age in this chapter like shadow rule of

Fujidhvaja (200 A.D.), Gnomon shadow in summer solstice day at Ujjain (at a period when Ujjain became prominent in Indian tradition), but the calendric theory explained there is only a reproduction of the Jaina school of 5 yearly cycle (XX – 55 to 60, 64, 66). We are inclined to believe that the court astronomers of Aśoka followed the Jaina cycle in dating these inscriptions.

Unfortunately, these datings do not serve the purpose for which the dating system was developed. Consider, for example, the edict no. XIII. If the epoch of the regnal year be a *saṃvatsara*, i.e. initial year of a cycle, the elapsed 7 years should contain 86 lunations or 2538 days.

Accordingly, Kaliñga was conquered 2538 days after his coronation. But if the epoch be reckoned from the second year of a *Yuga*, the elapsed seven years should contain 87 lunations and then we get that Kaliñga was conquered 2567 days after his coronation.

We cannot identify the date when Kaliñga was conquered. The same limitation holds true in all the edicts where a date has been mentioned.

After Aśoka, the Sātavāhanas used their regnal years in the datings of their inscriptions. But here also, we have no evidence to ascertain the epoch of these regnal years and in addition, we cannot ascertain the school of astronomy they followed as a result we cannot decipher them. The special features of these datings are that months' days have been designated by ordinary numbers and not by *tithis* or moon's *nakṣatra*; while the *pakṣa* (dark or bright half) of the month and the season have also been mentioned there. As an illustration, we quote below one such inscription of *Śatakarṇī* (1st century AD) :

"In the 18th year elapsed on the 1st day of the second *pakṣa* in the Varṣā season."

Here, a season consists of 4 months or eight *pakṣas* and a year consists of 3 seasons *Varṣā, Grişma* and *Hemanta. Varṣā* consists of *Śrāvaṇa, Bhādra, Āśvina* and *Kārtika.* Second *pakṣa* of *Varṣā* therefore means *Śukla pakṣa* of *Śrāvaṇa.* Such a division undoubtedly is unconventional to Indian tradition.

By the time of Aśoka, the Greeks had developed a much improved calendar based on the Meton cycle. Astronomical parameters in Greek calendar were also far more accurate than their Indian counterparts.

The Greeks also established an era, the Seleucidean era which was in general use and ran continuously. Its epoch is the day when Seleucus occupied the city

of Babylon. Because of all these, the datings in Seleucid era can be correctly deciphered. It may appear strange why this Seleucid calendar did not influence the crude and unpractical 5 yearly *yuga* calendar of India.

One likely reason may be that cultural contact with the Greeks were not established till then. The Greek invaders who came to India were warriors and opportunists, and not cultural delegates. Cultural exchange with western countries was initiated by Aśoka himself and perhaps through such exchanges improved Western astronomy made its entry into India after Aśokan period. We propose to discuss this development in a later section.

The Obscure Era of Seven Sages

Varāhamihira, following Vṛddha Garga, states in his *Bṛhat Saṃhitā* (XIII – 3) :

The seven sages (the Great Bear) make a sidereal revolution at the rate of 100 years per *nakṣatra.* The sages were in *Maghā* when Yudhiṣṭhira was reigning in the Śaka year 2526.

Any attempt to make out any astronomical significance of this statement will be futile unless we make some fantastic conjectures on some inner or deeper meaning of it. We restrict ourselves from doing so and we take this statement in its face value.

The epics *Rāmāyaṇa* and *Mahābhārata* and most of the *Purāṇas* speak of a system of 4 *yugas* viz. *Satya, Tretā, Dvāpara* and *Kali.* The *Mahābhārata* itself states that the *Bhārata* war was fought at the commencement of *Kali*[2].

This *Kali* beginning was assigned astronomical recognition by two different hands, one by Vṛddha Garga as we shall see now and then by Āryabhaṭa as we shall consider in a later section.

Although researches on the date of *Mahābhārata* are of recent origin, yet the Indian tradition as stated above holds that the war took place at the beginning of *Kali.*

According to Vṛddha Garga's commentators, the sages, in course of their sidereal motion, were in the *Maghā nakṣatra* at the *Kali* epoch when the war was fought, and this view was shared by other astronomers also. "The position of the seven sages (in *Maghā* asterism) at the junction of *Dvāpara* and *Kali* is confirmed by the quotations from Vṛddha Garga and Kaśyapa by the commentator Bhaṭṭotpala"[3].

We find the following rationale behind this fanciful motion assigned to the sages. This was perhaps a time-scale for recording chronology. We are told that :

The sages were in *Punarvasū* when Nanda ruled[4]. The sages never moved through the *nakṣatras*; the verse indicates the time factor by a supposed motion through 10 *nakṣatras* at 100 years per *nakṣatras* i.e. Nanda ruled for 1000 years after *Kali*. Indication of a time scale in terms of such a motion is found in *Rāj Tarañgini*, a historical account of Kashmir.

This is the only explanation that occurs to us to explain this motion of the sages. The zero time was reckoned when the sages were in Maghā, and then each 100 years was denoted by one *nakṣatra*. To add a touch of authenticity, this zero time was perhaps linked with *Kali* or *Bhārata* war.

Dating in Kharoṣṭhī Inscriptions

Continued use of an era in dating is found in the Kharoṣṭhī inscriptions of Śaka and Kuṣāṇa kings of north-west India. From the designs of letterings and engravings in these inscriptions Sten Konow[5] has classified them into two sets, the first set being earlier than the second one. These two sets are now known as Konow's A list and B list. Konow however, does not rule out the possibility of intermixing of some inscriptions in the two sets.

We propose to show that these datings belong to the Greek calendar based on the Meton cycle of 19 years and for that purpose we make a summary review of the Greek calendar.

The 19 years cycle due to Meton (c. 433 BC) is :

19 years = 6939.75 days

235 lunations = 6939.69 days.

These figures are far more refined than their counterparts in contemporary India's five yearly cycle.

In Greek calendar, months are new moon ending lunations. The first year of a cycle begins from a new moon at autumnal equinox, the first month being Dios. Seven lunations are intercalated in 19 years so that after each 19 years the cycle repeats itself in the same order. These extra seven lunations are intercalated in the 1st, 4th, 7th, 9th, 12th, 15th and, 18th year. The days of the months are designated by ordinal numbers and not by *tithis*. The months are assigned alternatively 30 and 29 days from Dios onwards.

Many of these inscriptions are dated in years, months and days. The special features of these datings are :

1. Months are designated by Greek names, Sanskrit names and Sanskritised Greek names. Days are always designated by ordinal numbers and not by *tithis*.

2. Continued use of an era is introduced. In the A list, the era continued from year 58 to 399 and the era in B list continued from year 1 to 98. All the datings in B list refer to the year of King Kaniṣka of the Kuṣāṇa dynasty. Scholars are now unanimous that the epoch of this Kaniṣka era is 78 A.D. and we shall see later that the classical Indian Śaka era also has the same epoch.

The following is a list of names of months found in these inscriptions.

A list		B list	
Prosthavatasa	(Prosthapada)	Daisimkasya	(Daisios)
Panemasa	(Panemos)	Ashadasa	(Asadha)
Vesakhasa	(Vaisakha)	Kartiyasa	(Kartika)
Sravanasa	(Sravana)	Arthamisiya	(Artemisios)
Jethamase	(Jyaistha)	Avadunakssa	(Audunaios)
Aspaiusa	(Asvayuja)	Apelae	(Apellaios)
Ashadasa	(Asadha)	Prosthovadasa	(Prosthapada)
		Jethasa	(Jaistha)
		Chetrasa	(Caitra)
		Margasirasra	(Margasirsa)
		(Three letters are defaced here)	

For the sake of illustration we quote two inscriptions one from each list.

1. *A list* : In the seventy-eighth 78 year (during the reign) of the great king the Great Moga, on the 5th, 5 day of the month Panemos (the text reads *Panemasa masasa divase pancame* 41 .....)

2. *B list* : (During the reign) of the Maharaja Rajatiraja Devaputra Kaniska, in the 11th year, anno 11, on the eighteenth day, d. 18, of the month Daisios (the text reads *Daisimkasya masasya divasem athavise di* 10 4 4).

These Śakas in their homeland used the Greek calendar. After they made contact with India, they were influenced by Indian culture and they fitted the Indian months to their calendar and gradually accepted the Sanskrit names for the equivalent Greek months. The conventional *Caitra Śuklādi* year beginning near at vernal equinox of Indian system is of latter origin. We believe that the year beginning of this revised calendar was reckoned from autumnal equinox following the Greek convention. All the changes that were made in this revised calendar were that months were assigned fixed number of days, Meton cycle was followed for computational works and intercalations as well. We shall see that months were also changed to full moon ending lunations.

Seleucid years are current years whereas years in Indian eras are elapsed years. An Indian astronomical text, *Romaka Siddhānta* is an exponent of the Meton cycle. In Indian calendrical theory Meton cycle has no application and so it is likely that the outline of this *Siddhānta* was formulated by the court astronomers of the kings whose names these inscriptions bear. However this *Siddhānta* has also followed the convention of elapsed years.

Two inscriptions in the *B list* mention, along with date, the *nakṣatra* in which moon stays in that day. We quote them below :

B 26. Anno II, on the 20th day of month of Āṣāḍha, in Uttar Phālgunī, at this term a well was dug.

B 35. Anno 61, on the 8th day, d. 8, of the month Caitra, at this term (was dug the well) in Pūrvāṣādhā.

As already explained, anno 11 means that 11 years of Kaniṣka have expired and the 12th year is current. Further also, *Āṣāḍha* is a month near summer solstice. If we take the epoch of Kaniṣka at 78 AD near autumnal equinox Anno11 *Āṣāḍha* falls in 90 AD and similarly a Anno 61 Caitra falls in 140 AD.

In B 26, if *Āṣāḍha* be a new moon ending month, then on 20th *Āṣāḍha,* we should expect Moon – Sun = 20 x 12 =240° (nearabout) or Sun = Moon – 240°. Now, if moon be in conjunction with Uttar Phālgunī (tropical longitude in 90 AD = 144° 46'), we should have, Sun = 144° 46' – 240° = 265° (say), and Sun's position comes to nearabout winter solstice, which cannot be the *Āṣāḍha* month. But if the month be full moon ending, then we get Moon – Sun = 5 x 12 = 60° and Sun = Moon – 60° 144° 46' – 60° = 85° (say) i.e. nearabout summer solstice, which can indeed be *Āṣāḍha* month.

Repeating the same argument for B 35, under new moon reckoning, Sun = 152° 40'

and the month cannot be *Caitra*. Under full moon reckoning, Sun = 332° 40'.

Now, *Caitra* is a Spring month and so we should expect the Sun nearabout vernal equinox. In the Indo-Greek calendar, *Caitra* can be an intercalary month. If we regard anno 61 as a year with intercalation at *Caitra*, then the dating fits into full moon ending lunations.

From astronomical tables (say, Lahiri's tables) if we compute mean tropical longitude of Sun (L) and mean elongation of Moon in days (D), we get :

DATE	*L*	*D*
June 21, 90 AD	87°16'	4.81
Feb 28, 140 AD	335°44'	22.03

These lunisolar positions are in complete agreement with the inscriptional dates; we may perhaps identify these dates as Julian equivalents of the inscriptional dates. However, our calculations are based on the assumption that anno years are elapsed years. Using this scale, we can decipher all other inscriptional dates in the *B list*.

Our method does not apply to the *A list* because no *nakṣatra* has been mentioned in any inscription. Even then as the datings follow the Indo-Greek scheme we may assume the months there to be full moon ending. We shall also see next that epoch of the era in these inscriptions has now been fixed at 123 B.C.

The Kali Yuga and Saka Era.

We have seen that the era *Kaliyuga* was given astronomical (or pseudo astronomical) recognition by Vṛddha Garga and others by assigning an obscure motion to the Great Bear. A second astronomical recognition of it was made by Āryabhaṭa by proposing that all the planets (including the sun and the moon, which were then reckoned as planets) were in a great conjunction at the initial point of the ecliptic at the beginning of the *Kali era* when the war was fought and since then, all the planets have been moving around the earth making integral number of revolutions in a period of 4320000 years. According to his own statement, Āryabhaṭa was 23 years old when 3600 years had elapsed since *Kali*[6].

It requires no elaboration that these planets were never in such a conjunction. Even commentators of Āryabhaṭa knew well that this conjunction was a myth and was devised for computational works only. According to them, mean positions of planets on 3600 *Kali* years as found using Āryabhaṭian parameters did not require any correction.

Now, 3600 years, contain, according to Āryabhaṭa, 1314931.25 days. It now remains to determine arithmetically a past date so that from an initial conjunction in that past date, the planets, after so many days occupy the positions, derived from Āryabhaṭian parameters which are visibly correct. We shall see next that this past date was very successfully found out by Bentley while he was working on *Sūrya Siddhānta* (SS). This date, as found out by Bentley, fits into all the Indian traditions on *Kali* and *Śaka era* as found in Indian Astronomy.

But far before Bentley, Indian astronomers also knew that the initial conjunction at *Kali* was a myth, and that this was devised by back-calculations for computational purposes only. Putumana Somayaji[7] in his *Karaṇapaddhati* said : The measure of *Kalpa* etc. have been conceived by the (ancient) authorities differently, for it is only the result that counts, not the means.

All agree that today, the current *yuga* is *Kali* in the 28th (*Catur*) – *yuga* of the 7th *Manu* in the present *Kalpa*.

Parameśvara and Somayaji both agree that[8] the astronomical parameters as given in the different siddhāntas do not give correct results. Hence, either these parameters should be recasted, or the initial conjunction at *Kali* beginning should be remodelled if these parameters are to be used. To quote Sarma, "In the verses following (in *Sūryasiddānta Vivarana*, after verse 5) the author (Parameśvara) has worked out the actual positions of the planets that would have been occupied by them at the beginning of *Kali*, on the basis of the current rates of their motions.[10]

By the time of Parameśvara, the cumulative errors in these parameters had become pronounced but in Āryabhaṭa's time, particularly when he was aged 23 years, these would give correct results within the limits of observational accuracy of that period provided computations were made from an initial conjunction.

The text *Dṛkkaranam*[10] says : In the year *giritunga* (3623) was his work Āryabhaṭīya composed and therein he stated the revolutions of the planets. He had adjusted these revolutions in such a way that there was no zero correction at the beginning of *Kali*. Haridatta[11] observed :

In course of time, deviations were observed (in the results arrived at by Āryabhaṭa's) computations. Then in the *Kali* year *mandasthal* (3785) equivalent to Saka *tanuta* (606) several astronomers gathered together and derived by observation (a system) wherein the correct number of revolutions were found by multiplying the current *Kali* year minus *giritunga*.

The *Suryasiddhānta* (SS) also asserts that there was a general conjunction at the

beginning of *Kali*. Bentley argued that the planetary positions derived using SS elements must hold true on the time the SS text was written or compiled. Now a general conjunction of all the planets never occured, and so he made a trial attempt by finding a situation most similar to a conjunction and found the date February 18, 3102 BC Ujjain Oh. as most suitable. The complete table of the planetary positions can be found in Burgess's Translation (p. 20) of the *Surya Siddhānta* reprinted by Indological Book House, Varanasi; we simply state here that except for Mercury and Venus, all other planets and the Moon and the Sun were in conjunction within an error of 20°, errors in the first two were 33° respectively. The ayanāñsa of the *Suryasiddhānta* initial point at 3102 BC was 50° 23' and this conjunction occured at 350° 23' of *Suryasiddhānta* initial point.

From this data, Bentley calculated the planetary positions for different periods of time, and found that these errors were least in 1091 AD. He concluded that the text was composed in 1091 A.D. The complete table of errors for different years will be found in p. 24 of the same translation.

This identification of *Kali* epoch with 3102 B.C. is found to satisfy all the conventions on *Kaliyuga* as found in Indian astronomy, we mention some selected few only.

1. If we count 13,14,931 full days from February 18, 3102 BC we get 21 March, 499 AD. According to Indian conventions, Āryabhaṭiya parameters should give correct planetary positions on that date.

We reproduce the following entries from the table given in p. xx, *Āryabhaṭiya* of *Āryabhaṭa* by K.S. Sukla and K.V. Sarma, INSA (1975).

Mean positions of the planets at *Kali* 3600 elapsed i.e. on Sunday, March 21 AD 499, mean noon at Ujjain

Planet	Āryabhaṭa			Modern*		
	°	'	"	°	'	"
Sun	0	0	0	359	42	5
Moon	280	48	0	280	24	52
Mars	7	12	0	6	52	45
Mercury	186	0	0	183	9	51
Jupiter	187	12	0	187	10	47
Venus	356	24	0	356	7	51
Saturn	49	12	0	48	21	13

A comparison of Columns 2 and 3 confirms the Indian tradition that 3600 years *Kali* planetary positions required no corrections.

The Indian tradition is that the *Śaka* era was established when 3179 *Kali* years had expired. Varāhamihira has used this relation in finding *Jovian Years* in his *Bṛhat Saṃhitā*[12]. Brahmagupta has made specific mention of it.

The Siddhantic calendar till then had not developed in India, even then this tradition was handed down to astronomers of later India. Accordingly we get :

3179 *Kali* (exp.) = O *Saka* (exp.) = 78 A.D.

This relation fully satisfies all the relation between *Saka* and *Kali* year, their Christian equivalent years in Indian history. The Śaka equivalent 499 AD is 421, and this agrees with the Indian tradition on birthday of Āryabhaṭa.

The following story has been constructed to correlate the *Śaka era* and *Kaniṣka* era[13].

The *Śakas* left their homeland in central Asia under the leadership of Azes and conquered Bactria from the Parthian emperors in 123 BC. As a token of victory they founded an era in the same year. This era was used in the inscriptions collected in Konow's *A list*. It was called era of Azes after the name of this leader, but now it is called old *Śaka* era. Till then they had been using Greco Chaldean calendar. North-Western India was then under the control of several Greek dynasties and they had been using different eras, but the epochs of all these different eras are not known with certainity. These Śakas, under the leadership of Moga (Greek Maues) subdued these Greek rulers and infiltrated further inside India. They were then influenced by Indian culture and gradually adopted Indian names of months in their calendar but not the Indian system of *tithis* or moon's *nakṣatras*. Their calender was within the framework of Meton cycle. The *A list* inscription were inscribed by them.

The epoch of this *Old Saka era* was variously fixed at 88 BC (Konow), 120 BC (Jayaswal), 110 BC (Herzfeld), 150 BC (Rapson), 155 BC (Tarn) and in one extreme case, it was identified with the epoch of *Vikram Saṃvat* (57 BC). But recent researches have shown that 123 BC fits into most of the circumstantial evidences on the origin of this era.

The credit of these *Śakas* is that they first introduced in India a scientific system of date reckoning. This era had a far-reaching effect in India in asmuch as the Indian *Śaka era* till now in use, owes its origin to this *Old Śaka era*. The *Kuṣāṇas*, another Śakish tribe, came from Śakasthān (modern Afganisthan) and

founded an empire in India. They also adopted Indian culture and started using full moon ending months (within the scope of Meton cycle) following the tradition of *Mauryas* and *Sātavāhanas*. These *Kuṣāṇas*, from the time of *Kaniṣka* in 78 AD, started using the old *Śaka* year of 123 BC omitting the 100th place so that at 78 AD, the equivalent old *Śaka* year (123 + 78) 201 was reckoned as 1.

This epoch was adopted in Hindu astronomy as *Śaka* Year.

Week days

In Āryabhaṭa's works the *Kali* epoch is assigned a week day i.e. Friday. Week days do not occur in the *Aśokan* or *Kharoṣṭhi* inscriptions, or in the two great epics or in any early Indian literature. The first mention of weekday in India is found in the following inscription of King Budhagupta of the Gupta dynasty :

12th *tithi* of light half of *Āṣāḍha* of the Gupta year 165 fell on a Thursday.

We shall see next that all the dates of Gupta inscriptions can be deciphered and the above date corresponds to June 21, 484 AD.

Week days came to India by the 5th century AD and it is of foreign origin.

The ancient Jews believed that the 7 day week is of Divine origin, it is a creation of God Himself. In the first chapter of Bible, God is shown as creating the world according to a pattern of 7 days, a custom orginating from the Mesopotamian origin of the Jewish people. But these seven days were not called by specific names, they were simply marked as 1st day, 2nd day, ... 6th day and Sabbath day. This last day was earmarked for religious purposes.

By the beginning of the Christian era, this system of 7 day week was adopted by the Greco-Roman world. The days of the week were linked with the 7 planets known to them and named after the Roman Gods. These Roman names were changed into their Sanskrit equivalents in India and were adopted into Indian tradition by the 5th century. We give below in a tabular form this evolution of names of week days.

Jewish	Roman	Saxon	Indian
1st day	Dies Solis	Sun' day	*Ravi vāra*
2nd day	Dies Lunae	Moon's day	*Soma vāra*

3rd day	Dies Martis	Tiw's day	*Maṅgal vāra*
4th day	Dies Mercurii	Woden's day	*Būdha vāra*
5th day	Dies Jovis	Thor's day	*Bṛhaspati vāra*
6th day	Dies Veneris	Frigg's day	*Śūkṛa vāra*
Sabbath day	Dies Saturnis	Seterne's day	*Śani vāra*

But week days are not generally used in datings in India, its mention is not common in the Indian inscriptions.

The Indian System of Datings, Gupta Inscriptions

The inscriptions of the rulers of Gupta dynasty are also dated in months, *tithis*, years and a new dating element, Jovian year.

The time Jupiter stays in a sign of the zodiac is called a Jovian yeaṛ *Aśvayuja* (or *Mahā Aśvayuja*, to avoid confusion with the month *Aśvayuja*) is the time Jupiter takes to move through the first sign *meṣa* and in this order the 12 Jovian years are named.

It it at once apparent that the zodiac and its signs, the initial point of the zodiac were known to the court astronomers of the Gupta rulers. To find Jupiter's position at any time, its initial position at an epoch and its rate of motion must be known. It occurs to us that the great conjunction of *Kali* and the cycle of 4320000 years were used by these astronomers i.e. these data were ready at their hands. We shall show that the Āryabhaṭian parameters fit into these inscriptional dates.

As the initial point of the zodiac was used by these astronomers, we are inclined to believe that the *Caitra-Śuklādi* beginning of year was devised by that period and using these data we can decipher all these inscriptional dates.

From Al-biruni's accounts, the epoch of Gupta era falls on 241 years after *Śaka Kāla* and hence its epoch is 319 AD. This date has been accepted by historians.

By 300 AD, the vernal equinox was almost opposite to the bright star *Citra* (α Virginis) and so it could be easily recognised in the sky. Correctly speaking, the vernal equinox was exactly opposite to *Citra* in 285 AD, but we neglect this difference of a few minutes. From standard tables, on March 8, 319 AD, the moon was 77 days old, and it was a date just befitting the *Caitra Śuklādi* beginning of year.

The following Gupta inscriptions bear dates together with Jovian year :

	Date	Jovian year
1.	*Kārtika śukla* 3 of year 156	*Vaiśākha*
2.	*Caitra śukla* 2 of year 163	*Aśvayuja*
3.	*Māgha bahula* 3 of year 191	*Caitra*
4.	*Caitra śukla* 13 of year 209	*Aśvayuja*

According to the methods of Āryabhaṭa, total elapsed days from last conjunction upto *Śuklā Kārtika* 3 of Gupta year 156 (= Saka 397) = 1306378 days. Jupiter moves in so many days from beginning of *Meṣa* = 301 rev. 6 signs 7 degrees. As Jupiter is in the 7th sign, its year is (seventh from *Aśvayuja*) *Caitra*.

Similarly, the Jovian years of the other dates work out to be *Aśvayuja, Caitra* and *Aśvayuja Caitra* and *Aśvyuja*. We see that except for the first case, the rest three Jovian years agree with the methods of Āryabhaṭa. We are unable to account for this discrepancy of one year in the first case. It occurs to us that the court astronomers of the Guptas used a slightly greater speed of Jupiter which was changed by Āryabhaṭa.

We start with the Gupta inscription dated : Āṣāḍha śuklā 11 of the year 82.

Counting from *Caitra śuklādi* upto *Āṣāḍha śuklā* 11 of year 82, we get 82 x 12 + 3 = 987 months. Total intercalary months in so many months, according to Āryabhaṭa are 30. So, total *tithis* elapsed upto śuklā 11 are (987 + 30) x 30 + 11 = 30521. Total expunged *tithis* in so many *tithis* are 477. Finally, total civil days work out to be 30044 days. Counting so many days from March 8, 319 AD, we arrive at June 8, 401 AD and from a lunar table (say Lahiri's table) we find that mean Moon on that day was 10.22 days old, equivalent to 11th *tithi*.

By an exact process, we get the following Julian equivalents of Gupta dates. We have, in a few cases, adjusted the *aharganas* to an extent of one day only to get the desired day of Moon.

Gupta date	Aharganas from Gupta epoch	Julian equivalent date	Mean Moon
Āṣādha S 11 year 82	30043	8 June 401 AD	10.22
Kārtika S 3 year 156	57204	10 October 475 AD	3.08

Caitra S 2 year 163	59535	7 March 482 AD	1.16
Āṣādha S 12 year 165	60371	21 June 484 AD	11.31
Māgha B 3 year 191	70064	3 January 511 AD	17.27
Caitra S 13 year 209	76349	19 March 528 AD	12.26

Retrospect

The seals found in Indus Valley have not yet been deciphered. Opinions differ on the purpose for which these seals were made as to whether these were used on commercial connections or these bear datings or these are mere astronomical tablets. Surprisingly, except these seals no other literary compositions like pillar or rock or metal or terracotta inscriptions have been found in the entire valley. It is not known for certainity whether the Mohenjodorans had any dating system.

The Āryans settled in India around 2500 BC. We have seen that by 1500 BC they formulated a crude form of calendar, but we nowhere find any reference to datings. There was of course a process of recording chronology in terms of genealogical tables as we find in the two great epics. In *Rāmāyana.* (Bāl - 70), Vaśiṣtha has given the ancestral order of Rāma from Manu, Ikṣvāku and so on upto Daśaratha and in reply,, Janaka stated his ancestral order from Nimi down to himself. But dating proper was first introduced in India by Aśoka though in an imperfect form.

The Royal dynasty of Sātavāhanas after Aśoka also used datings in terms of their respective regnal years, but they made no improvements over the limitations of Aśokan system.

The Greeks, after conquering north-western India, established different eras but the epochs of these eras are not known. The Śakas, under their leader Moga (Maues in Greek) after ousting the Greeks from north-western India, established an empire extending upto Panjab between 2nd century BC and 1st Century AD. These Śakas left some dated inscriptions in *Kharoṣṭhī* scripts which are collected in Konow's A list. The era used in these inscriptions is now called Old Śaka Era and its epoch was variously estimated at 88 BC, 120 BC, 150 BC etc. But now, this epoch has been established at 123 BC.

By the 1st century AD, the Kuṣāṇas, a Śakish tribe, established a kingdom within Indian Soil. King Kaniṣka of this dynasty omitted the 100th place from this era in 78 AD and renamed the era as Kaniṣka era and reckoned it as expired or elapsed years. They gradually adopted Indian culture and fitted their original Greek

calendar into the Indian system. The Court astronomers of this dynasty assumed the title Śākadvipī Brāhmins and devoted to astronomical and astrological studies. Perhaps at their hands the Kaniṣka era changed its name to *Śaka* era and found a permanent place in Indian Astronomy. The *Śākadvipī Brāhmins* made a revolutionary change in astronomical studies in India.

The last phase in the evolution of eras in India is the Gupta era where this new astronomical science is fully reflected.

References

1. Sen, Amulya Chandra (1956) : *Aśoka's Edicts*, Indian Publicity Society, Balaram Ghosh Street, Calcutta.
2. *Mahābhārata* : Ādi 2.13, Vāna 149.39, Śalya 61.23.
3. Max Muller : Preface to *Ṛgveda Saṃhitā*, Vol IV. Also see R.C. Dutta, *Ancient India*, p. 601.
4. *Viṣṇu Purāṇa*, 4.24.39.
5. Konow, Sten (1929) : *Corpus Inscriptionum Indicarum*, Vol II Part I, Govt of India, Central Publication branch, Calcutta.
6. *Āryabhaṭiya* III - 10.
7. Sarma, K.V. (1987) : Revision of *yugas* and *yuga* constants in Indian Astronomy; *History of Oriental Astronomy*, Cambridge University Press, p. 78.
8. Ibid p. 80.
9. Ibid p. 81.
10. Sarma. K.V. : 'Observational Astronomy in Medieval India'. *Journal of Asiatic Society*, Vol. XXX Nos. 1-4, p. 31.
11. Ibid p. 32.
12. *Bṛhat Saṃhitā* VIII, 20-21.
13. *Report of the Calendar Reform Committee* (1955), Council of Scientific and Industrial Research, Old Mill Road, New Delhi. p. 233.