The ancient Indian concepts of time: Examining the concepts of Yuga, Manvantar, Sandhyās and Kalpa from Scriptures

Kashish Mishra
Saniya
Maitreyi College, University of Delhi

ABSTRACT

This paper looks at ancient Indian ideas about time found in important astronomical and religious texts, including the *Surya Siddhanta, Āryabhatiya, Siddhānta Śiromaṇi*, and *Śrīmad Bhāgavatam Mahāpurāṇa*. It examines time as divided into two main types: eternal time, which controls the creation and collapse of the universe, and measurable time, which is further split into *mūrta* (real) and *amūrta* (unreal) units. The study describes the smallest units of time, from paramāṇu (the indivisible particle) and truṭi to larger divisions like *prāṇa, vināḍī, nāḍikā*, and different types of months: *nakṣatra, sāvana, candra,* and *saura*.

The paper goes beyond daily timekeeping to explore larger cosmic cycles, including divya *varṣa* (divine years), *caturyuga* (four ages), *manvantara*, and *kalpa*. It discusses their definitions in scriptures and their proportional divisions, such as the 4:3:2:1 ratio of the yugas. It compares models found in these texts, especially the differences between the *Surya Siddhanta* and *Āryabhatiya* systems.

The discussion also points out traditional time-measuring devices created in India, like the *ghati yantra* (water clock), *sūrya ghati* (sundial), *dhoop ghadi* (incense clock), and *nakṣatra ghadi* (stellar clock). These tools show a practical use of astronomical knowledge in civil, agricultural, and ritual activities.

By linking traditional time units to human years and connecting them to modern astronomical ideas, this study connects ancient and current views. It highlights how India's timekeeping traditions show a complex blend of observational astronomy, cosmology, mathematics, and cultural practices. This offers important insights into the scientific and philosophical legacy of ancient India.

Keywords- Timekeeping, *Kalpa*, *Manvantara*, Unit Of Time, Ancient India

1.INDRODUCTION

Time is a complex concept. In Physics, time is treated as a fundamental quantity because of its non- dependence on other physical quantities. It is one of the 7 fundamental quantities. It is denoted by t and the SI unit is second. According to classical mechanics (non- relativistic domain), time is absolute meaning it does not depend on the observer's frame of reference. On the other hand, the special relative theory states time as relative quantity. It also treats time as the 4th co-ordinate along with the position (x, y and z), forming a system called spacetime (x, y, z and t).

Measurement is an integral part of human civilization. It is the process of comparing an unknown quantity with a standard quantity. Chronometry is the science of time measurement. The definition of SI unit of time, second is based on the properties of caesium atoms. We define "the second as 9,192,631,770 cycles of the radiation that corresponds to the transition between two electron spin energy levels of the ground state of the ^{133}Cs atom." Based on it, we divide our day into seconds, minutes and hours and a year into months. Hence, the Gregorian calendar has become the most widely used calendar. This is the most common method we are using for time keeping used all over the globe. Now the question arises: Was the time-keeping the same in earlier times as it appears now? Different civilizations have different calendars to track their important events. They have different units and devices to measure the time.

In this paper we will describe some units of time mentioned in *Surya Siddhanta*(real) and *Shrimad Bhagwat Mahapuran* (unreal). We have described the units mentioned in these books with some other books on astronomy. Ancient India created several innovative types of clocks, each based on natural elements and careful observation. One of the earliest was the *Ghati Yantra*, or water clock. This clock featured a bowl with holes that floated in water and sank after a set time known as a *ghati*, which is about 24 minutes. The *Surya Ghati*, or sundial, used the sun's shadow on a marked surface to indicate the hours. This method was famously used in observatories like Jantar Mantar. The *Dhoop Ghadi*, or incense clock, measured time by the slow burning of specially designed incense sticks or coils; it was often used in temples and homes. More advanced shadow-based devices, such as the *Chhaya Yantra*, measured both time and seasonal changes by looking at the shadow's length and angle. Large *Yantra Mandala* devices

combined various astronomical tools for precise timekeeping, while the *Nakshatra Ghadi* tracked time using the rising and setting of certain stars or constellations, which was crucial for identifying auspicious moments in Vedic rituals. Collectively, these clocks reflect India's deep understanding of astronomy, physics, and ritual timing. The paper includes five sessions - Introduction, major sources consulted with description, concept and classification of *kala* according to *Surya Siddhanta*, conclusion and reference. The section- concept and classification of *kala* according to *Surya Siddhanta* and conclusion is further divided into two sections - *Amūrta Kāla* – Immeasurable Units of Time and *Mūrta Kāla* – Measurable Units of Time which details about different types of units.

2. MAJOR SOURCES CONSULTED WITH DESCRIPTION

We used *Surya Siddhanta*, *Siddhantasiromani*, *Aryabhatiya* and *Shrimad Bhagawat Mahapuran*. Along with the primary sources mentioned above we used several other research papers including Hayashi (2017).

Hayashi (2017) gives us good insight into Units of ancient and medieval India. The author surveyed various books written in Sanskrit, some Indian languages, Buddha as well as Jain literature. He explored a variety of time units.

Surya Siddhanta is an astronomical book. The author of this advanced book is unknown to us. It was during the end of *kṛta yuga*, when this knowledge was revealed to Maya, an *asura* by a part of the Sun (□□□□□ □□□). The *asura* had a desire to know the supreme knowledge and Sun (demigod) fulfilled this desire of him. It has a total of fourteen chapters. We survey only the first chapter named mean motion of planets (□□□□□□□□□□□). We referred two commentaries - one by Mahavir Prasad Srivatsava and other by Ebenezer Burgess (edited by Phanindralal Gangooly).

Āryabhatiya is the work of Āryabhata. It deals with mathematics and astronomy. Later Bhaāskara did Commentary on the Āryabhatiya. Āryabhata uses different parameters than those used in popular astronomical books in his times. His *yuga- kalpa* system is different from *Surya Siddhanta* and several other books (we will discuss later).

The book contains four chapters, better known as *pādas* (like Patanjali *Yoga Sutra)*. We explored the first *pāda* (*Gītikā pāda*) and the third *pāda* (*Kālakriyā- pāda)*. We used the *Āryabhatiya* of *Āryabhata* by K. S. Shukla and K. V. Sharma.

Siddhantasiromani is also an astronomical treaty authored by *Bhāshkarācārya* II. He was the greatest mathematician and astronomer. Like *Āryabhatiya* it also consists of four books namely - *Līlāvatī*, *bījaganita, Golādhyāya* and *Grahaganita*.We referred to *Golādhyāya*, chapter- *Madhyamādhikāra*, *Kālamāna* (first section). We used *Siddhaānta Siromani* of *Bhāshkarācārya* by Dr. D. Arkasomayaji.

We referred to *Shrimad Bhagawat Mahapuran* by Geeta Press Gorakhpur and Bhaktivedanta Book Trust to give a brief introduction of units smaller than *Prāṇa.* Canto 3 chapter 11 gave the complete information of the unit of time from atomic to cosmic scale. This part is a conversation between Maitreya and Vidur, where they discussed about calculation of time from *paramāṇu* to a day of *Brahma*.

3. CONCEPT AND CLASSIFICATION OF *KĀLA* ACCORDING TO *SURYA - SIDDHANTA*

Surya-Siddhanta, chapter 1, *Shloka* 10 divided time into two two broad categories:

□□□□□□□□□□□□□□□□□□ □□□□□□□□ □□□□□□□□□□

□ □□□□□□ □□□□□ □□□□□□□□□□□□□□□□□□□□□□□□□□□□ □□□□□□ □□

(10)

The first type of *kāla* cause destruction of the world and often referred to as *lokānām antakṛt*. This category of time is eternal. The world is created, maintained and eventually destroyed after a specific period of time, but time can not be destroyed. Whereas the second category of *kāla* can be utilized by humans in counting. The latter is further divided into two types: unreal (a*mūrta*) and real (*mūrta*). This division of *mūrta* and *amūrta* is based on whether the unit is measurable or not by the instruments available at that time. The unit of time from *Prāṇa* and above is measurable and hence called *mūrta* (real time). The unit of time below *Prāṇa* to *truṭi* is called *amūrta* (unreal time).

3.1) *Amūrta Kāla* – Immeasurable Units of Time

Surya-Siddhanta explained only real time. It do not explain unit of time below *Prāṇa*. We can find it in several other astronomical treaties and non- astronomical treaties like *Shrimad Bhagawat Mahapuran*. According to *Surya-Siddhanta* unreal time starts from *truṭi*. We will explain the unreal time from *Bhagawat Mahapuran* as it offers an interesting method to

understand the unreal time. It talks about three terms *paramāṇu, aṇu,*and *trasareṇu* before describing *truṭi*. *Paramāṇu* is well explained in Canto 3, chapter 11 *shloka* 1.

□□□□ □□□□□□□□□□□□□□□□□□□□□□□□ □□□□

□□□□□□□ □ □□□□□□□□ □□□□□□□□□□□□ □□□□□ **(1)**

This *shloka* described *paramāṇu* as minutest particle of the nature. It can not be divided further. Now two *paramāṇu* make one *aṇu*. Further, three *aṇu* makes one *trasareṇu* (mote). Now, the *trasareṇu* is the dust particles, which is visible in the sunlight. The time required to by the sunlight to pass through the mote is called *truṭi*. This definition is given in the *shloka* 6 (a) **(**□□□□□□□□□□□□□□□ □□□□□□□□ □□ □□□□ □ □□□□□□□ □□□□□□□**)**.

Bhāskara II in his *Siddhantasiromani* defined *truṭi* as the time for cutting lotus petal with the finest needle. Now, 100 *truṭi* make one *Vedha*, three *Vedha* make one *Lava* and three *Lava* make one *Nimeṣa*. Bhāskara II defines *Nimeṣa* as time taken during the fall of an eyelid. Three *Nimeṣa* make one *kṣaṇa* (□□□□ , moment), five *kṣaṇa* make one *kāṣṭhā*, fifteen *kāṣṭhā* make one *Laghu* and finally, fifteen *Laghu* make one *nādikā*. *Kṣaṇa* is the time taken to cut three feet of thread according to *Śārdūlakarṇāvadāna*.

3.2) *Mūrta Kāla* – Measurable Units of Time

3.2.1 *Prāṇa*

Prāṇa is called as *svāsa* in *Brahmasiddhānta.* It is also known by the name of *asu* in other astronomical treaties. *Surya Siddhanta* chapter 1, *shloka* 11 define *prāṇa* as one-sixth of *vinādī*. It was the smallest unit of time which can be measured at that time and hence, called *mûrta* . *Padmasamhitā* chapter 5 (*Yogapāda)* define *prāṇa* as the vital breath or the life energy. In astronomy it is used as a unit of time. Bridging these two perspectives, commentators often relate it with the breath rate of a healthy person. Hence, interpreted *prāṇa* as time taken by a healthy adult to inhale or exhale under normal condition.

Bhaskaracharya in *Siddhānta Siromani* in define *prāṇa* in terms of Chand- Shastra. He explained that the time required to pronounce 10 long syllables (*gurvakṣara*) at moderate pace is called *prāṇa*. The same description can also be found in *Aryabhatiya*, chapter 3, *shloka* 2 ab. *Gurvakṣara* is the heavy syllable. It takes two *mātrās* (unit of time in Sanskrit prosody) to pronounce one *gurvakṣara.* Lyengar, Viswanathan and Sudarshan (2021) found that the average duration per *gurvakṣara* is 0.4 second. They conducted an experimental study to check how

precise the system of *gurvakṣara* meters was. From the above study we can conclude that 1 *prāṇa* = 4 second (approximately).

3.2.2 *Vināḍī*

Vināḍī is the period of 24 seconds.According to *Surya Siddhanta* 6 *prāṇa* make one *Vināḍī*. Other names for *Vināḍī,* which we can find in different astronomical books are *Vināḍikā, vighati, vighatikā, vigalige* and *pala*.

Āryabhaṭa in his *Aryabhatiya*, Chapter 3 *shloka* 2 ab define *Vināḍī* as

□□□□□□□□□□□□ □□□□□□□□□□□□□□□□□□, □□□□ □□ □□□□□□□□□ **(2 ab)**

Which means one sidereal *Vināḍī* is equal to 60 *gurvakṣara* (in moderate flow) or 6 *prāṇa*. One can find the same division in *Siddhānta Siromani* and several other astronomical works.

3.2.3 *Nāḍī*

Nāḍī is the period of 24 minutes. Like *vināḍī,* the more common names for *nāḍī* are *nādikā, ghati, ghatika, galige* and *danda* (*Shrimad Bhagawat Mahapuran),* but *Surya-Siddhanta* used none of the these terms. Instead, it define *nāḍī* by stating that one *nāḍī* is made up of 60 *vināḍī.* It can be measured by a water clock. There are two types of water clock which can measure *Nāḍī*. The first type is the overflowing type and the second one is the shrinking bowl type.Hence, the name changed from *nāḍī* or *nādikā* to *ghati* or *ghatika*. Both the devices were used to measure the same unit, but with different principles and setups. One such shrinking bowl type water clock is described in *Shrimad Bhagawat Mahapuran* in Canto 3, chapter 11 *shloka* 9.

□□□□□□□□□□□□□□□□□□□□ □□□□□□□□□□□□□□□□□□□□ □

□□□□□□□□□□□ □□□□□□□□□□□ □□□□□□□□□□□□□□□□□□□□ □ **(9)**

Translation: “A pot (of copper) weighing six Palas or ninety-six Māṣas (8 Tolas) and with a capacity of one Prastha (two seers) of water should be bored (at the bottom) with a gold needle weighing four Māṣas and four Aṅgulas (a finger’s breadth) long, and left on water. The time which will be taken by such a pot to be filled with and consequently submerged in water is known as a Nāḍikā.”

Eight *tolas* is equal to 92-gram, two seers is approximately two liter (water), four *māṣas* is equal to 3 gram (approximately) and four *aṅgulas* is approximately equal to 5 to 6 centimeter (width of our four fingers). In short, take a 92-gram copper pot with a 2-liter capacity. Make a bore at the

bottom using a 3-gram gold needle about 5–6 cm long. When placed in water, the pot takes one *nāḍikā* to fully submerge.

3.2.4 Ancient Classifications of Days and Months

60 *nāḍikā* make one *Nakshatra Ahoratram* (a pair of day and night). The *Surya Siddhanta* mentions four different types of months. The names of the four months are: *Nakshatra māsa, sâvana māsa, chandra māsa* and *sâura māsa.* According to *shloka* 12 and 13 of chapter 1

□□□□□ □□□□□□□ □□ □□□□□□□□□□□□□□□□□ □□□□□□□□□□□□ □

□□□□□□□□□□ □□□□□□□□□ □□□□□□□□□□□□□□□□□□□□ □□ **(12)**

□□□□□□□□□□□□□□ □□□□□□□□□□□□□□□□□□□ □□□ □□□□□□ □

□□□□□□□□□□□□□□□□□□□□ □□□□□□ □□□ □□□□□□ □□ **(13)**

A *Nakshatra māsa* is made up of 30 *Nakshatra Ahoratram* (sidereal day), 30 *Chandra tithi* make one *chandra māsa* (lunar month) and 30 *sâvana divas* make one *sâvana māsa* (civil month). The moment of sun from one zodiac sign to another is marked by *sankranti* and the period is called *sâura māsa*.

The rotation of the Earth gives us the sidereal day . It is the time taken by the earth to complete one full rotation on its axis with reference to a distinct star. Lunar month is based on the conjunction of the Sun and the Moon. The *Chandra māsa* is divided into two *paksha- Krishana Paksha* (waning phase of the moon) and *Shukla Paksha* (waxing phase of the moon). The 15th day of *Krishana Paksha* is called *Amavasya* (No moon) and the 15th day of *Shukla Paksha* is called *Purnima* (Full moon). The lunar month is calculated either from full moon to full moon or new moon to new moon. During *Amavasya*, the angle between the Sun and the Moon is nearly 0 degrees (the moon is closest to the Sun) with respect to the earth. The angle increases as the moon moves ahead in the east and finally reaches 178 or 180 degrees apart from the Sun. This period is called *Purnima*. The conjugation of the Earth and the Sun is called civil day. A civil day is measured from Sunrise to sunrise. The plane of the Earth around the Sun is called the ecliptic plane. This plane is divided into 12 *rashi* (zodiacs) and hence we have 12 solar months. The earth travels all the 12 *rahi* to complete one revolution around the Sun. The number of days in each month depends on the time required by the earth to travel the particular zodiac corresponding to that month. The solar year consists of 360 solar days. The solar system is based on *rashi* whereas the lunar system is based on *nakshatr*. According to *Surya-Siddhanta* a

chandra māsa is equal to one day of *pitra*, which means 30 lunar years make one year of *pitra*. Āryabhata on the other hand, replaces *chandra māsa* with human years (solar year), which is rejected by many modern scholars. The civil day system has been out of use since ages, in the field of time computation. All the astronomical treaties used solar years for calculation above one year. The solar year or *sâura varṣa* is called the human year in further calculations.

3.2.5 *Divya-varṣa*

Surya-Siddhanta chapter 12 *shloka* 45- 46

□□□□□□ □□□□□□□□□□ □□□□□□□ □□□□ □□□□□□□ □
□□□□□□□□ □□□□□□ □□ □□□□□□□□□□□□□□□□□□□ □□**(45)**
□□□□□□□□□□□□ □□□ □□□□□□□□ □□□□□□□□ □□□□ □
□□□□□□□ □□□□□□□ □□ □□□□□□□ □□□□□□□□□□□□ □□**(46)**
□□□□□□□□ □□□□□□□ □□□□□□□□□□□ □□□□□□□□ □
□□□□□□□□□□□□□□□□□□□□□□□□ □□□□□□□□ □□□□□□□□ □□**(47)**
□□□□□□□□□□□□ □□□□□□□□□□□□□ □□□□□□□□□□□□□□□ □
□□□□□□□ □□□□□□□□□□□□□ □□□□□□□□□□□□□□□□□□□□ □□**(48)**
□□□□□□□□□ □□□□□□□□□□□□□□□ □□□□□□□□□□□ □□ □
□□□□□□□□□□□□□□□□□□□□□□□□□ □□□□□□□□ □□□□□□□□□□□ □□**(49)**
□□□ □□□□□□□□ □□□□□□□□□□□□□ □□ □□□□□□□□□□ □
□□□□□□□□□□□□□□□ □ □□□□□□□□□□□□□□□□□ □□**(50)**

The *devas* and *asuras* are considered to reside at the opposite point of the universe. When the Sun is in the northern hemisphere (Aries to Libra or *uttarāyana*) it is visible to *devas* but not to the *asura*. This means it is morning hours of *deva* but night hours for *asura*. Similarly, when the Sun is in the southern hemisphere (Libra to Aries or *daksināyana*) it is visible to *asura*. So, it is morning for *asura* and night for *deva*. This statement means that our 6 months (solar months) is day/ night for *deva* / *aura* and next six months is night / day for *asura* / *deva*. So, the length of the total day should be one solar year or one human year (HY).

This is what *Surya-Siddhanta* chapter 1 *shloka* 13 and 14 said:

□□□□□□□□□□□□□□□ □□□□□□□□□□□□□□□□□□□□ □□□□ □□□□□□□ □
□□□□□□□□□□□□□□□□□□□□ □□□□□□□ □□□□ □□□□□□□ □□ **(13)**
□□□□□□□□□□□□□□□□□□□□□□□□□□□□□ □□□□□□□□□□□ □

□□□ □□□□□□□□□□□□ □□□□□□ □□□□□□□□□□□□ □ □□ **(14)**

Twelve solar months make one solar year which is equal to one day of *deva*. This period is called *divya din*. The six times sixty of *divya din* make one complete year of *deva* / *asura* called *divya varṣa* (DV). Therefore

1 DV = 360 *divya* / *asura din* ——————————— (1)

1 DV = 360 HY ——————————— (2)

Nalla (2020) tries to correlate the Indian units of time mentioned in ancient texts and modern astronomical events. Nalla (2020) made an attempt to find a planet named X. The planet X has an orbital period of 360 HY. Nalla's work provides a new horizon for interdisciplinary study of astronomy and the Indian time keeping system and encourages deep research in IKS.

The *Surya-Siddhanta* and other books use *divya varṣa* or divine year (DV) for calculating higher time periods. We use Human Years (HY) to understand the time period more precisely. So, we need to learn equation 2 for further calculations.

3.2.6 *Caturyuga* / *Mahāyuga*

The period of twelve thousand divine years is called *Caturyuga* (CY) or Quadruple Age. The word *Caturyuga* can be found in *shloka* 17 (chapter 1) of *Surya-Siddhanta* only. In the preceding verses *yuga* is employed to denote it. *Aryabhatiya* and *Siddhānta Siromani* also used *yuga* but *Shrimad Bhagwat Mahapuran* preferred *Caturyuga.* We will use *Caturyuga* (CY) to avoid any confusion.

Reconsidering equation (2) i.e. 1 DV = 360 HY

Also, 1 CY = 12,000 DV ——————————— (3)

Therefore, 1 CY = 12,000 × 360 HY

⇒ 1 CY = 43,20,000 HY ——————————— (4)

The duration of a *Caturyuga* i.e 12000 DV or 43,20,000 HY is consistent in all four books mentioned above. The difference lies in the manner in which the *yuga* is divided.

We will first describe *Surya-Siddharth's* model of *Caturyuga* (see figure 1). For this we need to refer chapter 1 *shloka* 15-17

□□□□□□□□□□□□□□□□ □□□□□□□□□□□□□□□□□□ □

□□□□□□□□□□□□□□□□□□ □□□□□□□□□□□□□□□□□□□□□□ □□ **(15)**

□□□□□□□□□□□□□□□□□□□□□□ □□□□□□□□ □□□□□□□□□□□□□ □

□□□□□□□□□ □□□□□□□□□□ □□□□□□□□□□□□□□□□ □□ **(16)**

□□□□□□ □□□□ □□□□□□□□□□□□□□□□□□□□□□□□□□□□ □

□□□□□□□ □□□□□□□□□□□□ □□□□□□□□ □□□□□□□□□ □□□□□□□□ **(17)**

Translation:"Twelve thousand of these divine years are denominated a Quadruple Age (*caturyuga*); of ten thousand times four hundred and thirty-two solar years. Is composed that Quadruple Age, with its dawn and twilight. The difference of the Golden and the other Ages, as measured by the difference in the number of the feet of Virtue in each, is as follows : . The tenth part of an Age, multiplied successively by four, three, two, and one, gives the length of the Golden and the other Ages, in order : the sixth part of each belongs to its dawn and twilight." (15- 17)

According to the above description it is divided into four *yuga*s- *kṛta yuga, tretâ yuga, dvâpara yuga and kali yuga*. One can determine the number of human years by using the formula given in the verse 17 i.e.

Time period of a particular *yuga* = $\frac{\square\square\square\square\square\ \square\square\square\square\square\square\ \square\square\ \square\square\square\square\square\square\square\square\square \times \square}{10}$ ——————————— (5)

Where, Total period of *Caturyuga* = 43,20,000 HY

N is the ratio of *dharma* (righteousness)

In *kṛta yuga, darma* stands on its four legs, in *tretâ* three, in *dvâpara* two and in the age of *kali* only one leg is left. Therefore for *kṛta yuga, tretâ yuga, dvâpara yuga* and *kali yuga* N is equal to 4, 3, 2 and 1 respectively. Therefore, total period of all four *yugas* including dawn (*sandhyā*) and twilight (*sandhyāṃśa*) is:

Total duration of *kṛta yuga* = $\frac{43,20,000 \times 4}{10}$ HY = 17,28,000 HY ——————————— (6)

Total duration of *tretâ* twilight = $\frac{43,20,000 \times 3}{10}$ HY = 12,96,000 HY

Total duration of *dvâpara yuga* = $\frac{43,20,000 \times 2}{10}$ HY = 8,64,000 HY

Total duration of *kali yuga* = $\frac{43,20,000 \times 1}{10}$ HY = 4,32,000 HY

We can call it the 4:3:2:1 system. This system was adopted in *Siddhānta Siromani* and *Shrimad Bhagwat Mahapuran*.

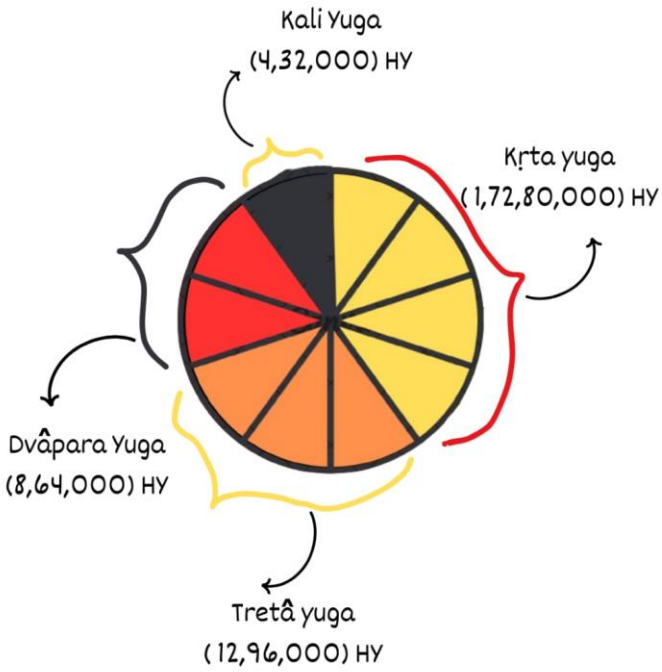

Figure 1: Sub - division of *Caturyuga* according to *Surya-Siddharth* (software used- canva)

Now, let's discuss *Aryabhatiya's* model (see figure 2). To understand our second model we need to refer *shloka*

□□□□□□□□□□ □□□□□□□□ □□□□□□□□□□□□□□ □□□□□□ □ □

□□□□□ □□□□□□ □□□□□□□□□□□□□□ □□□□□□□□□□□□□□□□□□ □

Translation: "The (first) half of a yuga is *Utsarpini* and the second half *Apasarpiṇi*. Suṣama occurs in the middle and Duṣṣama in the beginning and end. (The time elapsed or to elapse is to be reckoned) from the position of the Moon's apogee."

Āryabhata divided a *yuga* into two equal halves. The time period of each part is 21,60,000 HY. If we add the two halves we will get 4,32,000 HY. The first half is called *Utsarpini* (the auspicious one) and the second half is called *Apasarpinī* (the inauspicious half). The *Utsarpini* is further subdivided into two *dussamā* (10,80,000 HY) and *susamā* (10,80,000 HY). The *Apasarpinī* also has the same division but the first half is *susmā* (10,80,000 HY) and second half is *dussamā* (10,80,000 HY). We can find a similar division in Jain philosophy (*Jambūdvīpaprajñaptisūtra*). As stated earlier, both systems yield the same result i.e 43,20,000 HY.

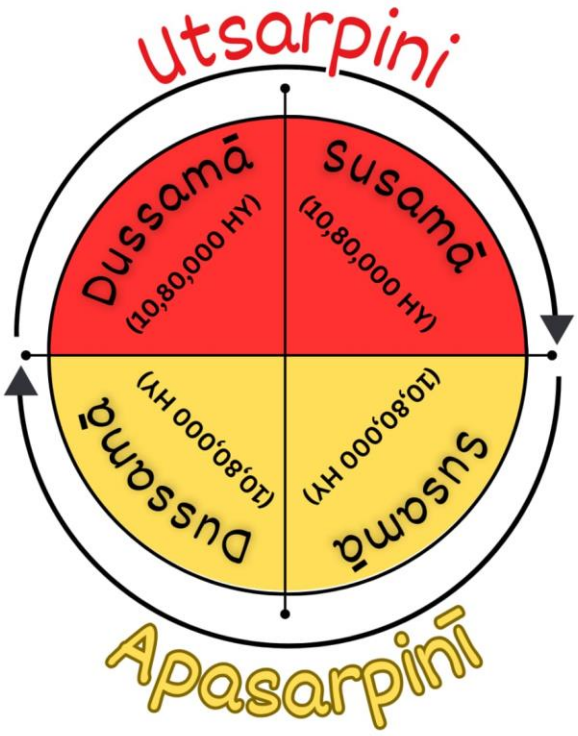

Figure 2: Sub - division of *Caturyuga* according to *Aryabhatiya* (software used- canva)

3.2.7 *Manvantara*

Manvantara is made up of two words- *manu* and *antara*. *Manu* is a universal ruler. He rules one *Manvantara* and then *Brahmā* creates another *Manu*. His lifespan is called *Manvantara*. In this case also both books have different opinions. The difference arises due to their way of handling the surplus time (we will discuss in the *kalpa* section). The *Surya-Siddhanta* consider the lifetime of manu as 71 *Caturyuga* (71 times repetition of four *Yugas*) whereas *Aryabhatiya* consider it as 72 *Caturyuga*.

According to *Surya-Siddhanta* the value of a *Manvantara*

1 *Manvantara* = 71 CY = 71 × 43,20,000 HY (from equation 4)

1 *Manvantara* = 30,67,20,000 HY ——————————— (7 a)

According to *Aryabhatiya* the value of a *Manvantara*

1 *Manvantara* = 72 CY = 72 × 43,20,000 HY (from equation 4)

1 *Manvantara* = 31,10,40,000 HY ——————————— (7 b)

According to *Shrimad Bhagwat Mahapuran* the current *Manu* is *Vaivasvata Manu*. At the end of each *Manvantara* there is mass destruction of the dominant species on Earth. Nalla (2021) compared one *Manvantara* period with the galactic year or cosmic year. It is the time required by our solar system to complete one full orbit around the center of the Milky Way galaxy. A;though, the time period is similar, not the same.

3.2.8 *Kalpa*

Two *Kalpas* together form one complete day of *Brahmā*. One *Kalpa* consists of 14 *Manvantara*. If we add the lifespan of 14 *Manus*, there still remains some extra time to complete one *Kalpa*. This extra time is called a surplus. Some early *purānas* and *Manusmriti* do not talk about this surplus. They mentioned that 71 *Caturyugas* is equal to one *Manvantara* and one *Kalpa* has 14 *Manu*.

The problem of this surplus can be solved by two methods. The first method is described in *shloka* 18- 20, chapter-1, *Surya-Siddhanta*

□□□□□□□ □□□□□□□□□□□□ □□□□□□□□□□□□□□□□□ □
□□□□□□□□□□□□□□ □□□□□□□□□ □□□□□□ □□□□□□□□ □□□□□□□ □ **(18)**
□□□□□□□□□□ □□□□ □□□□□ □□□□□□□□□□□□□□□ □
□□□□□□□□□□ □□□□□□□ □□□□□ □□□□□□ □□□□□□□ □□ **(19)**
□□□□□ □□□□□□□□□ □□□□□□□□□□□□□ □
□□□□□ □□□□□□□□□□ □□□□□□□□ □□□□□□ □□□□ □□□□□ □ **(20)**

Translation: “One and seventy Ages are styled here a Patriarchate (*manvantara*); at its end is said to be a twilight which has the number of years of a Golden Age, and which is a deluge. In an Mon (kalpa) are reckoned fourteen such Patriarchs (manu) with their respective twilights; at the commencement of the Mon is a fifteenth dawn, having the length of a Golden Age. The Mon, thus composed of a thousand Ages, and which brings about the destruction of all that exists, is styled a day of Brahmā; his night is of the same length.”

Now, *Surya-Siddhanta* solved the problem of surplus by adding 15 joints (□□□□) with 14 *Manvantara*. As explained earlier, there are two twilight before and after each *yuga* but we also have one twilight after each *Manvantara*. Unlike *yuga* (two twilight at the beginning and end of each *yuga*), each *Manvantara* is followed by a twilight period at the end. The book also assumes that a twilight period occurs at the starting of every *Kalpa*. Considering all these, we can

conclude that one *Kalpa* has 15 twilight periods. The time period of one twilight is equal to time period of *Kṛta*. Now, lets see the further calculations:

Reconsidering equation (7 a) i.e

1 *Manvantara* = 30,67,20,000 HY

We know,

1 *Kalpa* = 14 *Manvantara* + 15 twilight (□□□□)

1 *Kalpa* = 14 × 30,67,20,000 HY + 15 × 17,28,000 HY (from equation 7 a and 6)

1 *Kalpa* = 4,29,40,80,000 + 2,59,20,000 HY

1 *Kalpa* = 4,32,00,00,000 HY ———————————— (8)

Also 1 *Kalpa* = 1000 CY = 1000 × 43,20,000 HY = 4,32,00,00,000 HY (this relation is given in *shloka* 20)

Another solution to the surplus problem is given in *Aryabhatiya* by the author Aryabhata in chapter 1, *shloka* 5 (ab)

□□□□ □□□□ □, □□□□□□□□ □□□, □□□□□□□ □, □□□□□□□□ □□□□ □□**(5 ab)**

Translation: “A day of Brahmā (or a Kalpa) is equal to (a period of) 14 Manus, Since and (the period of one) Manu is equal to 72 yugas.”

As we already discussed, Aryabhata assumes the lifespan of *Manu* as 72 *Yugas*. Due to this, the whole system changed. Now we need no joints (as no extra time remains). Now the time period of 14 *Manus* alone can define one *Kalpa*. Just a small correction is needed. Instead of writing 1000 *Caturyugas* as one *Kalpa*, we will write 1008 *Caturyugas* to make one *Kalpa*. This will make all the maths fit perfectly without needing extra joints. In the form of equation:

Reconsidering equation (7 b) i.e

1 *Manvantara* = 31,10,40,000 HY

1 *Kalpa* = 14 *Manvantara* = 14 × 31,10,40,000 HY = 4,35,45,60,000 HY

Also 1 *Kalpa* = 10008 CY = 1008 × 43,20,000 HY = 4,35,45,60,000 HY

The value of one *Kalpa* from both the methods is slightly different. This version is only followed by a few and a majority preferred *Surya-Siddhanta’s* version. It is interesting to note that the author of *Natvāśivam* used 1008 yuga but used the 4:2:3:1 system to divide a *Caturyuga* (Unlike Āryabhaṭa’s special idea of equal parts for the *Caturyuga*). We are not numbering this equation because we do not use this equation further. We will also consider the *Surya-Siddhanta* method i.e 1 *Kalpa* = 1000 *Caturyugas* (equation 8) for further calculation.

4.2.9 One complete day of *Brahmā* and lifespan of *Brahmā*

Many people mistakenly believe that one *Kalpa* makes up an entire day of Brahmā but instead two *Kalpa* together completes one full day of *Brahmā*. This concept often causes confusion, but the *Sūrya-Siddhānta* clarifies it in *Shloka 20* i.e, "The *Kalpa*, thus composed of a thousand Ages, and which brings about the destruction of all that exists, is styled a day of Brahmā; his night is of the same length." The day mentioned in the above translation is the first half of a complete day and night is the second half. Now, adding two *Kalpa* we get:

One complete day of *Brahmā* = 1 *Kalpa* + 1 *Kalpa* = 4,32,00,00,000 + 4,32,00,00,000 HY (value of *Kalpa* from equation 8)

⇒ One complete day of *Brahmā* = 8,64,00,00,000 HY ——————————— (9)

The total age of *Brahmā* is 100 years. After that a new *Brahmā* is created. If we calculate *Brahmā's* age in human year, we will get :

One year of *Brahmā* = 8,64,00,00,000 × 360 HY

Lifespan of *Brahmā* = 31,10,40,00,00,000 × 100 HY

Lifespan of *Brahmā* = 31,10,40,00,00,00,000 HY ——————————— (10)

Equation 10 gives the lifespan of *Brahmā*.

1 Vedha = 100 Truti
1 Lava = 3 Vedha
1 Nimesa = 3 Lava
1 Ksana = 3 Nimesa
1 Kastha = 5 Ksana
1 Laghu = 15 Kastha
1 Nadika = 15 Laghu

Table 1: Division of Time according to *Shrimad Bhagawat Mahapuran* (unreal time) (software used- google sheet)

1 Vināḍī = 6 Prāṇa
1 Nnāḍī = 60 Vināḍī

1 Nakshatra Ahoratram = 60 Nnāḍī
1 Divya din = 12 Solar months
1 Divya- Varsa = 360 Sâura varṣa
1 Caturyuga = 12,000 Divya- Varsa
1 Manvantara = 71 Caturyuga
1 Kalpa = 14 Manvantara + 15 Sandhya
1 Kalpa = 1000 Caturyuga
1 Complete Day of Brahmā = 2 Kalpa
1 year of Brahmā = 360 Brahmā day
Life span of Brahmā = 100 Brahmā year

Table 2: Division of Time according to *Surya-Siddhanta* (real time) (software used- google sheet)

1 Prāṇa = 4 second
1 Vināḍī = 24 second
1 Nnāḍī = 24 minute
1 Divya- Varsa = 360 HY
1 Caturyuga = 43,20,000 HY
1 Manvantara = 30,67,20,000 HY
1 Kalpa = 4,32,00,00,000 HY
1 Complete Day of Brahmā = 8,64,00,00,000 HY
1 year of Brahmā = 31,10,40,00,00,000 HY
Life span of Brahmā = 31,10,40,00,00,00,000 HY

Table 3: The time division in terms of Human Year (software used- google sheet)

4. CONCLUSION

As mentioned earlier, this paper explained about different units of time used in two primary books namely *Surya-Siddhanta* and *Shrimad Bhagawat Mahapuran*. In this work we have tried

to give a detailed explanation about real time (*mūrta*) and briefly introduce the unreal time (*amūrta*), as we understand it at present.

The *Shrimad Bhagawat Mahapuran* also mentions units like *yāma, prahara, ayana, ritu* and *muhurat*. It also mentions the relationship between them and *Prāṇa*. *Aryabhatiya* mention a parallelism between the division of the circle (bha- gaṇa) and division of a *Nakshatra Ahoratram*. Bhāskara I define the term *ksetra* as the ecliptic. According to verse 3.2 cd circle (ecliptic) can be divided into *kalās*, *vikalās* and *tatparās*. Now consider the below table 4.

1 Revolution = 12 Sign (zodiac signs)
1 Sign = 30 degrees
1 degree = 60 kalas
1 kala = 60 vikalas
1 vikala = 60 tatparas

Table 4: The circular division (software used- google sheet)

We can see the similarity between the above two tables. So, we can conclude that *Prāṇa* is the time taken by the *Nakshatra Mandala* to move one arc minute. This parallelism can be seen in *Siddhāntaśiromaṇi* and *Brāhmasphuṭasiddhānta*. The english commentary on *Surya-Siddhanta* used for this research work also mentioned the same definition of prana. While explaining *shloka* 12 of chapter 1 the commentator writes “This is the method of division usually adopted in the astronomical text-books: it possesses the convenient property that its lowest subdivision, the respiration, is the same part of the day as the minute is of the circle, so that a respiration of time is equivalent to a minute of revolution of the heavenly bodies about the earth. The respiration is much more frequently called asu, in the text both of this and of the other Siddhantas.” Here the word respiration is *Prāṇa*. Ancient astronomical texts describe two different systems for measuring a day and a year, which are further extended to calculations of a *kalpa* and beyond. Unlike modern systems, where the measurement of days and years is interlinked, these two systems have no direct correlation with each other. The duration of a day is determined using the concept of *Nakshatra Ahoratram*. The length of a human year is calculated on the basis of the solar year. So the conversion of a day to a year is not given. Hence, no direct conversion from a day to a year is provided in these ancient systems.

Unlike the Western approach, the Indian timekeeping system is based not on convenience but on precision. Units such as the kalpa and yuga are not merely *purānic* philosophy but also serve in the computation of the mean motion of celestial bodies across the celestial sphere.

5. REFERENCE

[1] Joshi, D. (2020). Measurement of time (Ms. Sangeeta Abhyankar, Ed.; Siddhi Nitin Mahajan, Trans.; First). Vijnana Bharati, Head Quarter, Delhi. https://bvmap.org/images/bvmap/publications/Measurement_of_Time_English.pdf

[2] Wikipedia contributors. (2025, August 11). Spacetime. Wikipedia. https://en.wikipedia.org/wiki/Spacetime

[3] Wikipedia contributors. (2025a, May 4). Measurement. Wikipedia. https://en.wikipedia.org/wiki/Measurement

[4] Bhattarai, S. (2025, April). Ancient precision: A comprehensive analysis of traditional Hindu time yantras, calculation methods, and chronometric accuracy [Preprint]. ResearchGate. https://dx.doi.org/10.13140/RG.2.2.32616.79363

[5] Srivatsava, M. P. (1940). *Surya Siddhant Ka Vighyan Bhashya* (Vol. I). Allahabad.

[6] Burgess, R. E. (1935). *Translation Of The Surya- Siddhanta- A text Book Of Hindu Astronomy.* (P. Gangooly, Ed.) Calcutta: University Of Calcutta.

[7] Vedavayas, M. (n.d.). *Shrimad Bhagvat Maha Puran (code- 26)* (Vol. I). Gitapress Gorakhpur.

[8] Vedavayas. (n.d.). *Srimad Bhagavata Maha Purana With Sanskrit Text And English* (Vol. I). (C. L. Goswami, Trans.) Gita Press, Gorakhpur.

[9] JARKASOMAYAJI, D. D. (1980). *SIDDHĀNTA SIROMANI OF BHASKARĀCĀRYA.* KENDRIYA SANSKRIT VIDYAPEETHA.

[10] Aryabhata. (1976). *Aryabhatiya of Aryabhata* (Vol. I). (K. S. by K. V. Sarma, Ed.) Indian National Science Academy.

[11] B.V.Subbarayappa, K.V.Sarma. (1985). *Indian Astronomy - A Source Book.* BOMBAY: NEHRU CENTRE .

[12] Hayashi, T. (2017). The Units of Time in Ancient and Medieval India. *History of Science in South Asia*, 1- 116.

[13] Iyengar, Sudarshan, Viswanathan, *Akṣara the Basic Unit of Time Measure in Ancient India.* (2020, August 15). Retrieved August 15, 2025, from researchgate: https://www.researchgate.net/publication/348501311_Aksara_the_Basic_Unit_of_Time_Measure_in_Ancient_India

[14] Sarma, N. (n.d.). *Measures of time in ancient India.* Retrieved from academia: https://www.academia.edu/47520078/Measures_of_time_in_ancient_India?email_work_card=view-paper

[15] Nalla, V. (2022, October 17). *Decoding Indian Units of Time into modern* . Retrieved August 15, 2025, from researchgate: https://www.researchgate.net/publication/346192775