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Concept of Time in Indian Astronomy

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Abstract
Time is an important tool for mankind. We follow it with clocks and calendars. It is very important to measure time, as it keeps track of the age of people, animals and anything around us. Measuring time is always relative and not absolute. The need for fixing proper time for performing rituals urged the astronomical quest in India..Astronomy is a science which plays a vital role in our day to day life. The Hindu Calendar is called Pañcāṅga. Pañcāṅga is a tool for knowing the movement and position of various celestial objects. It is used to calculate the auspicious timings of any day for performing the rituals. It is based on the positions of Sun and Moon. Calculation and measurement of time had been a need and an enigma for man from time immemorial. As time passed man used various methods and devices for its measurement. Man keeps improving upon his methods and devices.

Keywords: Time, Horology, Pañcāṅga, Tithi, Nakṣatra, Yoga, Karaṇa

Introduction

Time is an important factor in our life. Time exists as thefourth dimension in science. Time travels in one direction, it is impossible for us to go back in time in our life and change the events that happened. We can only reset our clocks but not our lives. Time is everything. Time is identical with everything in the world. It is said

स्रवं संवत्सरः (S'B XIII.4.1.5 ibid 5.1.4, ibid 5.3.11)

Time is potent. Time follows the principle of equilibrium. Time is Uniform. Time has specific form. Time is Cyclic. Each time cycle is said to have three states: sṛṣṭi, sthiti, laya. Sṛṣṭi means Creation, sthiti means perservation and laya means dissolution. Each time cycle starts with creation, continues to exist for sometime and then dissolves.

This is evident from the life of a seed. Seed when planted grows into a plant, and then into a tree, bears flowers, fruits, again from the fruit another seed issues out, which has a potential tree in it. Everything in this world is explained in the context of space and time which are closely interlinked.

Time is interpreted differently by a physicist, an archaeologist and a philosopher. During Vedic time, Time used to be an important factor in the performance of Vedic rituals. Every ritual used to be performed at a specific time only. It is believed that the ritual bears the desired effect only when performed at a specific time in the specific manner. Astronomy has been a part of life right from the Vedic times. The earliest text on Astronomy that we can trace back and is available now is Vedāṅga jyotiṣam (Vedic astronomy).

In Indian texts, Time holds the form of measurement and also a great philosophical place. Time (कालः) is seen as a measurement, as a source of creation and also as a destroyer of beings. It is said in Bhagavad Gita, by Sri Krishna,

अहमेवाक्षयः कालः (B.G.X.38)

Sūrya-siddhānta classifies time as measurable and immeasurable. The immeasurable form of time is the one, that which is taken in the philosophical aspect.

Time in Vedas

Earliest reference we find for time is in theṛgveda. We find the wheel of year a which has 12 spokes and 3 hoves. It is said the 12 spokes refers to the 12 months of an year and the 3 hoves to the 3 seasons. We also see that they refer to the wheel of year with 360 spokes, where the spokes refer to the 360 days of a luni-solar year.

The Rgveda (I.164.11) says that the 720 sons of year are joined in pairs. This refer to the days and nights (360+360) of the year. In Atharva Veda we find two suktas dedicated for time.

कालो ह स्रवस्येश्वरः (AV. XIX.54.8)
प्रथमो नु देवः (AV.XIX.53.2)

These *sukta-s* say Time as the Lord of all and consider Time as the primal deity.

Time in the Upanishads

Though the principle subject of discussion in the Upanishads is Brahman, we also find a lot of discussions about Time here in Upanishads. Concept of time and space always goes together. They cannot be separated. In the Maitri Upanishad, it is said that Brahmam is of both the forms, He is the time and He is Timeless, which has much deeper philosophical meaning.

द्वे वावा ब्रह्मणो रूपे कालाश्चाकालाश्च। (Mai.Up. VI.15)

Measurement of Time

The science of measuring time is **Horology**. People who deal with time measuring instruments and scholars of horology are known as **Horologists**. Indians used the Calendar, pañcāṅga, for measuring time and fixing the appropriate time for the rituals. The pañcāṅga, as the name suggests has five parts (pañca-5 aṅga-limbs). They are

- Vāra (वार)
- Tithi (तिथि)
- nakṣatra (नक्षत्र)
- yoga (योग)
- karaṇa (करण)

Different types of pañcāṅga are followed in different parts of India. From Ancient times, Indians have followed two types of calendrical systems (i) Solar and (ii) Luni-solar. The calendrical system which is purely dependent upon the Sun's position is called are the **Solar calendar**. The Solar year starts when the Sun reaches th constellation with the star 'Mesha' in the Ecliptic. It occurs mostly around April 14th.

In India, two systems prevailed, as the New moon or Full moon may be taken as the end of a lunar month. They are : (i) Amānta and (ii) Purnimānta. In Amanta system the month starts with Sukla paksha pratipad and ends with Krishna paksha Amavasya. It is called '**Amānta**' as it ends with Amavasya. In Purnimanta system the month starts with Krishna paksha pratipad and ends with Sukla paksha Poornima. It is named **Purnimānta** as the month ends with Purnima. The Purnimanta system is mostly used in North India and the Amanta system in South India.

Let's see about the five limbs of the pañcāṅga briefly.

Vāra (वार)

A natural day i.e, a **solar day** is called as a vāra or sāvana divasa in Indian Astronomy. A solar day is measured usually from Sunrise to next sunrise. We say that a solar day has 24 hours, which actually is 23h 56m 4s. The variation in the time of a day is due to the slowing down of the Earth's rotation by 1 second every four years. The time taken by the earth to revolve around itself in tis own axis is known as a Solar day or sāvana divasa. It can also be said that, a Sauradina is the time-interval of time during which the Sun moves through 1° of the ecliptic.

A week is said to have seven days. The Naming of the days of a week is similar in Europe and in India. It is said that a day is determined or measured by Sun and Moon. The days are named after Sun, Moon and the 5 Principal planets.

1st day – Sun – रवि; 2nd day – Moon – सोम
3rd day – Mars – मङ्गल; 4th day –Mercury – बुध
5th day – Jupiter – गुरु; 6th day – Venus – शुक्र
7th day – Saturn – शनि

Time division that we could see in most of the ancient Indian texts is as follows:

Prativipala	= 0.006 of a second	
60 prativipala	= 1 vipala	= 0.4 of a second
60 vipala	= 1 pala	= 24 second
60 pala	= 1 ghatikā	= 24 minute
60 ghatikā	= 1 divasa	= 1 Solar day

In the Khaṇḍakhādyaka of Brahmagupta, another unit that is given as

6 prāṇas = 1 vināḍī

It also gives the Units of Angular Mrasurement as follows:

60 viliptās, vikalās or seconds = 1 liptā, kalā or minute

60 liptās	= 1 aṁśa, bhāga or Degree
60 aṁśas	= 1 Rāṣī or sign
60 rāṣīs	= 1 Bhagaṇa

Tithi (तिथि)

A tithi is a thirtieth part of a cāndra māsa, a lunar month. The interval between two amāvāsya or two pūrṇima is called as a lunar month. Suppose it is a New moon day, i.e, the Sun and moon are in 'conjunction'. When the Sun travels nearly 1° moon travels nearly 13.17°, i.e, the angular separation of the Sun and Moon would be nearly 12° per day. After nearly 29 ½ days, the moon and the Sun would be in 'conjunction' again. This period is called a 'Lunar Month' or 'Cāndra Māsa'.

The time taken for the angular separation to be 12° is called as a "**Tithi**". This angular separation is not uniform for all the days, thus the duration of the 'tithi's is also not equal. It is to be noted that the average duration of a tithi is 29.23/30, which is lesser than a solar day. We have 30 tithi s in a Cāndra Māsa. The Cāndra Māsa is divided into two fortnights or pakṣa.

The period between an amāvāsya and the following pūrṇima is called 'the bright fortnight' or the 'śukla pakṣa'. It is the waxing period of the moon. The śukla pakṣa is nearly 14 ¾ days and consists of 15 Tithis. Similarly, the period between a pūrṇima and the following amāvāsya is called the 'dark fortnight' or the 'kṛṣṇa pakṣa'. It is the waning period of the moon. Its duration is also 14 ¾ days and consists of 15 Tithis.

The names of the Tithis are prathamā, dvitīyā, tṛtīyā, caturthī, pañcamī, ṣaṣṭhī, saptamī, aṣṭamī, navamī, daśamī, ekādaśī dvādaśī, trayodaśī, caturdaśī, pūrṇimā.

Nakṣatra (नक्षत्र)

The path of motion of the Sun is known as 'Ecliptic' or the 'krānti-vṛtta', and is a great circle in the celestial sphere. The belt of sky, the 'Bha-cakra' is 18° wide, is known as the 'Zodiac'. This zodiac is divided into 12 zones, each one 360°/12 = 30° (approx), known as Constellations (rāśīs). There are 27 Nakṣatras in the Indian Astronomy. A 28th Nakṣatra, namely abhijit is also taken in account. A Nakṣatra is also a part of the division of the Zodiac. Nakṣatra is 1/27th part of the zodiac, i.e, each Nakṣatra division is nearly 360°/127 = 13°20' wide on the zodiac.

The time taken by the start to complete one rotation is called a 'sideral day'. A sidereal day is equalt to 23 hours 56 minutes and 4 seconds. After one sidereal day the Sun would not have completed one full rotaion, will lag behind by 4 minutes. A Solar Nakṣatra is the Nakṣatra division in which the Sun is situated and the same way, a Lunar Nakṣatra is the division in which the Moon is situated at that moment. A group of stars which appear to be close to one another is called a 'constellation'. 'The Great bear' or the 'saptarshimandala' is one of the commonly known constellation. It constitutes seven stars namely : Marichi, vasishtha, Angirasam Atri, Pulastya, Pulaha and Kratu.

Yoga (योग)

The word yoga means 'addition'. Yoga is calculated by adding the (nirāyana) longitudes of the Sun and the Moon. In sadratnamālā, in the Almanac chapter, we have, सूर्यस्फुटाढ्ये चन्द्रे तु तयोर्योगस्फुटं भवेत्॥ ३। १९, which means the longitude of the moon to which the longitude of the Sun is added is the longitude of the yoga. In other words, the time during which the joint motion of Sun and Moon is 13°20' (which is 1/27th of th zodiac) is called Yoga. If the sum exceeds 360°, then 360° is subtracted from it. This is divided by 13°20' (800'), the quotien is the number of completed yogas. By adding 1 to the quotient we get the current yoga. The length of yoga is also not uniform.

There are 27 yogas. They are: viṣkambha, prīti, āyuṣmat, saubhāgyā, ṣobhanā, atiganḍa, sukarman, dhṛtiḥ, ṣūla, ganḍa, vṛddhiḥ, dhruva, vyāgrāta, harṣana, vajra, siddhi, vyatipāta, varīyān,

parigha, śiva. In our day-to-day life (in our daily sheet calendars that we use now), we can easily spot out yogas as amṛta, siddha, maraṇa, which are determined by combination of some days and certain Nakṣatras.

Karaṇa (करण)

Karaṇa is half tithi i.e, karaṇa is the duration when the angle of separation between Sun and Moon is 6°. There are 60 half tithis in a Lunar month. There are 11 karaṇas. In śaḍratnamālā, we have करणं कृमसिंहाद्य, where we get that the names of the karaṇas begin with Krmi.

They are Krmi, simha, vyaghra, varaha, gardabha, gaja, surabhi, visti, sakni, catuspat, sarpa. Karaṇas repeat from simha to visti, from the beginning of the second half of pratipat of sukla pakṣa till the end of the 14th tithi. The second half of the 14th of krishna pakṣa is sakuni. The first and the second halves of new moon are catuspat and sarpa respectively. The karaṇa of the first half of pratipat of sukla pakṣa is krmi.

The karaṇas are also known as: Bava, Bāvala, Karlava, Taitila, Garaja, Vaṇija, Bhadra. In the Sūrya siddhānta we have the 7th karaṇa named as viṣṭi. These are known as Cāra-karaṇas or variable karaṇas. Each variable karaṇa occurs eight time in a month. They are distributed among 56 half tithis from 2nd half of sukla pratipat to 1st half of krsna caturdasi. There are other karaṇas, which are called sthiti karaṇas and corresponding to the 2nd half of kṛṣṇa caturdaśi, 1st half of the New moon, 2nd half of New moon and 1st half of śukla pratipat. They are known as śakuṇi, catuṣpada, nāgava, kimstughna and kimstughna.

The formula for computing the karaṇa given in śiṣyadhīvṛddhidatantram by Lallā is: Subtract the true longitude of the Sun from that of the Moon and divide the remainder by 360. Subtract 1 from the quotient and divide the remainder by 7. The remainder gives the Karaṇa beginning with Bava. The verse is as follows:

व्यर्कशीतकरलिप्तिकागणा-
दाप्यते करणमभ्रषड्गुणैः।
तद्वरिूपमगभक्तशेषकं
वद्धि शेषवधिरित्र यस्तथिः॥ २।२४

Concluding Remarks

Apart from these five basic units of measurement of time, we also come across bigger Units of time like, paksha (fort-night), Sauramāsa (Solar month), Cāndra māsa (Lunar month), abda (year – Solar, sidereal and tropical) in our daily use. Still bigger units like yuga, Mahāyuga, kalpa, Manvantara, are also well known to the Indian Astronomers. Almost all the Indian Astronomical texts deal with this concept in the madhyamādhikāra (Mean motion of the planets).

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